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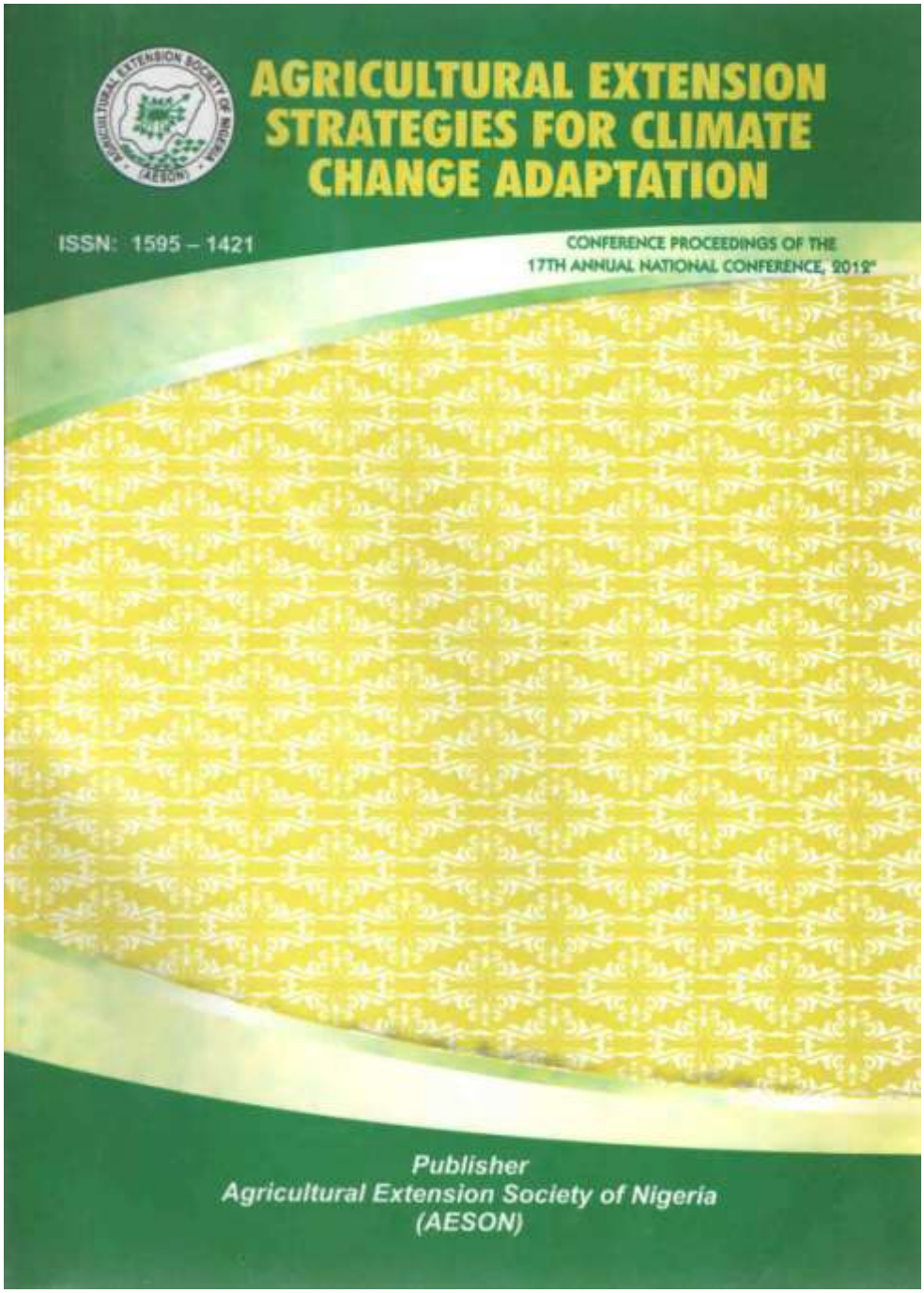
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PROCEEDINGS OF THE SEVENTEENTH ANNUAL NATIONAL CONFERENCE OF THE AGRICULTURAL EXTENSION SOCIETY OF NIGERIA
(11 – 14, March, 2012)

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PREFACE

The 17th Annual National Conference of the Agricultural Extension Society of Nigeria was held at the Princess Alexandra Unity Hall, University of Nigeria, Nsukka, Enugu State, Nigeria from the 11st – 14th March, 2012. The theme of the Conference was: Agricultural Extension Strategies for Climate Change Adaptation. This theme was examined under the following sub-themes:

Sub-themes

1. Climate Change Adaptation Mechanisms, Strategies and Practices
2. Climate Change Adaptation Mechanisms, Strategies and Practices
3. Impacts of Climate Change on Agriculture
4. Impacts of Climate Change on Agriculture/Indigenous Knowledge and Climate Change
5. Policy, Emerging, Women, Youth, Curriculum and Capacity Building Issues in Climate Change Mitigation and Adaptation

Over one hundred papers presented during the conference were peer-reviewed and the 49 papers in this proceeding are those that scaled through the peer review process.

Prof. M. C. Madukwe
Editor-In-Chief

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Agricultural Extension Strategies for Effective Mitigation against the Effects of Climate Change

(Keynote Paper)
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Abstract

Climate change, rapid population growth and stiff competition for available resources threaten human and animal survival. Hazardous climate-change impacts include environmental pollution, global warming, rising sea level and ocean salinity, changing rainfall patterns, water scarcity, disease and pest epidemics, droughts, floods, and decreasing land productivity. These impacts put intense pressure on leaders and followers to improve climate change adaptation and disaster- preparedness by proactively managing available resources prudently using research-based technologies. Effective extension mitigation strategies include sustainable land use; agroforestry; enterprise diversification; restoring denuded and degraded land through reseeding and crop rotation, fertilizer and manure application, reduced-till and no-till cropping, contour farming, terracing, and mixed farming. Also: irrigation; fish farming; growing drought-resistant, early maturing crops; improving pasture and fodder, livestock feed intake efficiency and digestibility; improving and using crop residues as livestock feed; and safe chemical and industrial waste disposal. Others are use of model extension services; raising staff-farmer ratio through group extension methods; incorporating climate-change education in school curricula; and lobbying for good environmental policies through professional associations. Strategies also include resource conservation; water harvesting; establishing hedges; planting trees for shade, beautification, windbreaks, fruits, and timber on farms, homesteads, and along the roads; multiplying desirable animal breeds and plant species; using energy-saving and biological pest control technologies; and funding tree nurseries and community education on climate change. Nursery sowing of sorghum and Finger millet and transplanting when rains begin optimizes available moisture.

Key words: Agriculture, climate change, extension, mitigation strategies, resource conservation.

Introduction

As the world's population growth and competition for scarcely available resources increase, pressure is mounting on leaders and extension service providers in particular to ensure global food security through lasting, sustainable and inclusive rural economic development. The World Bank estimates that demand for food will rise by 50% and for meat by 85% by 2030 while global water use, according to UNESCO, will rise by 32% between 2000 and 2025 (Evans, 2011). In Kenya, for instance, wheat – an important source of food for both humans and livestock – is only second to maize in importance but 50% of domestic consumption requirements are not being met (Gamba, Ngugi,

Verkuijl, Mwangi & Kiriswa, 2011). Kenya, for instance, is still unable to meet its domestic wheat requirements despite the release of over 100 improved wheat varieties since 1927 by Kenya National Plant Breeding Research Centre (Gamba et al., 2011). The leaders are under intense pressure to satisfy human needs for food, clean water, clean air and affordable energy (Evans, 2011; Nordas & Gleditsch, 2007). Water use has been growing faster than the population for over a century and this trend is expected to continue. Global food consumption outstripped production in seven of the eight years between 2000 and 2008 (Evans, 2011). The need to optimize production and value addition of agricultural products particularly among small-scale producers and entrepreneurs who form the majority of the world's poor is becoming increasingly critical to human survival. More than ever before, well-trained, experienced and innovative extension service providers are required to teach farmers better ways of improving farm productivity sustainably using superior, yield-enhancing technologies (FAO, 2011).

Because of their mandate, availability and easy accessibility by farmers for consultations and their genuine commitment to socio-economic development, extension service providers are ideal for educating communities on how to make decisions on capital flow and use of technology in production and value addition. They can assist communities to own change and to take over development processes, technologies, innovations and activities. They can assist communities, through education and by linking them to researchers and other actors in the innovation systems to adapt to the negative impacts of climate change (Anandajayasekeram & Gebremedhin, 2009; Davis, 2009).

Anandajayasekeram and Gebremedhin (2009) have identified four types of innovation systems (IS). These include the National innovation system (NIS), which is a set of policies, organizations and functional institutions interacting constructively to achieve a common set of social and economic goals and objectives. It uses introduction of innovation as the key promoter of change. Second is the agricultural innovation system (AIS), which is a collaborative initiative that brings together stakeholders who work towards technological, managerial, institutional and organizational change in agriculture. Third is the commodity-based innovation system (CBIS), which incorporates various actors, their actions/ interactions and the environment within which they operate. Lastly is the intervention-based innovation system (IBIS), which is usually developed in the context in which the innovation will be applied relative to the nature of problem. Spielman (2006) emphasized that innovation systems provide an analytical framework for exploring complex relationships among diverse actors, social and economic institutions, and technological and institutional opportunities. He challenges claims that technological change drives social and economic development and suggests instead that development is driven by the institutional context in which technological change occurs.

In order to fulfill their community-education role on climate change mitigation strategies effectively and to strengthen community-level disaster-preparedness, extension service providers must first understand clearly the causes and impacts of climate change. The Intergovernmental Panel on Climate Change (IPCC) defines climate change as any change in climate, rainfall or productivity caused by natural variability and direct or indirect human activities that alter the composition of the global atmosphere (IPCC, 2001; IPCC, 2007; United Nations, 1998).

Knowledge of climate change hazards, successes and failures of past interventions may enable extension service providers to recommend feasible adaptation strategies that vulnerable communities can use to minimize the negative impacts of climate change. Adaptability, which aims to moderate the impacts of climate change, is the ability to minimize potential damages or consequences of climate change, its variability or extremes. A poor understanding of climate change issues is partly responsible for unsatisfactory public engagement and inability by extension service providers to move people to action. Secondly, extension service providers must overcome their knowledge and skill deficiencies and inability to appreciate the political, policy, biophysical and socio-economic constraints under which rural and urban communities work.Thirdly, extension service providers must understand the magnitude of the current climate change challenges, practical feasibility and effectiveness of potential mitigation strategies in creating long-term and sustainable positive impacts.

Causes of Climate Change

At the beginning of time, the earth had enough clean air; fresh, pure and safe drinking water; adequate light; good pH; fertile soils; and an abundance of healthy flourishing plants to support all living things. But man's increasingly unsustainable agricultural practices and environmental pollution have led to climate change resulting in land degradation. Effects of climate change are characterized by deforestation; depletion of biodiversity; air and water pollution; global warming; poor governance, increased poverty and food insecurity (Makenzi, 2011; Nordas & Gleditsch, 2007). Human activities, for instance, are behind the formation of the calamitous Katuk-Odeyo gullies in Nyakach area of Western Kenya (Standard on Saturday, 2011, December 3). These gullies are over 30m deep, 30m wide, stretch for 50km and are growing at 500m annually towards Kericho County - a key water catchment area in Kenya. They were largely caused by human-induced clearing of land for farming and human settlement, cutting of trees for burning charcoal, sand harvesting, break making, overstocking in free range cattle grazing, torrential rains and increasing population. Livestock production contributes to climate change directly through production and emission of greenhouse gases (GHGs) and indirectly through destruction of biodiversity, land degradation, desertification as well as water and air pollution.

Challenges and Impacts of Climate Change

Climate change is a serious threat to sustainable development. It is arguably the most important long-term driver of change in the food, water and energy sectors (Evans, 2011; Kisoyan, 2011). It accounts for 90% of the world's natural disasters and causes over 95% of all deaths attributed to natural disasters occurring in developing countries and its cost in Africa could be as high as 7%-10% of GDP by 2100 (ASARECA, 2009; Kisoyan, 2011; Nordas & Gleditsch, 2007). Such disasters are worsened by pollution; over-exploitation and mismanagement of natural resources.

In 2009, they killed over 10,000 people, affected over 119 million others, and caused huge economic damage. They are characterized by low, erratic and poorly distributed rainfall; decreasing water levels in rivers and lakes; acute water shortages; high cost of hydro-electricity due to deforestation and destruction of water catchments; and increased disease and pest epidemics.

Deforestation and bush clearing have made wild fruits rare where they used to exist and wind-related hazards such as roof rip offs more frequent. Drought-induced water scarcity and insecurity have made farming less attractive, investment in farming risky, impoverished rural people forcing some of them particularly the youth to migrate to urban areas in search of alternative livelihood sources. The rural-urban migration tends to increase the work burden of women and youth who are mostly left behind to carry on with farming. These challenges resulting mainly from increased rainfall variability have made planning of farm operations harder

and caused more deaths from water-borne diseases and conflicts over limited resources (ASARECA, 2010: Evans, 2011; Nordas & Gleditsch, 2007).

Water security - defined as people's access to enough, safe and affordable water to satisfy their needs for household use, food production and livelihoods – is vulnerable

to impacts of climate change particularly in developing countries (ASERECA, 2010). This is partly due to their heavy reliance on water-based industries such as agriculture and partly due to low incomes and poor institutional capacity that limit their ability to cope with variations in water supply. Demand for water outstrips supply for 40% of the world's population. The situation deteriorates with increasing population, economic development as well as agricultural and industrial expansion. In Africa where up to 90% of freshwater is used for agriculture, higher temperatures, increased evaporation and lower rainfall reduce water flow by 40% in major rivers causing recurrent drought (ASERECA, 2010; Evans, 2011). Variations in water supply damage crops, degrade land through ***gully formation***, and reduce food production leading to increased malnourishment and starvation as saltwater intrusion in coastal groundwater supplies reduce food security. Rivers in some parts of Kenya, for instance, have become seasonal and borehole water saline or dried up altogether increasing competition between humans and animals at remaining watering points.

The situation could spark violence as most conflicts are related to climate change, whose impacts might kill 184 million people in Africa before the end of the 21st century (Nordas & Gleditsch, 2007). Heat waves caused by rising temperatures increasingly create breeding grounds for malaria-causing mosquitoes in areas where the vector could not survive before (Daily Nation on the web, 2009; Nordas & Gleditsch, 2007). Other climate change related disasters include regular, more frequent and severe droughts and devastating floods that destroy grasslands causing massive livestock and wildlife deaths, widespread destruction of the environment, infrastructure and people's livelihoods (ASARECA, 2009; Makenzi, 2011). Over 4,500 people in Siaya County in Kenya were displaced wh4en River Nzoia burst its banks leaving homes, churches and a police post flooded (Buluma, 2011). A decline in agricultural productivity of rural areas caused by the impacts of climate change may accelerate migration of people to cities increasing unemployment and risk of political instability and conflict (Nordas & Gleditsch, 2007).

Globally, the area of land classified by the IPCC as 'very dry' has more than doubled since 1970s with 19 of the 20 warmest years on record having occurred since 1980 (ASERECA, 2010).

Drought, famine-related stress, food shortages resulting from crop failure due

to poor rains, high food prices, livestock pests and diseases have repeatedly led to increased banditry and cattle-rustling in Kenya's Turkana and West Pokot districts (Daily Nation on the web, 2009). Prolonged droughts often force the Maasai to drive their livestock into cities and wildlife areas in search of pasture (Daily Nation on the web, 2009, July 20). A study on the economic impact of climate change based on 9,000 farmers in 11 African countries found that revenues fell with global warming for dry-land crops and livestock but rose for irrigated crops (ASARECA, 2009). In Africa, irrigation is a practical adaptation to climate change since irrigated farms are less sensitive to climate change.

Impacts of climate change may be biophysical or socio-economic (FAO, 2007; IFAD, 2010).The biophysical impacts include physiological effects that reduce the quantity and quality of crops, pastures, forests and livestock; changes in the quantity and quality of land, soils as well as air and water pollution; increased weeds and pests; and a rise in temperatures, sea level and ocean salinity that endanger marine life (FAO, 2007; Voices Newsletter No. 89, 2009). Socio-economic impacts include decreasing yields, land productivity and marginal gross domestic product (GDP) from agriculture; fluctuating market prices; and changing geographical distribution of trade. They also include increased poverty for people at risk of hunger and food insecurity; human and animal migration; and civil Makalia Falls 2003 Makalia Falls 2009 unrest that lead to conflicts over control of available resources. The Local Initiatives for Biodiversity, Research and Development (LIBRD) points out that erratic rainfall that leads to decreased agricultural productivity and drying of water sources is the most potent impact of climate change (LIBRD, 2011).

Other impacts are global warming; depletion of biodiversity; changes in rainfall patterns and planting seasons; crop failure caused by prolonged more frequent droughts; and increased, often unpredictable floods (Kisoyan, 2011). Climate change impacts are more severely felt by marginalized and resource-challenged communities. If not addressed promptly and effectively they may affect and even threaten a community's quality of life. But the community can overcome them by adapting effective mitigation strategies and having the resilience or capacity to reduce their vulnerability (FAO, 2007; Voices Newsletter, 2009). Adaptation – the complementary response to mitigation strategies - includes all activities that help people and ecosystems to minimize the costs of natural disasters (Business and Industry Advisory Committee to the OECD, 2009; IFAD, 2010). Vulnerability is the degree of susceptibility of an ecosystem or society to the adverse impacts of climate change, variability or extremes (IPCC, 2011). These impacts are felt more severely by poor people who rely heavily on the natural resource base for their livelihoods. Over 40% of the world's population (2.6 billion) lack toilets Standard on Saturday, 2011). Faeces-related cholera and diarrhoea kill 6,000 people in the world daily (Saturday Nation, 2011; Standard on Saturday, 2011).

Overcoming Political and Socio-Economic Constraints

Climate change mitigation campaigners may be highly motivated and determined to excel in their jobs. They may have the best intentions and knowledge of the negative effects of climate change; and an excellent understanding of the consequences of inaction, and adequate knowledge of the appropriate climate change mitigation technologies. But without political goodwill and support from the stakeholders particularly those in power, their

efforts will be less successful. The late Nobel Peace Prize winner, Prof. Wangari Muta Maathai, is an excellent example of a globally recognized environmentalist who received little support and recognition from her country's political elites of the day (Mwangi, 2011). She overcame insurmountable obstacles to remain focused towards the achievement of her goals.

Knowledge and Skills Extension Service Providers Need

Public understanding of climate change and its impacts is generally low and therefore needs to be improved through a focused public awareness campaign (Kisoyan, 2011). In order to overcome the negative impacts of climate change, extension service providers need knowledge of the appropriate climate change mitigation technologies and strategies. They can use this knowledge to advise vulnerable communities on how to adapt. For instance, they need knowledge of how to jointly design and implement appropriate adaptation responses with vulnerable communities. Proper understanding of climate change challenges and how to confront them enhances better planning and use of resources. Extension service providers should therefore focus less on improving farm yields, training farmers, and transferring technology. Instead, they should focus on increasing farmers' capacity to solve problems and to initiate and sustain effective links with producers, markets and other stakeholders in the agricultural product value chain (Davis, 2009). Imparting adult non-formal education should be strengthened by provision of relevant information through print and electronic media (Flyers, Radio and Television, Internet), field demonstrations, and farmer field schools. The focus should be to build community resilience and capacity to respond to climate change hazards; how to proactively work with multiple stakeholders; and how to use soft skills to communicate, build teams, and improve knowledge-sharing networks.

Effective Climate Change Mitigation Strategies

The complex challenges of climate change require innovative solutions developed consultatively. Key stakeholders should meet, share experiences, learn from one another and devise strategies for turning ideas and plans into concrete actions. They should build people's resilience to climate change hazards and should mainstream climate risk management in development by using research-based knowledge to build soil fertility, harvest and conserve rainwater, store farm products safely and rear livestock effectively. Extension service providers should teach farmers skills for dealing with climate uncertainty and variability and for making informed market decisions. They should encourage the use of agroforestry; drought-resistant crop varieties such as cassava, sorghum, Finger millet and yams; maintaining soil fertility; and restoring denuded and degraded lands through reseeding and crop rotation, reduced tillage, no-till cropping, contour farming, strip cropping and terracing. Also, they should encourage protection, maintenance and improvement of biodiversity; integrated crop and animal farming; sequential cropping; enterprise diversification involving, for example, beekeeping or incorporation of less water demanding crops like cassava and yams; and proper nutrient, manure, crop and livestock management. Efforts should be made to promote the development and use of post-harvest technologies that protect farm products from pests and diseases so that they can last longer, in good quality. Based on weather trends, extension service providers should advise farmers on the appropriate time to carry out farm activities for optimum productivity. They should encourage pasture and fodder supply improvement; use of crop

residues for livestock feeding; and tree planting to improve soil and water conservation as well as sustainable household food security and income. They should always ensure that mitigation strategies against climate change are feasible and affordable. Mitigation options in livestock include use of drought-tolerant, faster-growing breeds to improve feed intake efficiency and digestibility; improving farm sanitation; and reducing losses through waste products by finding alternative uses for them. This may, for instance, include production of biogas from animal manure. A higher proportion of concentrate

in the diet reduces methane gas (CH4) emission while for ruminants; pasture grazing reduces CH4 emission from manure. Use of grass species and legumes in grazing lands enhance carbon storage in soils.

Extension is a cost-effective tool that may be used to bring greater economic returns to farmers with significant positive effects on knowledge, adoption, and productivity (Davis, 2009). It has productivity rates of return of 13% to 500%. It may therefore be used to counter the negative impacts of climate change effectively; to help farmers improve their farm productivity and household income; and to move them above the poverty line. However, extension service providers' effectiveness may be compromised by poor preparation, inadequate skills, low staff- farmer ratio, and handling too many things at the same time. In order to incorporate climate change education in their basic training, extension service providers should plan, implement and evaluate their work based on mutually set targets. The best trained, rewarded and motivated among them should be deployed at farm level with the resources they need to do their jobs well.

Being centres of research and outreach, universities should offer model extension services and should initiate and maintain professional associations designed to impact the development of good environmental policies. Where water is available or can be harvested, stored and used for crop and livestock production, extension service providers should encourage use of irrigation to increase farm productivity. In areas of water scarcity, they should advise farmers on how to improve establishment of Finger millet. This would involve establishing the seedlings in the nursery or polythene bags one month before the expected onset of rains, watering and protecting them from birds and rodents until they are 15cm tall. The seedlings are transplanted at the onset of rains to make the best use of available moisture (Kamau, Kavoi, Kirigua, Masila & Nganga, 2011). Seedlings transplanted one per hole at 10-15cms spacing and 45cms between rows produce up to 20 tillers per plant in dry areas, which increases yield compared to low yield obtained under direct planting.

In order to increase the staff-farmer ratio, extension service providers should target groups rather than individuals and should encourage agroforestry and growing of early maturing crops that are well adapted to climate change. They should also encourage farmers to plant hedges around their homesteads instead of using ordinary fences; plant trees for shade, beautification, windbreaks, fruits and timber on farms, homesteads and along the roads; and to use energy-saving and biological pest control technologies. Kelvin Macharia Kuria - a student at the University of Nairobi – has, for instance, developed a shrub-based organic pesticide that paralyzes the system of crawling insects and then kills them. His non-synthetic innovation is environmentally friendly and does not increase GHG emissions.

More information about this innovation can be obtained from kelvin@innovatorskenya.org +254-(0)724173453.

Or kelvinmachariakuria@yahoo.com.

Extension service providers should advise farmers on how to protect rivers, clean contaminated environments, improve and use crop residues such as chopped maize stover as livestock feed especially during drought or prolonged dry seasons, and how to select suitable tree species for specific areas and purposes. They should also advise them on how to select and use appropriate technologies for crop and livestock production and storage to prevent nutrients, environmental weathering water and loss

of harvesting, and conservation multiplication of desirable animal breeds and plant species. Water harvesting is an alternative source of water supply. Water harvesting and storage improves water availability particularly during dry periods. Water transfer increases water accessibility by moving resources from water-rich areas to regions of scarcity. Extension service providers should use the media and faith-based organizations to discourage deforestation and irresponsible disposal of chemical and industrial waste; and to lobby for inclusion of climate change education in school curricular at all levels of education. They should seek more funds for staff and community education on climate change policies, impacts and mitigation strategies; and for developing tree nurseries with capacity to provide enough seedlings for afforestation, which may ultimately increase the amount of rainfall and regulate temperatures. They should seek enough funds for producing and distributing brochures, DVDs and other relevant awareness creating information on climate change.

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Mainstreaming women in Climate Change mitigation and adaptation: Issues for consideration

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Abstract
There is clear evidence that climate is changing. Climate change is a global phenomenon whose impact is felt in every parts of the world. The impact of climate change varies from one country to another or even from one community to another. In some, the impact may be increased flooding which can wash away a whole village and destroy human beings, crops and livestock. In some other places, climate change is in form of drought in which the affected people can no more cultivate crops or rear animals. As climate change impact varies from one place to another, so does it have varied effect on women and men. This is so because socio-cultural differences exist between women and men. These socio-cultural differences have also brought issues for consideration which should be of concern in planning interventions to mainstream women in climate change mitigation and adaptation. This paper looks at various issues that are pertinent to mainstreaming women in climate change mitigation and adaptation.
Key words: climate change, mainstreaming, women, adaptation, mitigation

Introduction

Climate change is a global phenomenon with direct and indirect impact on man. It is recognised that it is those who are already the most vulnerable and marginalised who experience the greatest impacts, and are in the greatest need of adaptation strategies in the face of shifts in weather patterns and resulting environmental phenomena (IPCC, 2007). Children, youths and women belong to the vulnerable and marginalized group. It is the vulnerable and marginalised who have the least capacity or opportunity to prepare for the impact of a changing climate or to participate in negotiations on adaptation. As women constitute the largest percentage of the world's poorest people, they are most affected by these changes. Children and youth – especially girls – and elderly women, are often the most vulnerable (ECA, 2009).

The vulnerable and marginalized group suffers more from the impact of climate change. Masika, (2002) reports that it is commonly recognised that climate change exacerbates existing inequalities in the key dimensions that are not only the building blocks of livelihoods, but are also crucial for coping with change, including wealth, access to and understanding of technologies, education, access to information and resources.

Mainstreaming efforts consider the concerns and experience of women, men, youths, children and vulnerable groups as an integral part of any intervention to improve their lives so that they all benefit equally in such intervention. An understanding of existing inequalities between men and women and how these

constitute issues in mainstreaming of women in climate change mitigation and adaptation is very important.

Lambrou and Piana, (2006) described adaptation as changes in “processes or structures to moderate or offset potential dangers or to take advantage of opportunities associated with changes in climate’’ while mitigation is about preventing or limiting the occurrence of climate change. As such, mitigation focuses on tackling the causes of climate change: the increase of greenhouse gas (GHGs). Mitigation strategies may focus on establishment of tree plantation through various agro-forestry programmemes and less burning of fossil organic materials that release gases into the atmosphere.

According to Soussain *et al* (2003), the fundamental goal of adaptation strategies is the reduction of the vulnerabilities to climate-induced change in order to protect and enhance the livelihoods of poor people.Adaptive strategies in climate change may include adoption of best agricultural practices and use of water and drought resistant varieties of crops, use of irrigation facilities that guarantee all year round farming, and use of pest and disease tolerant/resistant varieties of crops and animals stocks.

Diversification of crop and livestock varieties, including the replacement of plant types, cultivars, hybrids, and animal breeds with new varieties intended for higher drought or heat tolerance that are recommended as adaptation options to climate change are rarely available to such women farmers (Kurukulasuriya and Rosenthal, 2003).

Mainstreaming of women in climate change mitigation and adaptation requires that strategies and interventions recognize issues of differences between men and women and are able to meet the needs of women during such intervention.

Issues for considerations in mainstreaming women in climate change mitigation and adaptation

It is an established fact that gender inequality exist between men and women in the areas of resource control and use, division of labour, technology, access to credit, extension services and information. These inequalities pose challenges in mainstreaming gender in climate change mitigation and adaptation.

Women and access to productive resources

According to Lambrou and Piana (2006), the ability to adapt to change in the climate at the household level depends on control over land, money, credit and tools; low dependency ratios, good health and personal mobility, household entitlements and food security, secure housing in safe locations and freedom from violence.

In rural areas, because majority of the dwellers are farmers, land is more or less the most important productive resource. Women are disadvantaged in the ownership of land (Boserup, 1990). In many rural communities, inheritance law excludes women from inheriting their parents or husband lands. Kwesiga (2002) and Tuyizere (2007) report that, in traditional African societies, women cannot own property as they are considered to be part of the household property. Lack of ownership of land by women retards development and contributes to poverty. Because land in most

families belongs to the men, many women do not have security of tenure, as their tenure depends on the male access givers (Tripp, 2004). When there is natural disaster, land may be destroyed or there may be a need for people to migrate from their ancestral land. Women in this situation are more affected; the little land that is owned by them is lost. Climate change may predispose women to use more marginal land with very low productivity.

In Nigeria, under fertilizer distribution women are mostly excluded from allocations. Fertilizer is the most limiting input for arable crop production because land rotation or shifting cultivation is no more practicable as a result of pressure on land. Women grow arable crops mostly and fertilizer requirement of arable crop is higher than non-arable crops. Inability of women to access fertilizer like men has accounted for their low crop productivity compare to men.

Men and women also have different taste for crops and livestock. These preferences will influence their choices for crops and livestock. In most cases the preference of women and men for a particular crop or livestock is not considered during seed/seedlings and livestock input supply.

Effective mainstreaming of gender in climate change mitigation and adaptation requires that women should have access to land and other productive resources like their men counterpart to participate in rural productions which depend mostly on these. Women should be encouraged to organize themselves into groups to increase their access to land, inputs & credits facilities.

Gender division of labour and climate change mitigation and adaptation

Gender division of labour is determined by culture unlike sex division of labour which is determined by biological characteristics. From country to country and community to community, culture is a major determinant of the roles performed by both men and women. In most African society, culture has put women in a situation in which they perform roles that have made them pre-occupied for most of the time.

Women are faced with the triple burden roles of productive, reproductive and communal unlike their men counterpart (Gladwin, 1991). Productive roles are those roles that people perform as means of livelihood that generate incomes. Men and women engage in productive roles. Reproductive roles include carrying pregnancy and taking care of the children from birth to maturity and other daily home chores. Communal roles are those roles that involve giving helping hands during ceremonies such as wedding, naming and burial ceremonies, and taking care of the community environment (Caroline, 1999).

In some communities, reproductive and communal roles may be optional for men but nature and cultural values do not allow women to have option in reproductive and communal roles. Our cultural ties demand that women give helping hands during neighbours or relatives' ceremonies such as naming and burial. Only women carry pregnancies and breast feed babies 24 hours. This task is highly demanding which leaves very little time for women to pursue productive roles that provide income.

Climate change increases the burden of women who already have triple roles because it has led to reduced food production, reduced water availability, reduced income, increase in disease outbreak and other environmental hazards. Women bear the burden of food production, fetching water and gathering of firewood.

Cropping patterns are changing as a result of climate change. Only very few areas in Nigeria can produce arable crops of short duration such as maize twice during a raining season. The implication of this is that there is no room to spread the burdens of such arable crop production into two times in a raining season. These burdens affect women more because they are the majority food producer in developing countries.

Climate change is a threat to water supply. Most water wells and perennial streams dry soon after raining season is over. One of women's tasks is to provide water for their households, in doing this they trek long distances which increase their burden.

Women are faced with the challenges of taking care of the increased number of sick people resulting from diseases outbreak caused by climate change. When people are displaced, women are faced with the extra burden of looking for food, fire wood and water for the household. Labour saving devices which reduce drudgery involved in the processing activities and enhance productivity should therefore be introduced to women.

Women, credit and climate change mitigation and adaptation

Gurung *et. al.* (2006) reported that women are often less able to adapt to climate change than men since they represent the majority of low-income earners, they generally have less education than men and are thus less likely to be reached by extension agents and they are often denied rights to property and land, which makes it difficult for them to access credit and agricultural services. Moreover, gender biases in institutions often reproduce assumptions that it is men who are the farmers.

When disasters occur the first effect is threatened food security and hunger because the sources of livelihood of people are affected. The most vulnerable to food security and hunger are the women. It is therefore necessary that hunger should quickly be addressed. One way of addressing the issue of hunger may be immediate availability of consumption credit to the affected people. This is followed with production credit which may be necessary to replace lost production assets arising from the disaster.

Agricultural credit is a "blood'' of modern agricultural production. Farmers are generally poor while women farmers are poorer. Credit is needed for adoption of modern technology such as hybrid and improved seeds, traction, fertilizer, herbicides, high yielding animals and value addition. In comparison, it has been established that the rate of loan repayment is higher among women than men. This may be taken that women are better user of credit than men in agricultural production.

In Nigeria, the low level of education, property ownership, information and high level poverty among women have limited their access to credit. Ownership of land in the rural areas shows that land owner is not "alien'' in the society. This increases trust that if credit is given to such a person he will not run away. Sadly, very few women own land in the rural areas. The implication of this is that women may be taken as "aliens'' in their places of births and may not be able to access credit based on this. There are different sources of credit available. Society may frown at women who patronize some of these sources of credit. At most, a woman may borrow from friends and relatives but not to seek credit from sources such as money lenders,

banks and other similar institutions. This scenario limits the sources of credit to women.

For effective gender sensitive climate adaptation:

- Women like their men counterpart should have access to credit for production. Some percentage of total loan portfolio may be assigned to women so as to reduce men dominance of credit which at times may lead to non-accessibility to credit by women;

- The capacities of women should be built to make them user of credit. This may be through technical training on use of resources or special enterprise skills. Financial training about credit management for women will also make them better user of credit. The extension activities that will improve credit use of women and men will promote climate change adaptation; and

- Credit policies should have gender outlook. The planning of any credit project should consider gender differences and challenges in the use of credit. Therefore, the plan should be made to benefit both men and women

Women and information in climate change mitigation and adaptation

Effective climate change mitigation and adaptation requires information on adaptive mechanisms to climate change effects. When people are displaced from their ancestral home they need information about their new environment from government agencies and NGOs that could be of help to them, sources of credit which is germane to climate change adaptation and how to overcome some challenges and problems arising from climate change. These challenges may include outbreak of diseases, selection of new crops and livestock varieties, poor quality water, and sources of input for production activities.

Common sources of information in the rural areas include:

- radio;
- extension agents;
- village gatherings/meetings;
- markets places; and
- visits to other places

Women generally have lesser access to information than men. Radio as a common source of information is owned virtually by every man who in turn has time to listen to radio programmemes. A typical Hausa – Fulani community may be used as a case study on use of radio as a source of information. A typical Hausa-Fulani man does not own a radio for fun; he accesses information from local radio stations as well as international radio stations that broadcast in Hausa language which may provide ample information about climate change and its adaptation. This is unlike a typical Hausa-Fulani woman who in most cases does not own radio and are preoccupied with triple tasks that do not allow them to listen to radio programmemes.

In the rural areas, men usually gather together from time to time to discuss and share information. In addition, men do not have barriers that prevent them from associating or moving from one community to another. In the course of moving from one place to another and through associations, men gather useful information.

Culture and the triple roles of women amongst others are barriers that do not allow them to associate freely. In some society, women, especially married ones, do not visit markets. Market places are good sources of information because markets serve as meeting points for people of diverse backgrounds.

The limitation of women to information should be a concern during interventions that will lead to climate change adaptation. This could be addressed by providing technical information needed by women to operate their tasks efficiently to reduce the risk of climate change. Also, awareness and education programmemes should be aimed towards eliminating socio-cultural hindrances or barriers to women concerning technology usage.

Women, technology and climate change mitigation and adaptation

New agricultural technologies including the replacement of plant types and animal breeds with new varieties intended for higher drought or heat tolerance – are rarely available to women farmers (Lambrou and Piana, 2006). There is a need to consider technology inequalities in climate change mitigation and adaptation. Developed technologies should have gender consideration. When technological adoption is very low it limits climate change adaptation. The reason is that technology plays vital roles in coping mechanisms that people may adopt to cushion the effect of climate change.

Some factors for consideration in gender, technology and climate change adaptation include:

- **The taste of men and women**. Men and women have different tastes. This factor may affect the choice of men and women for technology adoption especially those that have to do with crop and livestock selection;

- **Cost of the technology**. Technology should be affordable for men and women to promote adoption. Women are generally poorer than men. There may be a need to provide special credit facilities that will help the adoption of technology by women;

- **Ease of use of the technology**. Will men and women be able to handle the technology? Will there be a need for a separate technology for women to perform the same task? The biological make up of men and women are different. This difference will affect technology adoption. The design of a technology should consider the nature of women;

- **Cultural consideration**. Does the culture of the place support the use of the technology? This consideration is very important. Take for instance in some places in Nigeria use of pedestrian bridges are not adopted because the culture of the people does not support women using such bridges;

- **The tasks performed by men and women**. Men and women perform different tasks in production activities. Women in most cases are associated with post-harvest activities; and

- **Side or residual effects of such technology**. Does the use of the technology pose health hazard to women? Some technology residual effects are gender specific.

Mainstreaming women into climate change mitigation and adaptation

UNECOSOC (1997) defined gender mainstreaming as the process of assessing the implications for women and men of any planned action, including legislation, policies or programmemes, in any area and at all levels. It is a strategy for making the concerns and experiences of women as well as of men an integral part of the design, implementation, monitoring and evaluation of policies and programmemes in all political, economic and societal spheres, so that women and men benefit equally, and inequality is not perpetuated. The ultimate goal of mainstreaming is to achieve gender equality.

Mitigation and adaptation intervention should therefore:

- have a defined objectives that incorporate gender dimension;
- ensure that the activities identified will include actions to mainstream gender in climate change mitigation and adaptation;
- determine specific activities that address gender inequalities related to climate change;
- identify climate change mitigation actions and strategies with a gender component as well as gender-sensitive adaptation measures;
- include specific actions to combat gender inequalities, especially if such gender inequalities have a demonstrable effect on climate change; and
- verify the capacity of institutions to address gender issues that are related to climate change.

Gender analysis is a key to gender mainstreaming and helps to address the issues of gender equality. According to Ekwoge *et. al.* (1997), gender approach assumes that men and women have different roles in each society and therefore, different interests. The situation analysis of a target group must explain how tasks, responsibilities and rights are divided along gender line.

The summary of key gender analysis steps is given by NZAID (2006).

- Collect sex disaggregated household, workplace and community data/information relevant to the programme/project for each area below.
- Assess how the gender division of labour and patterns of decision-making affects the programme/project, and how the programme/project affects the gender division of labour and decision making.
- Assess who has access to and control over resources, assets and benefits, including programme/project benefits.
- Understand women's/girls' and men's/boys' different needs, priorities and strengths.
- Assess the barriers and constraints to women and men participating and benefiting equally from the programme/project.
- Develop strategies to address barriers and constraints, include these strategies in programme/project design and implementation, and ensure that they are adequately resourced.
- Assess counterpart/partner capacity for gender sensitive planning, implementation and monitoring, and develop strategies to strengthen capacity.

- Assess the potentials of the programme/project to empower women, address strategic gender interests and transform gender relations.
- Develop gender-sensitive indicators to monitor participation, benefits, the effectiveness of gender equality strategies, and changes in gender relations.
- Apply the above information and analysis throughout the programme and project cycle.

Conclusion

Climate change has direct and indirect impacts on women and men. The impacts are more felt by women than men because of economic and socio-cultural differences that exist between them. The existing inequalities between women and men are issues that call for consideration in mainstreaming women in climate change mitigation and adaptation. Women and men have different assigned roles and responsibilities. These assigned roles and responsibilities of women have predisposed them to situation of deprivations. It is necessary that rural developers have information on various inequalities between women and men and how they constitute issues in development.

Some of the issues for considerations in mainstreaming women in climate change mitigation and adaptations are access to resources, women triple roles and gender division of labour, credit, information and technology. The issues should be of concern to rural developers so that inequalities between women and men are bridged.

Recommendations

1. Policies, programmemes, projects' planning and implementation should take into consideration socio-cultural differences between women and men so that such policies, programmemes and projects will benefit women and men equally. Women like their men counterparts are expected to be involved in decision making process.
2. There should be gender sensitization for agricultural and rural development workers (change agents/extension officers). Such workers should understand the differences between women and men and how to take care of women interests in their activities.
3. Collection of gender disaggregated data should be encouraged. This will help to give true picture of situations amongst different gender groups; especially socio-cultural differences between women and men.
4. There should be promotion of equitable access to resources. There should be a special arrangement that will ensure women have access to basic inputs of production. Government at local government level or even state level can acquire land for exclusive use of women for productive activities. The design of micro credit scheme should make provision for certain portfolio to women.
5. The triple roles of women and extra burden brought by climate change are issues for consideration for effective mainstreaming of women in climate change mitigation and adaptation. Efforts should be made to reduce the burden of women. Boreholes should replace local well that easily dry up

during raining season. Early maturing arable crops varieties should be provided so that people can cultivate such arable crops twice during raining season thereby spreading the burdens of production. Irrigation land should be developed that will enable farmers including women cultivate crops all year through. Alternative sources of heat for cooking rather than firewood should be provided for women.

6. Extension activities should have a gender face. Extension programmeme should be conducted where and when women can attend. The triple roles of women and time limit for other activities should be taken into consideration when planning extension activities that will take care of both men and women. Meetings should be held in a place that will make attendance possible for men and women. Where culture may not allow men and women to sit together then separate meetings should be organized for them.
7. Production and processing technology should be gender friendly; for instance in agricultural production activities, technology development should not only focus on tasks that men undertake during production activities. Women perform post-harvest activities mostly. Technology should reduce drudgery of post-harvest and major activities performed by women either in agriculture or other production activities.
8. Smallholder listener clubs should be set up for rural women during a collectively agreed free period daily or weekly. Through advocacy, the capacity of smallholder women farmers would be built to produce episode climate change radio drama featuring series of climate risks and management strategies in local languages.
9. Partnership with telecommunication industries to record and send key messages in local languages and indigenous knowledge that will enable women farmers adapt to climate change.
10. Value addition training for women to enhance market value of agricultural produce should be given adequate attention.
11. Soil based technology training such as land levelling, terracing, conservation tillage, reduced tillage, zero-tillage, application of organic matter to soil, mulching / residue management should be organized for rural women by extension services.
12. On-farm seed priming with simple, low-cost, low-risk technology that hastens germination and seedling emergence should be introduced to women farmers.
13. Practical targeting mechanisms should be developed to promote equality and equity in climate change mitigation and adaptation interventions.
14. Extension outfits should introduce crop varieties that are more droughts tolerant and less affected by time of sowing to women farmers.
15. Special credit scheme for women be established that will address bottlenecks in obtaining credit facilities

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Mainstreaming Nigerian Youths into Ecological friendly Agriculture: Panacea for Climate Change

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Abstract

Climate change, the current global challenge of our time, is an environmental as well as a developmental issue. Climate change has posed serious threats to the attainment of Millennium Development Goals (MDGs) in the developing countries. Attainment of development indices: poverty reduction, food security, economic development, health, human rights, governance and equality as enshrined in the MDGs of the United Nations (UN) are negatively impacted by climate change. This paper observes that developing countries are more vulnerable to the change and suggest that agricultural sector is worst hit. It X-rayed crisis situation in Nigerian agriculture. The challenges of climate change in Nigeria were identified and some possible solutions to the challenges documented. This paper concluded that Nigerian Youths, the forgotten part in Nigeria development agenda, can and need to be effectively mainstreamed into Eco-friendly agriculture as a surest panacea to the threat of global climate change in Nigeria.

Introduction

Nigeria agriculture is bedevilled with serious crisis. Rapid population growth, fluctuation in agricultural produce market prices, interest rate and a host of other factors have frustrated and are still frustrating the efforts of farmers. Farmers' yields have essentially stagnated for decades. Total output has been rising steadily not by developing high yielding technologies but by simply extending the land area under cultivation. The increase therefrom has not commensurately taken care of the food and fibre needs of Nigeria's increasing population. Food production capacity in particular has fallen and the number of undernourished people is increasing by the years. Agriculture is generally typified by continued dependency on uncertainties of rainfall, degraded soils whose nutritional value has been compromised by poor management, underdeveloped markets, the small and scattered farm size holding, farmers lack of management and technical skills, high rate of illiteracy, underdeveloped rural infrastructure, neglect of youth and women farmers; and the scourge of HIV/AIDS. Successive governments in Nigeria have been formulating agricultural policies that had only been providing weak economic incentives to farmers and generally lacking innovative ideas and/or incentives and programs to attract youths into agro-allied careers. Similarly, implementation of such policies had usually lacked necessary business integrity. Agriculture in Nigeria has also been starved of adequate investment. Not only have overall donor aid levels declined, but donor priorities have simultaneously shifted away from agriculture toward other sectors. Despite the Maputo Declaration where African Heads of State agreed to invest 10% of GDP starting in 2010, a majority of African, but also Caribbean and

Pacific countries still do not invest adequately in agriculture and rural development (Hansjorg, 2010). The summary of Nigerian agriculture's annual budgetary allocation between 1990 and 2002 as revealed by the CBN statistical bulletin was between 1.86% and 6.38% which is far below the 10% as agreed by the Maputo declaration. That is partly because government in several African countries merely pay lip service to the multi-dimensional potentials of agriculture towards solving socio-economic and sustainable livelihood problems. Bruno (2010) commented that while African governments, including Nigeria have well understood the need to ensure food security; they do not yet appear to have fully grasped the more global structural challenges and the role that agriculture has to play. For at least the next two decades, agriculture will remain pivotal to Nigerian economies. Its role will of course be to feed an ever growing population and also to provide jobs, distribute incomes and strengthen the continent's productive base. For agriculture to effectively play these roles, the current challenges facing the farmers in Nigeria notable amongst which is climate change must be adequately addressed. Eco-friendly agriculture is a practical means to address the challenges of climate change and the consequential global warming. This can best be approached by attracting and training Nigerian youths for agricultural careers; otherwise the attainment of Millennium Development Goals in Nigeria may turn out to be ordinary mirage in the long run.

The emerging challenges of climate change in Nigeria

It is very evident that the world is currently facing a complex set of challenges from climate change. While agricultural sectors in temperate and polar countries may appear to benefit from the change, tropical and sub-tropical agriculture, especially in Nigeria and other African countries are more vulnerable to the change (Mendelsohn, Ariel and Arne, 2000). However, effects of climate change on Nigeria Agriculture are expected to differ across the agro-ecological zones. The climate conditions are quite different as precipitation varies across the zones. Rain forest of the southern Nigeria is very moist, whereas the Northern Nigeria is mostly semi-arid to arid. Similarly the temperatures also vary with Northern Nigeria being the warmest regions, while Southern parts of Nigeria are more temperate. Climate change problem is adjudged to be severe in African countries, including Nigeria because current level of knowledge and information is poor, technological change has been the slowest while the domestic economies depend heavily on agriculture. The implications of climate change for the attainment of Millennium Development Goals whose prime is to eradicate extreme poverty and hunger, especially in developing countries where resilience is low, are obvious. These include:

- **Vulnerability of agricultural activities**

Agricultural production and food security, access to clean and abundant water resources and gainful employment that underpin the solution to extreme poverty and hunger are vulnerable to climate change. Climate change threatens to destroy infrastructural facilities, increases the displacement and migration of families, especially the able bodied youths and thus disrupting and limiting productive capacities of farm family members.

- **Vulnerability of women**

Women, the very marginalised in the use of agricultural resources, are also very vulnerable to climate change. Climate change has put to high risks the resources

they need and depend on to fulfil their traditional roles as mothers, home managers, lovers and caregivers.

- **Climate change and human health**

Climate change is worsening human health mainly through increased vulnerability to poor health due to reduced food and water security; increased incidence of water-borne diseases associated with reduced water quality; more favourable conditions for the spread of vector-borne and air-borne diseases; and higher incidence of heat stress due to increased temperature. Diseases such as malaria, tuberculosis (TB) and HIV/AIDS have strong impacts on farmers' ability to work and can create absenteeism or low performance due to illness. Costly medical care and time taken off to look after sick relatives is another drain on household income.

- **Threatened sustainable environment**

Resources upon which the "rural poor" in developing economies depend are being progressively threatened. Climate change threatens environmental sustainability. It has caused fundamental alterations in ecosystem relationships; it has changed the quality and quantity of available natural resources and has also reduced ecosystem productivity. The "poor farmers" in Nigeria do not help the situation, either. In search of livelihood, they have embarked on intensive logging of forest products (deforestation), especially varieties considered sacred and associated with rain making in some communities, thereby further exposing farmlands to hazards of climate change.

- **Challenges to achievement of Millennium Development Goals**

Climate change threatens to exacerbate current challenges to the achievement of the MDGs. Some climate change factors such as temperature, precipitation, sea level rise, atmospheric carbon dioxide content and incidence of extreme events also affect the agricultural sector. Reduction in agricultural productivity and crop yields is being experienced especially in some agricultural zones, where crops have reached their maximum tolerance. Crop yields decrease due to an increase in the temperature. Increase in temperature has also aided the astronomical growth of pests that are detrimental to crop production. Quantity of water now available for use in most parts of Nigeria is limited due to inadequate rainfall or irregularity in rainfall pattern as a result of climate change.

"Last cropping season, rain refused to fall between August and September when we normally have it sufficiently. This led to the failure of my maize and soya beans farms. I thought I would make it up in cowpea, but rainfall was even too much around October when we farmers don't need so much of it for our cowpea. We really suffered!" (Mrs.Olatunji. personal communication. June 2011)

Climate change increased livestock production cost and output directly. The difference between heat production and heat dissipation is so high that it resulted to heat stress. The availability of feed and fodder are also indirectly affected. In Nigeria, Fulani herdsmen found it extremely difficult getting pasture to feed their flock. Most livestock farmers also experience same thing. Extra cost has to be incurred on feed supplement like maize offal which automatically increases the cost of production.

"Heat stress has significantly reduced my egg outputs and my income recently. I had expended more on drugs, especially antistress and antibiotics to combat the

excessive heat which was never experienced in the many years of my poultry production business. Even this year my groundnut residue is not enough to feed my livestock because the crop didn't do well" (Mallam Audu. personal communication. March 2011). His experience typifies that of several other farmers.

Climate change had increased the incidence of vector and vector born diseases in Nigeria, where an increase in temperature and humidity freely create ideal conditions for malaria, sleeping sickness and other infectious diseases that directly affect the availability of human resources for the agriculture sector. This conspicuously affects farmers' productivity in Nigeria in recent periods.

"We frequented our local hospital in this past five years more than before. My children, wives and farm labourers frequently complained of one illness or the other. A lot of the times when we were supposed to be in the farm working, we were in the hospital" (Bro. Ernest. personal communication. November 2010). This complainant who is head of farm household in Ikeduru Local Government Area of Imo state, Nigeria could as well as be speaking as representative of others

In essence, farmers have been shown to be very vulnerable to climate change. Payson (2008), reported the obvious when he said that the poor, especially the rural poor who depend on natural resources for their livelihood, are the most vulnerable to environmental shocks and stresses. He reported further that climate change by itself will seriously degrade many of the natural resources and ecosystems on which these people and the communities depend for their livelihoods. He stated that climate change will expose an additional 75-250 million people in Africa to water shortages and that 300 million Africans already live in drought or drought-prone areas. The inability to adapt to the changes in climate is more devastating to the agriculture sector, the main source of income, employment and sustainable livelihood to the majority of the population in Africa. Nigeria undoubtedly is one of the African countries whose agriculture, a major source of livelihood to many is susceptible to the scourge of climate change.

The utmost concern therefore is a better understanding of the impacts and proper identification of strategies to mitigate or and to adapt to its detrimental impacts of climate change.

Tackling the challenges of climate change in Nigeria

Tackling the challenges of climate change in Nigeria requires effective collaboration of all stakeholders in Nigeria agricultural development i.e. the Government, Civil Society, Farmers' Groups, Private Organisations, Non Governmental Organisations (NGOs), Community and Faith Based Organisations (CBOs, FBOs). Effective solutions should be integrated. However, effective implementation of the following recommendations by the development partners would help in effectively surmounting the challenges of climate change in Nigeria:

- **Provision of farmers with quality but cheap production resources**

Rights to land, water and all production resources should be guaranteed to farmers at the cheapest cost to ensure positive livelihood for them. This demands that the land use decree and acts which define rights of human being to access and use land be reviewed in regions where such acts limit the productive capacities of farmers.

- **Integration of climate change initiatives into Millennium Development Goals development plans**

As a matter of policy, climate change initiatives must be effectively integrated into national Millennium Development Goals-based sustainable development plans by developing countries as part of their contribution to global climate change mitigation. This should also be done at the regional or agro-ecological zones of Nigeria.

- **Proper identification and prioritisation of energy resources**

As a matter of necessity, Nigerians should carefully identify and prioritize all their energy resources, especially the renewable ones. All stakeholders in agricultural development in Nigeria should be ready to assist in this task and fill in the gap.

- **Proper utilisation of aids from developed countries**

Developed countries should ensure that they meet their aid commitments to achieve the Millennium Development Goals and also be ever ready to make available extra aid in kind and cash when new measures to tackle climate change are discovered. Global institutions need to redouble their efforts to scale-up investment and provide development aid especially in African countries where climate change is threatening the lives and livelihoods of impoverished families and their prospects for a better life. Such aids, when accessed, should be properly harnessed and judiciously utilised in Nigeria.

- **Adoption of effective mitigating and adaptive technologies**

Through effective collaboration, developed countries should also ensure effective transfer of existing and workable technologies discovered to effectively mitigate climate change to the developing countries. New discoveries that are adaptable should also be adequately transferred to African, Nigerian and other developing economies for adoption. Researchers in Nigeria should also take up the challenges of developing cost effective and culturally compatible adaptive technologies for Nigerian farmers to adopt.

- **Strengthening of Research activities across Nigeria**

For researchers to develop effective climate change adaptive technologies, research activities should be further strengthened in Nigeria. Current efforts across African countries are yielding good results. In South Africa, small scale farmers have set up traditional food seed banks to help them combat climate change. It was discovered that seeds developed over generations were better suited than commercial hybrids to withstand drought and pest. Vegetable gardening using treated waste water is providing a welcome cash stream for urban farmers in Zimbabwe. The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) has worked to develop and distribute improved varieties of millet, sorghum and groundnut in West Africa. In Kenya, research has produced a variety of pigeon pea adapted to shorter rainy seasons. To replace the staple maize, farmers in Kenya, Malawi, Tanzania and Uganda have embraced this variety of pigeon pea. The Africa Rice Center has developed New Rice for Africa (NERICA), a rain fed rice that combines the drought tolerance of African varieties with the high yields of Asian varieties. The World Vegetable Center and ICRISAT have teamed up to couple the development of improved local vegetables with simple and inexpensive irrigation systems that use little water. An improved variety of high

yielding tomato is becoming widely grown in Niger. Malawi has followed Angola, Swaziland and Zambia in launching two new disease resistant maize varieties: ZM 309 and ZM 523. The move is part of the drought Tolerant Maize for Africa (DTMA), a joint programme of the International Maize and Wheat Improvement Center (CIMMYT) and the International Institute of Tropical Agriculture (IITA). The limiting factor in the diffusion of all these new varieties is cost. Apart from financial Aids from willing developed countries, government in Africa, and especially Nigeria should provide financial Aids and other necessary assistance to farmers in this direction. Functional linkages for research should be established among the international, national and local agro-based research organisations in Nigeria to fight the scourge of climate change.

- **Implementation of deep emission cut in Nigeria**

Development stakeholders in Nigeria should create incentives for farmers and other Nigerian citizens to limit their emissions of carbon dioxide gas while safeguarding their right to development and as a matter of urgency also implement deep emission cut.

- **Institution of New Partnership for Nigeria Development**

New Partnership for Nigeria Development (NPND) should be instituted. This should perform functions that are very similar to New Partnership for Africa Development (NEPAD). The instituted NPND should not pay lip service to implementing programmes that will liberate Nigerians and reduce unemployment, poverty and other socio economic vices.

- **Agro forestry and other conservative practices should be encouraged**

Agriculture has been undervalued and underestimated as a means to combat global climate change. Soil carbon data show that regenerative organic agricultural practices are among the most effective strategies for mitigating Carbon dioxide emissions. Crops will not thrive well if the environment is not conserved. Agro-forestry practices and mixed farming to fight soil erosion and conserve biodiversity through sustainable agriculture should be practised by farmers in Africa. Therefore, adoption of organic or eco friendly agriculture above and on top of conventional traditional agriculture in African countries should be given immediate priorities.

- **Ecological friendly Agriculture should be encouraged in Nigeria**

Ecological friendly agriculture otherwise called organic or sustainable agriculture is a sure panacea to climate change in Nigeria. Organic farming is a complete self reliant system of agricultural production with little or no requirement of conventional inputs. It emphasises the use of management practices in preference to the use of off-farm inputs. This is accomplished by using, where possible, agronomic, biological, and mechanical methods, as opposed to the use of synthetic materials, to fulfil any specific function within the system. Organic agriculture will bring about the desired revolution against the climate change effects on Nigeria Agriculture. However, it will require that stakeholders in agricultural revolution and promotion in the country provide the desired, highest level of commitment.

From the forgoing, it is evident that organic agriculture has the potential to contribute to ecologically sustainable, socio-economic development of Nigeria. It also has the potential to facilitate the conversion and the use of “waste local

resources" e.g. cattle dung or manure; household manure etc, to create "wealth" and enhance cost reduction and cost-effectiveness in agricultural production while at the same time preserving the ecosystem. Eco-friendly Organic farming can produce enough food on a global per capita basis to sustain the current human population in Nigeria, and potentially an even larger population, without increasing the agricultural land base. However, achieving a purely organic, eco friendly, sustainable agriculture in Nigeria is bedevilled with numerous challenges.

Challenges of purely ecological friendly Agriculture in Nigeria

- **Provision of enough food**

Food security and its relationship to sustainable agriculture and rural development have increasingly become matters of concern for developing countries and for the international community. Michael (2010) reported that the world population is expected to grow to nine billion by 2050 and that productivity needs to increase by about 70% from current levels to meet projected demand. This poses a huge problem for the food industry. With Nigeria population estimated at about 150 million according to 1991 National Census, with organic agriculture being adopted sole in Nigeria; farmers would be faced with the challenge of how to provide enough food without clearing environmentally valuable forests.

Crop rotation in succession is another agricultural practise which guarantees the success of organic or sustainable agriculture. However, farmers have to deal with some specific environmental conditions like rainfall, restricted access to farmland which may make crop rotation difficult.

- **Inadequate information on eco-friendly agriculture**

Quality information enhances informed decision. Information and other resources on organic, sustainable, eco friendly agriculture are still inadequate. In Nigeria, poor literacy level of farmers and farm location in remotely rural communities limit the farmers' access and capacity to apply useful and relevant research results which would have been helpful in the practise of eco-friendly organic agriculture. The best route to overcome this constraint is to attract and capacitate appropriately trained youths into agro-allied careers.

- **Quantity of organic matter required**

Organic farming would most likely suit small producers, but for large scale producers, activities involved in organic agriculture may not be easy and suitable. Compared to inorganic fertilizer, larger quantity of organic material is required per hectare of farmland. Apart from this, Organic farming is also highly labour intensive. This may however be viewed as a plus because it will offer greater opportunities for rural employment.

- **Challenge of getting enough nutrients for plants**

Plants need macronutrients such as nitrogen, phosphorus, and potassium, as well as micronutrients and symbiotic relationships with fungi and other organisms to flourish, but getting enough nitrogen, and particularly synchronization so that plants get enough nitrogen at the right time when plants need it most from organic sources, is likely a greater challenge for organic farmers.

- **Organic weed control**

Challenges of total weed control without use of synthetic herbicides are experienced in organic farms. Organic weed management promotes weed suppression, rather than weed elimination, by enhancing crop competition and phytotoxic effects on weeds.

- **Meeting the standard Required of organic farming**

Organic standards require rotation of annual crops, meaning that a single crop cannot be grown in the same location without a different, intervening crop. Organic crop rotations frequently include weed-suppressive cover crops and crops with dissimilar life cycles to discourage weeds associated with a particular crop. Farming systems in Nigeria and fragmented nature of farmland holding may discourage most rural farmers in Nigeria to conform to this standard.

Strategies for surmounting the challenges of eco-friendly Agriculture in Nigeria

The challenges of eco friendly organic agriculture are not insurmountable. A unified effort on the part of the farmers, the industry, the government, environmentalists, and the public is required to propagate eco friendly agriculture among rural farmers in Nigeria.

- **Intensification of research efforts in Nigeria**

In Nigeria, research efforts and farmers' efforts to fertilize their farmland with organic matters are on, but should be intensified. In Zimbabwe, livestock are being used as a tool to restore degraded land. At the Africa Center for Holistic Management (ACHM) developed by ecologist Allan Savory, a scheme dubbed operation Hope is reversing desertification. Holistic management involves combining animals into large herds to harness the power of their hooves to break up hard ground so that air and water can penetrate. The livestock trample on old grass so the soil is covered and less prone to the drying effects of sun and wind. The animals dung and urine helps fertilise the soil and controlled grazing keeps perennial grasses healthy, minimising the need to burn them and expose soil. In some cases where there is need to amend soil pH, natural pH amendments strategy include the use of lime and sulphur. Farmers in Nigeria should be helped to adopt simple and cost effective organic farming technologies that work in the other African countries.

- **Revitalisation of mixed farming system**

Mixed farmers stand a better chance of success as organic farmers since organic manure from their livestock can provide the required fertilisation for organic agricultural production. In this case, farmlands are fertilised through nitrogen-fixing grasses and cereals, agro forestry trees and economic crops can be grown when fertility is established. Crop rotation and green manure or cover crops also help to provide nitrogen through legumes which fix nitrogen from the atmosphere through symbiosis with rhizobial bacteria. Intercropping, which is sometimes used for insect and disease control, can also increase soil nutrients, though there may be competition between the legume and the other crop. Wider spacing between crop rows is required. Crop residues can be ploughed back into the soil, and different plants leave different amounts of nitrogen, potentially aiding synchronization. In Senegal, women farmers group had long notice that saline soil was becoming more fertile in places where organic waste had been thrown. They spread household

waste including millet bran, groundnut shells and residue left after threshing on the saline soil where they grow organic rice. Weeds and crop residue are left in the rice fields and worked into the soil soon after the first rains. In addition to adoption of simple and workable, almost cost free agricultural practices for rice production as done by women in Senegal, farmers should be encouraged and helped to embrace and modernise mixed farming for a successful organic agricultural practices.

- **Minimisation of the use of synthetic herbicides**

Organic farmers can integrate cultural, biological, mechanical and physical methods to manage weeds without applying synthetic herbicides. Mechanical and physical weed control practices used on organic farms include: Tillage – This involves the turning of the soil between crops to incorporate crop residues and soil amendments; remove existing weed growth and prepare a seedbed for planting; Cultivation - involves disturbing of the soil after seeding; Mowing and cutting - involves removing top growth of weeds; and Mulching – involves the prevention of soil water to the atmosphere through evaporation and blocking of weed emergence with organic materials like saw dust etc. For Nigeria to make headway through eco friendly organic farming and thereby surmount the challenges of climate change the missing gap “the neglect of Nigerian youths in the development agenda” need be properly bridged. The great bulk of today’s 1.2 billion youth are in developing countries (Carl Haub, 2010). World Bank’s report (as cited in Spores, 2010) identifies youth unemployment and underemployment as a serious threat for social instability and argues that creating jobs for young people is a precondition for Africa’s poverty eradication and sustainable development. In spite of growing rural-urban migration, however, more youth still live in rural areas. World Bank report further reveals that the average youth is not an urban migrant from the countryside, but a poor, literate, out of school female living in a rural area, a factor that highlights the importance of focusing development on rural youths and women. For the attainment of eco friendly agriculture as a panacea to climate change, Nigerian youths, male and female; must be effectively mainstreamed into development agenda. They have been forgotten long enough and that is why conflict, war, hooliganism, prostitution, political thuggery and the likes thrive in Nigeria.

Strategies for mainstreaming youths into ecological friendly agriculture in Nigeria

Youths represent a disadvantaged and marginalised social group, being over-represented among the global poor and unemployed. As such "pro-poor" strategies must be "pro-youth". Any development intervention seeking sustainable impact must address the youth cohort. Agriculture is sadly not been made attractive to the youth. It is seen as a poor man’s sector and not as a business or as income creating opportunity. That perception need to change. The prospects of so many youths could present a window of opportunity, if the right investments are made in education, health, rural agricultural development and training. Making farming more rewarding to the Youths and life in agricultural areas more attractive should be one of the priorities of Nigeria Heads of government at all levels. These can be given special consideration:

- **Educational and cultural services**

Governments should enhance educational and cultural services and other incentives in rural areas to make them more attractive to youths. Experimental

farming programmes directed towards youths should be initiated and extension services expanded to maintain improvements in agricultural production, processing and marketing.

- **Collaboration of governments with other development organisations**

Government at all levels-The State and Local, in collaboration with NGOs, CBOs, FBOs, Research institutes and Youth organizations, should frequently organize agricultural events that enhance exchanges between urban and rural youth. Youth organizations should be encouraged and assisted in organizing seminars and meetings in rural areas, with special efforts to enlist the cooperation of rural populations, including rural youth. These will arouse the interest of more youths and would be absorbed into agriculture.

- **Provision of land grants and other support services to youths**

Grants of land should be provided to youth and youth organizations. This should be supported by financial and technical assistance and training. Governments, consistent with their rural development schemes and with the assistance of international organizations, as appropriate, should work with volunteer youth organizations on projects which would enhance and maintain the rural and urban environments.

- **Training of youths in eco-friendly income generating agricultural enterprises**

Training programmes directed towards improving methods of agricultural production, processing and marketing should be developed for youths. The training should be integrated and based on rural economic needs and emphasise various techniques of rural enterprises production and processing. It should also emphasize adoption of all strategies that will make eco friendly, organic farming on a large scale easy and possible. The aim of the training should be properly directed to make income generation by youths and their contribution to food basket possible, and hence attractive to youths. The training programmes should be such to encourage active participation of both young men and women, to improve youth retention in rural areas, to facilitate youths urban to rural migration, to adequately empower youths with special disabilities, street and helpless youths, youth living with special disease such as HIV/AIDS and those in conflicts prone areas.

Leventis foundation agricultural training school experience in Nigeria

Efforts of Leventis Foundation Nigeria Training Programme are fashioned towards the recommended strategies and have been found to be productive and successive. Success stories of youths who had been trained and are now economically independent abound. Leventis Foundation is a Non Governmental Organisation in Nigeria established and owned by the family of Late A.G Leventis. The NGO has the mandate to sustainably contribute to Nigerian food basket through the training of Youths in modern, integrated and eco-friendly agriculture and agric-based income generating enterprises. The training which is free of all costs (including tuition, feeding and accommodation with modest monthly stipend for the trainees) is designed to attract youths, male and female into productive income generation in agriculture. The training curriculum is structured to incorporate organic farming and to teach youths to be conscious of environmental conservation. The training has been successful for the past 24 years of its existence, and it has been solely funded

by A.G Leventis family. This programme has bridged the gap and has been providing necessary training and competencies needed by youths to manage farm business profitably. From inception to date, more than 5,000 youths usually referred to as modern farmers in Nigeria have been rolled out by the training programme. These have become role models to other youths and have served as catalyst to improved production practices and have enhanced productivity among aged farmers in their various communities. Consequently, agricultural production practices in rural Nigeria have gradually improved and are still improving yearly. There is now a paradigm shift from traditional or conventional agricultural practices to more eco friendly organic practices with attendants' improvement in the standard of living of the youths and aged farmers in Nigeria. This training programme is worth adopted by and replicated for all states in Nigeria, with little modifications depending on different state. This requires effective collaboration of all stakeholders in Agriculture in Nigeria with adequate financial aid and support from the federal, state and local government. Non Governmental Organisations, local farmers and Institutes of Agricultural education should take very active part in this arrangement.

Conclusion

Climate change cannot be addressed without consideration for the increased energy need of the people. Poverty cannot be addressed without accounting for the effects of climate change on agriculture which is the most reliable source of livelihood, especially for the rural poor in Nigeria. Both rural and urban economies have demand for energy and both must work together to reduce national poverty. Climate change should not be viewed as war situation between developed and developing economies at global level, and rural and urban economies at the national level. This period should be viewed as time for both to advance the course of humanity through joint provision of effective and lasting solution to the scourge of climate change. All stakeholders in Development must come out united to sustainably tackle the challenges posed by climate change to ensure the attainment of MDGs. Nigerian leaders must as a matter of urgency legislate the mainstreaming of Nigerian youths into eco- friendly organic agriculture. Otherwise climate change will compound the already existing crisis in Nigeria Agriculture.

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Influence of Climate Change on Biodiversity Conservation in Nigeria

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Abstract

Modelling studies combined with experimental evidence of species tolerances point to significant changes in ecosystems, principally due to increasing temperature and altered precipitation regimes. Likely distribution changes include pole ward shifts, especially in none equatorial regions and upward shifts in montane systems where lack of space at higher altitudes may cause some systems to disappear entirely. Ecosystem distribution changes are also large and more complex in the tropics where effects of rising temperatures and reduced participation are exacerbated by effects of land use change. Drier conditions are expected to cause savanna ecosystems to move into equatorial regions now occupied by forests. At the species level, 484 plants species in 112 families of the 4,600 plant species are endangered in Nigeria. About 205 of the species are endemic. Current estimates also suggest that 400 – 500 vertebrates, about 100 invertebrates, and approximately 650 plants have become extinct in the past 400 years. Also 12% of birds, 24% of mammals, 30% of fish and 8% of plants are already threatened with extinction. Current extinction rates are much higher than the rate at which species evolves. In view of these, it has become important that efforts be made to reduce the major facilitators of climate change and causes of biodiversity loss locally.

Introduction

The Intergovernmental Panel on Climate Change Report (IPCC AR4; IPCC, 2007) concluded that climate change will have significant impacts on many aspects of biological diversity; on ecosystems, species, genetic diversity within species and on ecological interactions. The implications of these impacts are significant for the long term stability of the natural world and for many benefits and services derived from it. Climate change is a major threat that already has an observed impact on natural ecosystems. Global average temperatures have risen by $0.7^{O}C$ over the last century, and, are predicted to continue rising. The IPCC (2007) projects that average temperatures are likely to rise by $1.1^{O}C$ to $6.4^{O}C$ by the end of the 21^{st} century relative to the 1960 – 1999 baselines. Temperature rises are linked to changes in precipitation regimes. Increased incidence and severity of extreme events, such as catastrophic rainfall and drought are also likely. The local climate regimes comprising the full suit of climate variables are what influence the survival of species and ecosystems. With climate change, areas of rare climates are likely to shrink and may result in loss of rare endemic species (Ohlemuller et al, 2008). Other consequences of climate change that are critically important for many natural systems are sea level rise and the melting of Arctic Sea Ice which have been observed globally and are projected to continue (IPCC, 2007).

Atmospheric concentration of carbon dioxide can themselves have important direct influences on biological systems, which can reinforce, or act to counter responses to climate variables. The direct effects of elevated atmospheric CO_2 are especially important in marine ecosystems and in terrestrial systems that are not water limited. In view of the importance of climate change on biodiversity loss, the high level European Commission Conference in Athens, Greece recognized close links between climate change and biodiversity loss and the fact that neither can be solved without the other.

It is however important to stress that climate change is not the only pressure acting on natural systems and its effects are strongly dependent on interactions with other pressures. Land use change and the attendant habitat loss are currently major threats to biodiversity worldwide. They reduce organisms abilities to adjust their distributions in response to changing climate. They also produce local amplification of some climate change effects by causing fragmentation, degradation and dying of ecosystems (Barlow and Peres, 2009).

Climate change and land use change, including agricultural expansion, interact to increase the incidence of fire (Aragao et al, 2008), which is often raised further during extreme climate events. Pollution is also likely to amplify many impacts of climate change as is mining and oil and gas development (Fuller et al, 2008). In Nigeria, there are more than 123 gas flaring sites, making Nigeria one of the highest emitters of greenhouse gases in Africa (Akinro *et al*, 2008). Research has indicates that the impacts of climate change on agriculture and natural resources management will be felt more in countries of Africa, Asia and Latin America (Speranza, 2010). Because of the low adaptive capacities and the projected impacts of climate change, a consensus has emerged that developing countries are more vulnerable because of their predominant dependence on rain fed agriculture, scarcity of capital for adaptation measures, their warmer baseline climates and their heightened exposure to extreme events (Fischer *et* al, 2005; Nnamchi and Ozor, 2009). In this paper, the effects of climate change on biodiversity are considered in the context of interacting pressures.

Methodology

This study was carried using extensive information from research work on influence of climate change on biodiversity by experts. As much as possible emphasis was laid on work carried out by experts in the subject area in sub Saharan Africa.

Objective

The main objective of this work is to provide state of art information on the influence of climate change on biodiversity conservation in Nigeria for research community and policy makers. This is expected to guide future research work in the areas of biodiversity conservation and to provide impetus for national planners in Nigeria on the influence of climate change on biodiversity.

Climate Change and Phenology

Changes in phenology as a result of temperature and precipitation variations have been reported in Europe. Studies indicated that 78% of the 65 species of birds examined commenced breeding earlier. In North America, breeding of the snow goose was advanced by 30 days while in Central America, Mexican jays

commenced breeding earlier (Brown et al, 1999). Similar scenarios have been observed with amphibians, and butterflies that starts breeding earlier (Beebee, 1995). The geopolitical range of many species is determined by climate and of recent, there has been a northward movement of species range boundaries in agreement with global warming in birds, mammals and butterflies (Thomas and Lennon, 1999). In mountainous areas, climate changes rapidly with elevation (approximately $1^{O}C$ per 160m) than it does with latitude (approximately $1^{O}C$ per 150km) (IPCC, 1996). As a result rapid changes in mountain biota are expected as climate changes.

Loss of biodiversity

Nigeria's First National Communication (FNC) (2003) identified the nations natural ecosystems, agricultural ecosystems and water resources including coastal and marine ecosystems as highly susceptible to climate change impacts. These include:

(i) Over 850sq km^2 coastal line which harbors highly diverse flora and fauna and important spawning grounds;

(ii) Northern Nigeria which is experiencing increasing drought leading to accelerated desertification and water scarcity;

(iii) The nation's forest resources which mostly occur in the southern part of the country.

Biodiversity include all plants, animals, microorganisms, the ecosystem of which they are part and the diversity within species and of ecosystems. Forest ecosystems which also constitute a biodiversity provide a wide array of goods and services. Approximately 11% of the total area of the country is reserved forest estate. Out of this, 80% is savanna woodland and 20% (or 2% of the total land area is high forest; which produce the bulk of the country's timber. Within this area, swamp, riparian and mangrove forests occupy 369,080 ha; rubber, oil palm and raphia palm occupy 44.379 ha; while others (mosaic forest swamp farmland) occupy 315,632 ha. Within the natural forests, there are many non timber species, herbs, and shrubs of major economic importance as producers of food, fodder, fibre, drugs, wild fruits and other commodities of importance to the rural economy (Okafor, 1980a, 1980b).

A considerable part of Nigerian forest is being destroyed through incrimination and reckless logging of timber, extraction of non timber forest products and log transportation. Nigeria is traversed by a variety of raw materials, most especially, those of agricultural origin. The development of the raw materials is hindered by lack of adequate attention, inefficient policy direction and implementation, coupled with lack of knowledge of the production, processing and utilization of some of the raw materials. For instance, between the root crops of the South and the grain crops in the North there are over 300 edible plants in Nigeria (NEST, 1991). Only a few of these crops, perhaps less than 20 are handled in real large tonnages.

Some of the major raw materials that can provide the fulcrum for expanding the nation's foreign exchange generation base are the timber and non timber forest products (NTFPs). However, despite the economic and social importance of these products, the sector has remained predominantly characterized by inefficiency and low productivity due to inefficient policy directives (Bee and Mc Mermott, 1989; FAO, 1983, 1994a; Gupta and Guleria, 1982).

To compound the problem, as a result of pressure on the resources, forest products are being depleted at an unprecedented rate due to increasing human population pressure and demand. In Nigeria, approximately 400,000 ha of forests are destroyed or seriously degraded annually, principally, through agricultural expansion, uncontrolled livestock grazing, logging and fuel wood collection. As a result, there is real possibility of extinction of many indigenous plants species through deforestation and forest degradation. Gbile *et al* (1981) reported 484 plants species in 112 families of the 4,600 plant species in the country to be endangered. About 205 of the species are endemic and their loss will mean extinction from the earths surface (Okafor, 1993). These development is impacting negatively on rural economy as a result of aggravated poverty as the economy of households of people living in rural communities depend on forest products (Clarndom, 2001; Belcher *et al*, 2005; FAO, 2006). At the national level, the importance of NTFPs to expanding the foreign exchange generation potentials locally cannot be overemphasized. During reckless deforestation a considerable number of wild animals are killed and their habitats destroyed, altering their feeding and grazing patterns. In Nigeria animal biodiversity is concentrated in the savanna and the high forest. Although a few detailed studies have been conducted on the effect of climate change on terrestrial animals in Nigeria, Hulme (1996) predicted that climate change could alter the range of antelopes in the country. Out of the world's antelope biodiversity, more than 90% of the 80 species are concentrated in Africa (Macdonald, 1987). Also about one third of African birds migrate on a seasonal basis within Africa, and an additional on tenth migrates annually between Africa and the rest of the world (Hockey, 2000). If climate conditions or specific habitat conditions at either end of these migrating routes change beyond tolerance of the species, Africa will incur significant losses of biodiversity.

Causes of biological diversity disappearance

Loss of biological diversity results from various causes, some of which are natural but aggravated by human activities such as climate change (SCBD, 2002). The earth is subjected to many human induced natural pressures that have significantly altered, degraded, displaced and fragmented terrestrial ecosystems, often leaving biologically impoverished landscapes (SCBD, 2001). The main causes of species extinction as a result of human activities are introduction and competition from invasive exotic species, habitat destruction and conversion, overexploitation, agricultural and urban expansion, overgrazing and burning. Current rates of species extinction related to human activities far exceeded normal background rates (Pimon *et al*, 1995). Current estimates suggest that 400 – 500 vertebrates, about 400 invertebrates, and approximately 650 plants have become extinct in the past 400 years. Currently 12% of birds, 24% mammals, 30% fish and 8% of plants are already threatened with extinction (SCBD, 2001).

Based on gross estimates of total number of tree species in the world, 3,609 species are vulnerable while up to 77 species are extinct. According to Pimon *et al* (1995), current extinction rates are much higher than the rate at which species evolve. Some of the causes of biodiversity loss are listed below:

Rapid environmental disturbances: A series of storms or a single cold spell/cold season can decrease total species diversity. Large scale disturbances such as drought over a region for several years can cause temporary decrease in biodiversity. Nigeria has experienced many drought episodes causing massive

farming and biodiversity loss in some Northern Nigeria States. These occurred in 1882 – 1886, 1913 – 16, 1942 – 45, 1971 – 73, 1983 – 84, 1987 – 88 and 1997 – 98 (Tarhule and Woo, 1998). The most severe droughts years (1973, 1983, 1987 and 1997 – 98) coincided with El-Nino years (NIMET, 2006).

Pollution: The potential of pollution to decrease biological diversity was first brought to public attention on the effect of DDT on birds (Carson, 1962). In general pollution by toxic substances simplifies forests by reducing the number of species. Severe pollution can reduce all forms of biodiversity in different ecological zones. Examples are effluents discharged by industries such as pulp and paper and aluminum producing outlets into surrounding streams, rivers, etc.

Deforestation: Between 1850 and 1890 about 15% of the earth forests and woodlands disappeared as a result of human activities. The forests and woodlands of North America and the middle East, for example declined by 60% and by 20% in Africa (Houghton, 1990). Loss of forests continue to be a problem to biodiversity in these regions.

Agricultural development: The major causes of deforestation are the expansion of subsistence agriculture and large economic development programmes involving agriculture. The current agents vary from small farmers practicing shifting cultivation or clearing forests for subsistence needs to large agricultural concerns that clear vast tracts of forest lands in order to establish cattle ranches or agro-industrial plantations. With a soaring population growth rate of about 2.5 to 3.5 per annum (NEST, 1992), the fallow period became progressively shorter and soil is not allowed to fully regain its fertility before farmers return to it.

Uncontrolled forest fires: Fire retards natural development of vegetation towards a forest or woodland type climax and may hold it more permanently in a tree savanna stage. Fierce hot fires occurring during the late dry season are particularly destructive of woody elements, especially seedlings and suckers.

Fuel wood collection: FAO (1995) noted that for daily energy needs, more people depend on wood for domestic heating and cooking. Fuel wood is the only energy source for the poor in Nigeria as most households cannot afford kerosene, gas and electricity as a result of their costs. The demand for wood energy has been exacerbated by recent increases in oil prices.

Logging activities: Commercial logging is an important threat to Nigerian primary rainforests and its dependent species. Illegal logging operations are responsible for removing valuable mature trees, often of rare species, causing biodiversity loss in the ecology of many protected areas (WWF, 2000).

Urbanisation: This involves construction of roads, public and private buildings, dams and religion centres. The construction of new roads has a profound effect on the forest. Loggings roads are also among the most important types of access roads that facilitate biodiversity loss. Forests are encroached on by industrial and residential development as population grows and cities extend outwards. Mining not only destroy forests, but expose them to colonization by subsistence farmers who follow exploitation crews (Roper and Roberts, 1999).

Political unrest and war: There is clear evidence that armed conflicts or political instabilities still correlate with an accelerated rate of forest destruction. Forests are being destroyed in order to facilitate sheltering of guerilla forces (SCBD, 2002). In

Nigeria, the larger part of Shasha forest reserve was destroyed and logged illegally during Ife and Modakeke war in the South West.

The way out

The world's biodiversity is under threat. This is as much due to root causes such as poverty, social change and invasive species, pollution, etc. This suggests that a broad approach involving a wide range of stakeholders are needed to tackle the effects of climate change. Some of the strategies for conserving the remaining biodiversity are highlighted below:

Environmental awareness and education: Environmental Education is a process of reorganizing values and clarifying concepts in order to develop skills and add tools necessary to understand and appreciate the interrelationships among man, his culture and his biophysical environment with the main purpose of mobilizing peoples awareness of the importance of biodiversity and the need for their conservation. In a study carried out on the state of awareness and adaptation of farmers in the Niger delta by Nzeadibe (2001), nearly 60% of respondents know little or nothing about climate change and its impacts. Specifically 41.5% stated that they know little about climate change while 17.5% of respondents indicated that they know nothing about the phenomenon. On the other hand, about 32% of respondents indicated that they know about climate change impacts to a reasonable extent. Only 8.5% of respondents claimed that they were very knowledge about climate change impacts. This indicated the need for education of the general populace on climate change.

Good governance: Lack of good governance, rampant corruption and fraud are part of the major underline causes of forest decline. Among the activities that promotes these are illegal logging, poaching, etc. Political and civil servants must be trusted with responsibilities of promoting conservation culture at all levels.

Strategies for bio-diversity conservation

Several methods are available for conserving forest genetic resources and the appropriate method will depend on nature of material and on objective and scope of conservation envisaged (Frank *et al*, 1970). Nevertheless the need to promote greater diversity within production systems and natural ecosystems strengthens the opportunities for resource sustainability and for diversity conservation. The two methods of biological conservation are subsequently discussed:

In situ biodiversity conservation: In situ conservation means continuing to maintain a population within the environment where it originally evolved (Frank *et al*, 1997). In situ conservation is probably the most important and most viable option under certain conditions. It is the most preferred conservation strategy for wild plant species, including some of the wild relatives of crop species. The strategy involves the maintenance and regeneration of forest communities in their biological environment. The forest species are adequately protected in their area of origin, on their soil and site of occurrence, the climatic conditions of the area are adequate for species biological formations. According to Ola-Adams (1981), there were established strict nature reserves in Nigeria. However, as at today most of them have been lost to illegal loggers, encroachers and social developmental projects due to lack of funds coupled with weak and inconsistent legal framework.

Ex situ conservation: This involves conserving and maintaining genetic resources outside the area of origin. This method helps the conservation of endangered species, formation of gene banks, provenance zone and seed zone. The essential element of ex situ conservation are related to the need to identify, then conserve and manage the range of variability within species, primarily through development and management of regeneration in various forms in the fields. Examples of ex situ conservation are establishment of zoological and botanical gardens and gene banks for seed storage, pollen storage and the use of cultured tissue and meristem.

Conclusion

Ecosystems promote many services to human society, including carbon storage and climate regulation including water flows. Tackling climate change means using natural resources sustainably to maintain ecosystem services. Numerous countries have launched greening initiatives with this in mind. In addition, many governments responding to the current financial crises have put greening economy at the centre of stimulus packages.

Climate change is one of the most serious environmental and human threats undermining the achievement of the Millennium Development Goals (MDGs) and the international communities' efforts to reduce poverty. The need to conserve biodiversity in Nigeria has become very important. The rate at which the nation's gene pool of plant resources are being eroded is very high and all hands must be put on deck if adequate and sustainable solution is to be found to the problem of biodiversity loss locally. In ensuring that biodiversity is conserved adequately, the nation's forest reserves should adopt community strategy and proper demarcation of the boundary carried out. The 20% recommended forest cover for the country should be attained through environment planting, plantation establishment of indigenous tree species as specified in the nation's forest policy (heterogeneous planting should be encouraged). The forest reserves must meet the purpose of conserving biodiversity and clearing of forest reserves for other purposes discouraged by appropriate policy framework.

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Climate change and food security in Nigeria

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Abstract

Climate change is currently defining the patterns of agricultural development and industrial activities globally. Its influence on food security is associated with its impact on agricultural production and productivity. The northern parts of Nigeria do experience water stress, drought and desertification while the southern parts experience flooding during the raining season. Already Nigeria is experiencing incursions of the Atlantic ocean in the southern parts while Sahara is encroaching southwards at a rate of about a kilometer per annum. Agro climatic data from Oyo State showed decrease in annual rainfall and in number of rainy days. The temperature also showed slight increase in recent years while the humidity has been irregular. All these result in irregular planting seasons, making food security vulnerable to extreme weather. This affects the age long practices of farmers to predict when to plant crops. Experts have predicted that in the next 20 years, half of Nigeria's population will be facing water shortages and agricultural yields will reduce by more than 25%. This will lead to food scarcity which will in turn reduce the quality of life. The debilitating effect on livestock, forestry, fisheries and increase salinity of freshwater will further compound the problem.

Introduction

Climate change has been defined by the Intergovernmental Panel on Climate Change (IPCC) as statistically significant variations in climate condition that persists for an extended period, typically for decades or longer (IPPC, 2001). It refers to the long term average weather conditions of a region while weather is the daily fluctuating state of the atmosphere around us.

Over the past thirty years, researchers have gathered evidence to show that the earth is becoming warmer and that the major change is caused by Green House Gases which consists of water vapour which causes about 36-70% of greenhouse effect, $C0_2$, which causes 9-27%; methane, 4-9%, ozone, 3-7%, and hydrocarbon and perflorocarbons. The green house effect let in some energy received from the sun (ultraviolet and visible light) and stopping it from being transmitted back to space (infrared radiation or heat). For several thousands of years, the atmosphere has been delicately balanced with relatively stable levels of green house gases. However, human activities such as burning of fossil fuel and spread of intensive agriculture to meet food demand have led to an increase in greenhouse gases in the atmosphere, causing an enhanced greenhouse effect and extra warning.

As a result of the above, mean global temperatures have been increasing since 1850 and the process of global warming shows no signs of abating. As a result, these changes will have serious impact on the four dimensions of food security which include food availability, accessibility, utilization and food system stability. These effects are already being felt in the global food market, and, are particularly significant in specific rural locations where crop fails and yields declines. While advances in storage, preservation and transportation technologies have made food

processing and packaging economic activities, thus allowing food distributors and retailers to develop long distance marketing chains food insecurity persists mostly in parts of the world where intensive agriculture, long distance marketing chains and diversified non agricultural livelihood opportunities are not economically significant. Rising sea levels and increasing incidence of extreme events pose new risks for the assets of people living in affected zones, threaten livelihoods and increasing vulnerability for food availability problems.

In Nigeria, the First National Communication (NFNC, 2003) reports that temperature rise of 2^oC to 3^oC has been observed in the various ecological zones. In addition and persistent drought has also characterized the Sudano-Sahelian zone since the late 1960's. Similarly, IPCC's projection for the humid tropics suggested that rainfall will increase in Southern Nigeria. However in view of the expected increase in evaporation and evapo-transpiration there is the likelihood of localized drought in the humid parts of the country. IPCC (2007) also predicts less rainfall in the Savanna zone thereby worsening the existing seasonal and inter annual climate variability in the region. As a result of this, Nigerian agriculture and food security is expected to be affected by climate change.

Methodology

This write up was written using existing literature pertaining to the topic. As the paper is expected to provide detailed information on climate change and food security in Nigeria for use of scientists, students and policy makers in Nigeria and other parts of Africa, efforts were made to use existing work done in Nigeria and other parts of sub Saharan Africa on climate change and food security where available.

Objectives

The primary objective of this write up is to provide detailed information to research scientists, students and policy makers on the effect of climate change on food security in Nigeria. The information provided is expected to guide research work in the areas agronomy and agricultural extension as relates to food production. It is also expected that policy makers and national planners in Nigeria and other parts of Sub Saharan Africa with similar conditions will use the information contained to protect Nigerian agriculture and food availability from being stressed through introduction of appropriate policies.

Food Security

The concept of food security has been variably defined. According to Wikipedia food security refers to the availability of food and ones access to it. FAO's vision of a world without hunger is one in which most people are able by themselves to obtain the food they need for an active and healthy life and where social safety nets ensure that those who lack resources still get enough to eat "(FAO,2007). This vision has its root in the definition of food security adopted at the World Food Summit in 1996. The definition states that food security exits when all people at all times have physical and economical access to sufficient, safe and nutritive food to meet their dietary needs and food preferences for an active and healthy life (FAO, 1996). Consequently, Food security for a household means access by all members at all times to enough food for an active and healthy life. Food security includes at a minimum.

(i) The ready availability of nutritionally adequate and safe food, and

(ii) An assured ability to acquire acceptable foods in socially acceptable ways (that is without resorting to emergency food supplies, scavenging, stealing or other copping strategies (USDA, 2008).

The stages of food insecurity ranges from food secure situations to full scale famine. In view of the above, Nigeria has a huge responsibility of feeding her population of about 150 million people under a changing climate.

Climate Change, Agriculture and Food Security

Agriculture is important for food security in two ways: it produces the food for people to eat and it provides primary source of lifelihood for 36% of that total world's work force. In heavily populated countries of Asia and the Pacific, this share ranges from 40 to 50%, and in Sub Saharan Africa, two thirds of the working force make their living from agriculture (Ilo, 2007). If agricultural production in low income developing countries of Asia and Africa are adversely affected by climate change, the livelihoods of large numbers of the rural poor will be put at risk and their vulnerability to food insecurity increased. The links between climate change and food security have mostly been explored in relation to impacts on crop productivity and hence, food production. While there has been considerable progress in understanding the sensitivities of crop yield to climate change, assessments of climate change effects on food security remain rather limited (Gregory *et al* 2012). Emerging evidence have shown that Food security is not only a subset of availability but includes access to, and utilization of food. Consequently studies which focus only on crop production provides only a partial assessment of food security-climate change relationships. This is of particular concern in policy based issues as most countries based food security on crop productivity. Recognition that food security depends on robust food systems that encompass issues of availability, access and utilization has necessitated that these issues be formulated into research and development activities on food security projects locally.

Food Systems

There are several definitions of what constitutes food systems, each formulated in relation to a specific range of issues (e.g. globalization of the agric-food system Goodman 1997, community food systems, Gillspie and Crillerspie, 2000; ecological interests, Francis *et al,*2003). In general, food systems can be defined as a set of dynamic interactions between and within the biogeophysical and human environments which results in the production, processing, distribution, preparation and consumption of food

They encompass components of

(i) Food availability (elements related to production, distribution and exchange)

(ii) Food access (with elements related to affordability, allocation and preference)

(iii) Food utilization (with elements related to nutritional value, social value and food safety

Food insecurity can be caused by a range of factors in addition to climate and other environmental changes (e.g. conflicts, changes in international trade agreement and policies, HIV (AIDs) and may be particularly acute when these factors act in combination. Food system may be simple as in the case of a subsistence farmer

who produces process and consumes food on farm. However, there are comparatively few individuals or households that are totally self reliant for food throughout the year and in almost all cases, there is element of battering, exchange or the cash economy to bring food into the house. In many places, the food system has changed radically in the last century and continues to become increasingly more complex. Urbanization, coupled with introduction of supermarkets has enabled marked changes to access and utilization of food around the world. It thus provides the context in which to evaluate the likely effect of climate and other environmental changes on crop production and food security. Vulnerability and poverty are often interrelated because the likelihood of exposure to stresses is greater among the poor and because a greater proportion of their resources are spent purchasing or producing food, thereby, reducing their capacity to cope with perturbations. Although, from all indications, climate variation is only one of the several interacting factors affecting food security, however, as the frequency and intensity of severe weather increases, there is growing risk of storm damage to transport and distribution infrastructure with consequent disruption of supply chains. The rising cost of energy and the need to reduce fossil fuel usage have led to a newly calculated –"food miles which should be kept as low possible to reduce emissions. These factors could result is more local responsibility for food security which needs to be considered in formulation of adaptation strategies.

Impact of Climate Change on Nigerian Agriculture

Nigerian agriculture which is made up of small holder farmers produce about 80% of the total food from about 30.7 million hectares or 33% of the country's total land area. Farming is mostly subsistence in nature and increasing agricultural production is predicated on expansion of the area under cultivation. Nigeria like many other countries within the semi arid regions of Africa has been beset by several climate anomalies during the last century. In particular, the weather variation experienced since the late 1960's through early 1970's to date have impacted on various environmental processes and human activities in various parts of Nigeria. The most dangerous part that will facilitate adverse effects of climate change on agriculture is that Nigerian agriculture is rain fed and therefore vulnerable to climate change (NFNC, 2003). Similarly, livestock production is mainly an economic activity in the dry lands of Nigeria, making it heavily dependent on rainfall and equally vulnerable.

Agricultural vulnerability has been defined by IPCC (2001) as the risk of negative consequences of climate change that are difficult to ameliorate through adaptive measures. Among the types of vulnerability include risk of large yield reductions, risk of reduced profitability to farmers, risk of economic decline and risk of hunger for people with limited access to food or means of acquiring it. Climate change, due to increased levels of CO_2 will be reflected in the production of both C_3 (e.g. cassava, yam, cow peas, wheat, soybeans, rice and potatoes) and C_4 crops (millet, sorghum, sugarcane and maize) (Rosenzweg and Hillel, 1998). Comparatively, higher increases in productivity will be expected with C_3 crops. The C_4 crops would be adversely affected as many of them are functioning at near optimum conditions. Climate change in Nigeria will be accompanied by variability in rainfall and temperature. Higher temperature increase moisture stress on crops directly by increasing evapotranspiration as well as atmospheric holding capacity for water vapour. Indirectly, higher temperatures will cause breakdown of organic matter,

culminating in less moisture retention and additional crop moisture stress. Plants in early stages of development are especially vulnerable to extreme weather. For example, temperatures greater than $36^{O}C$ cause corn pollens to lose viability while temperatures higher than $20^{O}C$ depress tuber initiation and bulking in potato (Paulsen, 1994). Increased rainfall variability would lead to frequent floods and droughts, resulting to variability in crop yields in different ecological zones. Higher rainfall in the southern part of the country coupled with sea level rise would lead to crop losses due to water logging, loss of arable land and increase pest infestation. Drought conditions brought about by lower amount of precipitation will have several consequences on both crop and livestock production. Crop yields would suffer if dry period occur during critical developmental stages such as reproduction. In most grains, flowering, pollination and grain filling are especially sensitive to water stress. Heat and drought stresses often occur simultaneously, one contributing to the other. The contributions are often accompanied in Northern Nigeria by high solar irradiance and high winds. Such behavior reduces transpiration and consequently raises plant temperature, leading to poor yields. The risk of agricultural losses due to pests may also increase in changed climate. This is likely to be brought about in changes in the distribution of weeds; insects and plant diseases.

In terms of livestock production, a decrease in rainfall in Sudan and Sahel savannah would reduce available pastureland, surface water resources and increased salinity at watering points because of increased temperature and evaporation. Total rainfall is the most dominant limiting factors in dry rangelands. Drought diminished rangeland productivity; it also adversely affects feed quality and species diversity. Drought also affects the composition and size of herd. If drought continues to the extent of rangeland classification, pastoralists abandon the area (Squires and Sidahmed, 1998). In the arid and semi-arid zones, livestock density is above potential carrying capacity most of the year, and these are the areas where desertification takes place. The excessive heat due to warming of drylands of Nigeria resulting from changing weather and climate will also reduce the feed intake, feed conversion efficiency, and weight gain of the livestock. The consequences of these are changes in milk production and reduced reproduction. This will also have a negative feedback in the economy when supplies of proteins and hides and skin are reduced.

Impact of Climate Change on Agriculture and Food Security

Agricultural production and the biophysical, political and social systems that determine food security in Africa are expected to be placed under considerable additional stress by climate change (FAO, 2007). In Nigeria presently, every State of the Federation suffers one form of environmental problem or the other in varying degrees, having implications on food security. While the northern part is under the siege of wind erosion, the southern part is actively under the influence of gully erosion and flooding. A study using EPIC crop model to give projections of crop yield during 21^{st} century for Nigeria shows a bad case of climate change scenarios for maize, sorghum, rice, millet and cassava (Adejuwon, 2006). Indications from the projections show that there will be increase in crop yield across all lowland ecological zones as climate changes during the early part of the 21^{st} century. However, towards the end of the century, the rate of increase will slow down. This could result in lower yields in the last quarter of the century. The decreases in yield

can be explained in terms of very high temperatures which lie beyond the range of tolerance for the current crop and cultivars.

- **Impact on Food Production and Availability**

Climate change affects agriculture and food production in complex ways. It affects food production directly through agro-ecological conditions and indirectly by affecting growth and distribution of incomes and thus, demand for agricultural produce. Changes in temperature and precipitation associated with continued emission of greenhouse gases will bring changes in land suitability and crop yields. Impacts on food production will affect food supply at the global and local levels. Globally, increase temperature may lead to expansion in areas potentially suitable for cropping in temperate latitudes. The length of growing period will also increase, and crop yields may rise. This may offset lower yields in tropical regions. However, in many low income countries with limited financial capacity to trade and high dependence on their own production to cover food requirements, it may not be possible to offset declines in local supply without reliance on food aid. Another important change for agriculture is increase in CO_2 concentrations. Higher concentrations will have a positive effect on many crops, enhancing biomass accumulation and final yield. However, the magnitude of this effect is less clear with important differences depending on management type (irrigation and fertilization regimes) and crop type. Experimental yield response to elevated carbon dioxide show that under optimal growth conditions, crop yields increase at 550ppm CO_2 in the range of 10% to 20% for C_3 crops and 0 to 10% for C_4 crops. However, the nutritional quality of agricultural produce may not increase in line with higher yields. Some cereals and forage crops for example, show lower protein concentrations under elevated CO_2 condition (IPCC, 2001). In general agricultural yields will reduce by 25% in Nigeria in the next few years. In sub-Sahara Africa land for double cropping will decline by between 10 million and 20 million ha and land suitable for triple cropping will decline by 5 million to 10 million ha. At the regional level, studies indicated that under climate change, the biggest losses in suitable cropland are likely to be in Africa. Nigeria is at the moment losing about 351,000sq km of its land to the desert which is advancing southward at a rate of 0.6km per year. With 55% of its land under siege from desert encroachment, Borno State which suffers a protracted 15 years drought is one of the most threatened land areas in Nigeria. Perhaps, more spectacular and of grave consequence are the persistence drought, which, a number of times have resulted in famine in the northern part of the country. During the drought of 1972 – 73, for instance about 300,000 animals died and farm yields dropped by about 60%.

- **Impact on Stability of Food Supplies**

Global and regional weather conditions are also expected to become more variable than at present with increases in the frequency and severity of extreme events such as hailstorms, floods, and drought (IPCC, 2007; IPCC, 2001). As a result of greater fluctuations in crop yields and local food supplies coupled with higher risks of erosion damage, climate change can adversely affect the stability of food supplies. If climate fluctuations become more pronounced and more widespread, droughts and floods, the dominant causes of short term fluctuations in food production in semi arid and sub-humid areas will become more severe and more frequent. In semi arid areas drought can dramatically reduce crop yields and livestock numbers and productivity (IPCC, 2001). Again most of these lands is in sub-Saharan Africa and parts of south east Asia, meaning, that the poorest regions with the highest level of chronic undernourishment will be exposed to the highest degree of instability in food production (Tubiello and Fischer, 2007). How strongly these impacts will be felt will critically depend on weather. However, such situations can be countered by investments in irrigation, better storage facilities or higher food

imports. A policy environment that promotes free trade, investments in transportation, communication and irrigation infrastructure can help address these challenges early on.

- **Impact of Climate Change on Food Utilisation**

Climate change will also affect the ability of individuals to use food effectively by altering the conditions for food safety and changing the disease pressure from vector, water and food borne diseases. IPCC (2007) provides a detailed account of the health impacts of climate change. The main concern about climate change and food security is that changing climate can initiate a vicious circle where infectious diseases can cause or compounds hunger, which in turn makes affected populations more susceptible to infections diseases. This can result in substantial decline in labour productivity and increase in poverty and even mortality. The report also emphasizes that increases in daily temperatures will increase the frequency of food poisoning, particularly in temperate regions. Warmer seas may contribute to increased cases of human shellfish and reef fish poisoning in tropical regions. There is evidence that temperature variability affects incidence of diarrheal disease in adults and children. Extreme rainfall effects can increase risk of outbreak of water borne diseases, particularly where traditional water management systems are insufficient to handle new extremes. Likewise impacts of flooding will be felt most strongly in environmentally degraded areas and where public infrastructure including sanitation and hygiene is lacking. This will raise the number of people exposed to water borne diseases such as cholera and thus lower capacity to effectively use food.

- **Impact of Climate Change on Access to Food**

Access to food refers to the ability of individuals, communities and countries to purchase sufficient quantities and qualities of food. According to Federal Office of Statistics, while Nigeria is experiencing increasing prosperity, the number of poor people earning less than 1 dollar per day is increasing. FOS (2012) put the number of people leaving below poverty level as more than 100 million out of a population of about 140 million, indicating that the access of average Nigerian to quality and nutritious food is limited. FAO longer term outlook suggests that improvements in undernourishment in Africa will be slower than for other regions as significant constraints (soil nutrients, infrastructure, water, etc) will limit the ability to further increase food production locally, while continuing low levels of income rule out the options of importing food. The strongest impact of climate change on the economic output of agriculture is expected in sub-Saharan Africa. Here the poorest and already most food insecure region is expected to suffer the largest contraction

- **Impact on food prices**

A number of studies have shown than food prices are expected to rise moderately in line with moderate increases temperature (until 2050). After 2050, further increase in temperatures will lead to more substantial increasing in food process. Really e*t al* (1996) forecast that the price of commodities such as sugar and rice will increase much as 80% above their reference levels. The increase in prices is expected to lead to stubbornly high number of undernourished people.

Towards Ensuring Food Security in Nigeria

It is a fact that climate change will impact negatively on food security in sub Saharan countries. Promoting food security in Nigeria will require a multi-dimensional approach. This will include improvement in technological development, promoting optimal adaptation strategies in the various ecological zones and ensuring increased agricultural production and productivity.

Some of the steps that can be taken are outlined below:

Promoting advancement in Technology

Advancement in Technology is sin qua non to development of the agricultural sector, planned adaptation and response to sudden environmental problems such as flooding, etc. Nigerian agriculture as it is presently practiced is at best rudimentary. Currently, more than 60% of the farms produce waste away on seasonal basis and farmers remained poor as they have to depend on shylock middle men purchase most produce at farm-gate prices as a result of inadequate infrastructure, poverty and illiteracy. Closely allied to these, most farmers lack access to improved planting materials including drought resistant planting materials which is fast becoming important in the savanna zones. Thus, to limit the impact ofv climate change on all the four facets of food security, there is need for technological advancement that will promote access to improved storage materials even at farmers level, optimal transportation to enable farmers secure better deals for their produce and consequently, increase income and purchasing power.

Adapting to Climate Change

Adaptation is the changes in processes, practices or structures to moderate or offset potential damages in climate (IPCC 2001). It involves adjustment to reduce vulnerability of communities, regions, or activities to climate change and variability. Adaptive capacity on the other hand is the potential or ability of system, regions, or community to adapt to the effects or impact of climate change. Enhancement of adaptive capacity represents a practical means of coping with changes and uncertainties in climate, including variability and extremes. Adaptive actions may be anticipatorily or reactive, spontaneous or planned. Adaptive actions may be community-based or government sponsored programmes. The capacity to adapt varies among socio-economic groups and will also vary over time. The ability to adapt and cope with climate change impact is a function of wealth, scientific and technical knowledge, information, skills, infrastructure, institutions and equity (IPCC 2001). Countries and groups that are limited along these dimensions are more vulnerable to climate change impact. Poverty is the most serious obstacle to effect adaptation. Despite economic growth, low-income countries are like to remain poor and vulnerable over the medium term, with fewer options than high-income countries for adapting to climate change. In Nigeria these adaptive practices include:

Education and Awareness

Climate Forecasting

The Nigerian Meteorological Agency (NIMET) has an important role to play here. If farmers can adapt to current year-to-year variability through the use of advanced information, communities will be in position to adapt to longer-term climate changes.

Drought Early Warning Systems

In an effort to cope with drought, Nigeria, should equip and update the equipment of the Nigerian Meteorological Agency (NIMET) to collect appropriate weather data necessary for developing drought early warning system for the country.

Water Management

In the dry lands, more than anywhere else, the availability of water is a vital requirement. These areas are characterized by high evaporation, and surface waters (rivers and lakes) generally tend to disappear relatively quickly. People, therefore, have to develop different ways to access underground sources. In the dry lands of Nigeria, adaptation to water shortage has involved many strategies that included rainwater harvesting. Rainwater is harvested or captured in water tanks or containers and or in depressions within fields or in stream flood plains for domestic use and agriculture. When used for agriculture, it is generally for the watering. In areas susceptible to flooding, like in the wetter, southern part of the country, the adaptation strategy is different Excess water must be drained quickly to avoid crop damages and crop loss as well to maintain current water levels for fisheries.

Restoration of Degraded Lands

In order to restore degraded lands for increased food production, cropping techniques should be improved by stabilizing the soil, while enriching them with organic matter. Both plants and animals provide inputs of organic matter to soils. In northern Nigeria, some farmers have developed a stable system, which strongly emphasizes the sue of animal manure on crops (Norman, 1992). Within a cropping system, manuring practice varies with location. On the traditional farms, the area nearer the household or village is highly fertilized with human and animal manure while the more distant fields received little or no organic matter (Fussell, 1992)

Appropriate Soil Tillage

During dry years the land often becomes bare and subject to erosion by wind and water. One important operation involves ploughing the bare ground with single furrows up to 25 cm deep and 3-10m apart depending on soil type. The aim is to produce large clods to help resist erosion. In seasonally wet-and-dry climate likes Nigeria, the most apparent benefit from tillage are weed control and evapotranspiration from weed preceding the crop.

Diversification of food production

Diversification of crop and animal production enables better utilization of land resources and prevent the over-production of a single product. A piece of land can sustain different plants and animal under mixed farming over long periods since their nutritional needs vary and the resources they removed from the land are complementary. Prolonged monoculture should be avoided on the same piece of

land and system of rotational crop production should be established to restore soil fertility.

Utilization of Improved Crop Varieties

Various Research Institutes in Nigeria are involved with crop improvement programmes. More funds should be allocated for the breeding of crops varieties that are heat and drought tolerant, low water-use efficient and salt-tolerant for use in dry lands and flood tolerant for the coastal region. The use of such varieties will enable farmers to diversify and produce profitably even under adverse conditions. Substantial progress is also being made through national research institutes, ICRISAT and ITTA in the provision of such needed crop varieties which are being distributed through the extension system of the Agricultural Development Programmes (ADP) of the country.

Cropping Adjustments

Throughout the world agricultural scientists have devised various means of copping with variability in weather. Fallowing land for water conversation or nutrients conservation or nutrient restoration is an age-old practice of proven value in modern and traditional agriculture. Deep seeding and wide spacing of plant increase the change of soil moisture being available for seedling establishment and growth. Terracing to reduce run-off and to conserve soil moisture in steep cultivated hillsides or areas are also good cropping practices.

Crop farmer in dry regions make frequent decisions about crops to plant. If rains come early, long-season cultivars are planted to take advantage of their greater yield producing potential. If rains are late or if dry periods kill crops planted early, short-season cultivars of the same crop or a different crop are planted Management decisions of this type are a normal response to temporal variability in rainfall, whether or not he season turns out to be drought-affected.

Policy Issues

To properly respond to climate change and drought with the accompanying desertification in Nigeria, the following policy issues need to be considered immediately by the government:

Energy Policy

The need to stop gas flaring has become germane. Successful mitigation of climate change will require the formulation of appropriate energy policies that will reduce GHGs significantly or maintain it below the threshold level. The use of hydroelectric power instead of fossil-fuel to generate energy, solar and biomass energy for domestic use as against fossil fuel and the use of solar-powered refrigerators and air-conditioners should be considered in the energy polices to reduce GHGs.

A**gricultural Policy**

Farming can affect GHG balance in many ways, including (1) release or sequestration of soil C, (2) use of fossil fuel in agricultural production, (3) release of N_20 in production, and (4) use of fossil fuels in the manufacture of inputs such as fertilizers. The national agricultural policy should include GHG mitigation policies.

Forestry Policy

In Nigeria and many other developing countries, the high rate of deforestation to meet energy demands is damaging the environment. Existing polices and activities need to be re-examined with the view to strengthening them. Afforestation and re-forestation programmes should be reactivated for the protection of our environment.

Conclusion

Climate change will affect all the four dimensions of food security. Essentially all quantitative assessments show that climate change will adversely affect food security. Climate change will increase the dependability of developing countries on imports and accentuate existing food in- security on sub-Saharan Africa. Within the developing world, the adverse impacts of climates change will fall disproportionally on the poor. However, how strong the impacts of climate change will be felt over all the decades will depend on the future policy environment for the poor. Freer trader can help to improves access to international supplies, investment in transportation and communication infrastructure will help provide secure and timely locally deliveries, irrigation and promotion of sustainable agricultural practice and technological development can play a crucial role in providing steady local and international supplies under climate change.

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Undergraduate Perceptions of Agricultural Extension Education and Training

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Abstract

This paper reviews the challenges of extension education and training, social perception and possible job opportunities influencing career direction in agricultural extension. It examined awareness level of undergraduates as well as social factors that influence prospective undergraduates in the field. A survey of one hundred (100) students of agricultural extension and agricultural related fields was carried out in Lagos State Polytechnic, Ikorodu to measure relevant variables using nominal and ordinal scales. This study revealed that 29.1% undergraduates that undertook Agricultural Extension courses at Higher National diploma (HND) level chose the course as an opportunity for advancement. 72.7% undergraduates of agricultural technology at National Diploma (ND) level were oblivion about jobs opportunities available in agricultural extension education. Poor and low awareness of the importance of extension education is a challenge to national development. The study however, proffers solution to enhancing the practice of extension education and training in Nigeria.

Introduction

Extension education and training is a tool towards rural development. FAO, (1985) posit that, rural development must therefore be considered with particular reference to agriculture, since agriculture is the basis of livelihood of most rural families. Extension is essentially the means by which new knowledge and idea are introduced into rural areas in order to bring about change and improve the lives of farmers and their families. Thus, the work of extension is critically important, because without it, farmers would lack access to supportive and improved services required to their productive activities.

However the image of agriculture among Nigerian youths seemed to have been bartered perhaps because of the high level of poverty in the rural areas compared to urban areas. Therefore, an improved image focusing on better farming practices and research and development in agriculture would serve to increase the profile of agriculture, along with careers available in agriculture and related areas, thus helping improve students' enrolment Matthew, et all (1999).

Extension education and training undertaken in some specialized institutions is therefore critical for national development as agriculture has always been identified as the engine of every economic growth and development.

The perception of agricultural extension training in Nigeria by undergraduates needs to be reviewed in order to enhance enrolment and the development of the rural

areas and farming activities in the country. It is worthy of note, that, number of students/graduates of agricultural and related courses have increased in the past two decades but this increment is not responsive to development of farm families and food production in the country Issa, (2008). It will therefore enhance agricultural productivity for more students to be attracted to study agriculture. If student possess a negative image of agriculture as a profession, it is important that improving the image of agriculture would be one step towards improving the number of student enrolments in agriculture and related areas. It would assist agriculture for more students in total, including more academic high achieving students, to be attracted to study agriculture, along with better informed urban community on agriculture and its related economic benefits and the ways resources are used and conserved.

Moreover, there is need to design programmes that would provide for wide or better use of extension agents in terms of performance. Thus, no programmes or plan of rural development either by government or any other agency can be of success if it lacks extension agents who are committed and hardworking. Professional competency of extension agents lies on the level of education and training required. For extension agents to be committed and hardworking, he must have attained a level of professional competency, which covers attitude, skill and understanding or knowledge needed to perform their job efficiency. Issa, (2008). Thus, the paper is tailored towards finding and exposing career prospect available to undergraduate of Agricultural Extension Education.

Purpose of Study

The essence of this study is to find out possible challenges faced by undergraduates of agricultural extension. It therefore, investigates the perception of undergraduates in respect of agricultural extension education and the available jobs opportunities. Thus the main objectives of the study are:

1. To determine the level of undergraduate students' knowledge about jobs available in agricultural extension education.
2. To analyze the factors undergraduate students considered important when choosing career in agricultural extension/agricultural related fields.
3. And to find out, if awareness of undergraduates about agricultural extension education can stimulate decision to pursue career in the field.

Methodology

Sample of students of Agriculture in Lagos State Polytechnic was surveyed to estimate the population characteristics. Since, it was impossible to take a complete and comprehensive study of the population because of the nature (time), and pattern of distribution and dispersion of the elements of the population. A data collection schedule, that is, questionnaire was designed to measure several variables Asika, (1991). The questionnaire was administered to sample size of one hundred (100) students. The questionnaire was administered as follows; ND students (33), HND (55) and other students undertaken agricultural courses (12).

Sample size was chosen using the stratified random sampling method. Accessibility of respondents was determined through personal contact with some students' leaders and lecturers in school of Agriculture to give a 'Pathway' for easy

administration. All the scales were fully administered in less than four days with management of some 'pocket' shortcomings ranging from misplacement of questionnaire by some respondents and delay in responding to the scales by the students. A total of thirty (30) questions (Variables) were asked (tested). These focused on four different sections as shown in the table below:

Part A	Part B	Part C	Part D	Total
06	10	12	02	30

Table1: Outline of numbers of questions in the scale of the study

- PART A: Personal Data
- PART B: Challenges to Extension Education and Training
- PART C: Consideration of career in Agricultural Extension
- PART D: Factors influencing career in Agricultural Extension.

Series of questions used on the scale were developed from review of related studies and personal discussion with group of students. Scales in Part A were measured using nominal scale while the other scales of the remaining parts were measured using ordinal scale. Frequency, percentage and chi square were the statistical tools used in analyzing the variables on Statistical Packages for Social Sciences SPSS (10).

Results and Discussion

Challenges to Agricultural Extension Education

A significantly ($p<0.01$; $n=100$) greater percentage of 27.0% of sample surveyed considered poor awareness of extension education as a problem to agricultural extension education. This view was confirmed by students of extension program at HND level (36.4%) at ($p<0.02$; $n=55$). While, 15.2% at ($p<0.01$; $n=33$) supported the view. But a greater percentage of (21.2%) of students of Agricultural Technology at ND level considered lack of teaching equipment as a major challenge to Agricultural extension education. 54.5% further affirmed that access to teaching materials like audio-visual, posters, etc, will spur understanding of Agricultural extension education. At $p<0.01$; ($x^2=15.680$; $DF=5$; $x_{tab}=15.09$), low awareness of agricultural extension education is a challenge to the field as highlighted in table 2 below. Basically, there is relationship between undergraduates of agricultural extension and challenges to agricultural extension education. 46.0% respondents disagreed and 27.0% strongly disagreed that funds available for agricultural extension are not enough to aid service delivery to farmers. 57.0% and 46. 0% strongly agreed and agreed respectively that development of research station can aid perception and improvement of extension education and training.

TABLE 2: Percentage Schedule of Awareness of Agricultural Students to Extension Education

Class	Sample size	Percentage (%)
ND	33	15.2
HND	55	36.4
OTHERS	12	33.3
TOTAL	100	27.0

Source: Field Survey, 2010

What can create awareness about prospect of Agricultural Extension Education to Undergraduates?

72.0% of respondents as reveal in the survey affirmed that, they have background on extension education. Surveyed sample (n=100) showed that respondents learn about extension both at secondary and post secondary school equally. 34.0% and 20.0% students at HND strongly agreed and agreed that guidance and counseling about prospect of agricultural extension education to secondary school students can help create awareness about extension activities. (At $p<0.01$; DF=2; $x_{cal}=11.09$; $x_{tab}=10.60$); it was revealed that guidance and counseling about prospect of agricultural extension education and training can create awareness of agricultural extension. This was further confirmed as 45.5% of students at ND level strongly agreed to impact of guidance and counseling about prospect of extension education.

Knowledge about Jobs Available In Agricultural Extension Education

Of the students surveyed, (52.0%; n=100) stated that, they did not have knowledge of any possible careers in Agricultural extension as revealed in table 3 below:

TABLE 3: Respondents Knowledge of Possible Careers in Agricultural Extension

Responses	Observed (n)	Expected (n)	Residual
Yes	48	50.0	-2.0
No	52	50.0	2.0
Total	100		

Out of the five jobs listed, which are available to someone with degree in Agricultural extension or Agricultural related field. 52.0% of respondents rate their interests very high in farming activities. This view was supported as 34.0% and 33.0% would like to start farming while in school and after NYSC respectively. 33.0% and 31.0% (n=100) rate their interest in teaching rural farmers high and very high. This opens students to pick-up teaching jobs at any level of institutions and a career as extension agent to rural farm-families. 52.0% and 36.0% of the respondents as well strongly agreed and agreed that; consultancy is one of the jobs available in Agricultural extension education. This view was further ascertained as 45.0% and 20.0% would like to start consultancy services while in school and after NYSC. Also, 72.0% of respondents prefer a career as an extension officer in Civil Service Commission as extension or agricultural officers.

Factors Influencing Career in Agricultural Extension

At significant level less than 2% ($p< 0.02$), there is relationship between students studying Agricultural Technology at ND level and factors influencing career in Agricultural extension education ($x^2 = 12.303$, DF= 4; $x_{tab}= 11.67$). 42.4% of sample surveyed (n=33) stated that community influence their decision about career in their present field. Likewise, 52.7% of students studying agricultural extension and related courses at HND level affirmed that, community aids their decision about career in their present field. While 47.0% and 27.0% took decision about career in Agricultural extension due to community and school influence respectively.

Awareness and Perception Aid Decision to Pursue Career in Agricultural Extension Education

Perception and awareness is pointer to undergraduates' decision to pursue a career in agricultural extension education. This is supported as 43.00% of sample surveyed (n=100) perceived extension education as means of improving rural farm

families, means of obtaining formal education and means to secure jobs. These variables are relevant to motivate students to pursue a career in agricultural extension. Also, 50.9% and 43.65% sample surveyed (n=55) at HND level strongly agreed and agreed respectively that review of teaching curriculum to cater for temporary employment for undergraduate and create jobs for graduate could improve interest in extension education.

Responses	Observed (n)	Expected (n)	Residual
Means of improving rural farm family	43	25.0	18.0
Means to obtain formal education	9	25.0	-16.0
Means to secure job	5	25.0	-20.0
All of the above	43	25.0	18.0
Total	100		

Source: Field Survey, 2010

Conclusions and Recommendations

The sample population size of (n=100) students in school of Agriculture, Lagos State Polytechnic was averagely sufficient to apply to the entire population of Agricultural students in south Western part of Nigeria. Hence, this limitation gives suggestion for further studies. The number of students enrolling for agricultural related courses at ND level were low (37.0%) and this attributed to the low and poor awareness of agricultural extension education. Out of 37.0% of agricultural students surveyed at ND level, 21.2% attributed lack of teaching equipment as a major challenge to extension education while 15.2% agreed that awareness of extension education was considerably low. These challenges could be traced to the perception of students' enrolment to agricultural studies. Most students in higher institution are resident of major urban cities as 52.0% of respondents visit rural areas occasionally, the table below has more details about visitation to rural area.

TABLE 5: Frequency Distribution of Undergraduates Visitation to Rural Area

Options	Frequency (100)	Frequency (33)
Very Regular	03	00
Regular	28	10
Occasionally	52	18
Never	17	05

Source: Field Survey, 2010

12.0% of sample surveyed (n=100), who were not directly agricultural students attributed inadequate skilled personnel to problem of extension education. 58.3% of this sample rates the level of skilled personnel to extension education averagely. Hence, there is need to improve the awareness of extension education even from secondary school education to orientate prospective undergraduates on possible prospect of extension education. 61.8% of students surveyed at HND level strongly agreed that guidance and counseling about prospect of extension education to secondary school students can help create awareness about extension activities, likewise, 45.8% ND students surveyed strongly agreed to this view. Following the

above challenges and possible way of alleviation, there is need for strict implementation of agricultural extension training right from secondary school. Extension education could serve as a means of motivations to agricultural education. Prospect of jobs highlighted in this study should be echoed to students even from secondary schools. This will give them considerable knowledge about extension education.

There is significant interest of undergraduate in consulting services as one of the jobs in extension education (x^2 = 103.100, P< 0.001; DF=4). Almost 88% (n=100) and 29% (n=33) of respondents showed interest in consultancy. Thus, this service industry will cater for the need of both small and medium scale farmers that reside in farm settlement of urban cities and some neighboring rural farm families in Lagos State. Over 75.0% of total sample surveyed (n=100) would like to start consulting services as soon as possible. Consequently, if ethics of consultancy service is noted, it will also improve farming activities and meet the major concern of extension education as a means of introducing new knowledge to rural farm families.

Teaching, which is perceived as one of the crude career in past decades is seen as a lucrative career recently. Over 60.0% of respondents (n=100) rate their interest high in teaching rural farmers. Therefore, if curriculum is review to cater for employment for both undergraduates and graduates, it will allow students to see the need to aid rural farm-families with innovation that are germane to their productive function.

Image of Agricultural extension and agricultural related education could be traced to sources of information about possible careers in agriculture. This study suggests that parents, friends, teachers and mass media to some extent are responsible to these negative views. About 47.0% of the total sample was influence about agricultural extension education through the community/environment. Most of them, through personal investigation felt that, they could meet their social status/ego of being a graduate to take care of themselves, while some, really have passion for nation building through provision of food for the nation.

The consequence of impact of extension education in agricultural sector is prominent to the view of sample surveyed, which showed 4.0% of respondents choosing career in extension education as a means of helping rural dwellers. If, rural farm-families are not developed with current trends in farming, the concern of providing food for the nation will be void. Thus, there is a great concern to address the essence of extension education to introduce new idea to rural farm families.

This paper, to large extent, suggests guidance and counseling about prospect of agricultural extension education to secondary school students and review of teaching curriculum as a means of creating awareness to prospective student of agricultural extension education. It further provides the following recommendations:

1. There should be an awareness campaign or re-orientation exercise for secondary school students and stakeholders in educational sector to address the concern of agricultural extension education, which are rural farm-families oriented.

2. There should be a compulsory course in teaching curriculum of undergraduates that will allow them practice extension service to rural farm-families. This shall allow them regular visit to rural areas and also, spur their interest in the profession.

3. An enforcement of Students' Industrial Work experience Scheme (SIWES); that is, a temporary employment which is directly related to students' major area of study.
4. Orientation and career counseling on prospective careers available to agricultural extension graduates, like; agro-consultancy, agro-journalism, extension broker, seedling producer and marketer, farming, teaching, civil service work, etc; should be emphasized at the entry point of students into higher institution.

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Improving Climate Change Coping Strategies among Crop Farmers in Nigeria

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Abstract

The degree of vulnerability to climate change and the impact of the change on humanity seem to be more severe than the threat of terrorism. Man's continuous interaction with nature invariably creates change, which impacts negatively on him. Man is the origin and the principal cause of climate change. The negative impacts of climate change on Nigeria agriculture by far outweigh various strategies adopted by farmers to cope with the change. For farmers to sustain production, improve food basket and ensure food security, current strategies adopted by farmers to cope with climate change in Nigeria need to be improved. This paper identified and discussed sustainable strategies that will enhance farmers' coping capabilities to climate change.

Introduction

In Africa, Nigeria inclusive, information about climate change is poor, technological change has been the slowest and the domestic economies depend heavily on agriculture (Action Aid, 2008). Nigeria has a population of 150 million – the largest in Africa – and a fast-growing economy. Agriculture is the mainstay of the economy, contributing about 45 per cent of GDP. The agriculture sector employs about two-thirds of the country's total labour force and provides a livelihood for about 90 per cent of the rural population. Nigeria is the world's largest producer of cassava, yam and cowpea – all staple foods in sub-Saharan Africa. It is also a major producer of fish. Yet it is a food-deficit nation and imports large amounts of grain, livestock products and fish (IFAD, 2009). As the population grows and puts pressure on dwindling resources, increased environmental problems threaten food production. Climate change is the most severe problem that has been faced in this present day and is more severe than the threat of terrorism (King, 2004). Nigeria is confronted by major environmental problems and every climate study indicates that Nigeria is one of the countries that are vulnerable to climate change (Obioha, 2008) and that the agricultural sector is under this threat. Land degradation as a result of extensive agriculture, deforestation and overgrazing becomes severe in many parts of Nigeria. Drought has become common in the north, and erosion provoked by heavy rains, floods and oil pollution is a major problem in the south-east and south-south. There are recently floods in Ibadan, Lagos and Sokoto state in Nigeria. These aggravate poverty by further diminishing resource base. Climate change has serious consequences for socio-economic and livelihood activities in Nigeria. It has been documented that climate change will further affect crop production, yield and food prices in the future except solutions are provided now (Oluwasola, Oke, Ibrahim and

Adewusi, 2011). In spite of low information about climate change, farmers have unconsciously responded to the change in climate by developing adaptation or coping strategies that may not be sustainable in the long run. It has been reported that farmers in Nigeria have little adaptive capacity due to lack of scientific, technical, financial and institutional capacity to evaluate the impact of climate change (Kehinde and Adegunloye, 2011). Farmers therefore need help to ensure that adaptation strategies adopted by them against the impacts of climate change are further strengthened to efficiently cope with more unfriendly climatic conditions in the future. This paper discussed the impacts of climate change on agriculture in Nigeria; the climate change coping strategies adopted by farmers and suggested strategies for enhancing farmers' coping capabilities to climate change in Nigeria.

Impacts of Climate Change on Nigeria Agriculture

McCarthy, Canziani, Leavy, Dekken and White (2000) asserted that Climate Change is perhaps the most serious environmental threat to the fight against hunger, malnutrition, disease and poverty in Africa, through its impact on Agricultural productivity. Mendelsohn, Ariel and Arne (2000) posited that Climate Change phenomenon impacts Agriculture in a number of ways.

- **Uncertainties in farming season due to changes in rainfall pattern and extreme weather events**

Uncertainties in the onset of the farming season due to changes in rainfall (early rains may not be sustained, and crops planted at that instance may become smothered by heat waves) lead to unusual sequence of crop planting and replanting. This results in food shortages due to crop failure. Extreme weather events such as thunder storm, heavy winds and floods devastate farm lands and also lead to crop failure. The location, size of, and characteristic relief in Nigeria have been reported to give rise to a variety of climates; ranging from tropical rain forest climate along the coasts to the Sahel climate in the northern parts of the country, each being different by its annual precipitation, sunshine, and other climatic elements ((FGN), 1997; Adejuwon, 2004). The diverse nature of biological diversity results, mainly, in seven vegetation zones: the mangrove swamps, the salt water and fresh water swamps, tropical rain forests, Guinea savannah, derived savannah, Sudan savannah, and Sahel savannah (Adejuwon, 2004). In Nigeria, agro-ecological zones with hitherto optimum temperature experience excessive temperatures, while areas with high temperatures are further characterized by higher and unbearably excessive temperatures. Rainfall is by far the most important element of climate change in Nigeria and a good source of water supply in the country. Nigeria experiences large, spatial and temporal variations in rainfall and less variation in evaporation and evapo- transpiration (Adejuwon, 2004). This suggests that climate change also affect rainfall patterns in Nigeria. Heavy rainfalls with resultant floods are frequent in areas hitherto known to have optimum rains. Delay in rains is experienced in areas where rains start early. Rains are further delayed in regions where rains start late. In some agro-ecological zones, especially rain forest zone, floods are experienced with devastating effect on agriculture and crop yield.

- **Reinforced water scarcity and drought**

The impact of climate change in Nigeria is vast. Some stable eco-systems such as Savannah and semi-arid belts have become more vulnerable to climate change. It

has reinforced the existing patterns of water scarcity and increased the risk of drought in these zones.

- **Totality of human existence is threatened**

The issue of climate change has become more threatening, not only to the sustainable development of socio-economic and agricultural activities of any nation, but also to the totality of human existence (Adejuwon, 2011; Oyekale as cited in Oke et al, 2011). Intergovernmental Panel on Climate Change (IPCC) seems to agree with this observation. The impacts of climate change on human and natural systems identified by IPCC include human settlement and health, water resources, wet lands and fresh water eco-system, energy, industry and financial services; agriculture, food security, land degradation and forestry; and Coastal zones and marine eco-system. Some of the direct impacts of climate change in agricultural system include: Seasonal changes in rainfall and temperature, altering growing seasons, planting and harvesting calendars, water availability, pest, weed and disease population, alteration in evapo-transportation, photosynthesis and biomass production; and alteration in agricultural land (IPCC, 2007).

- **Poverty and food crises worsened**

Analysis of poverty in Nigeria indicates that poverty has a feminine face. This implies that poverty does not affect men and women equally. International Food Policy Research Institute, IFPRI (2008) reported women to lag behind men in most indicators of socio-economic development. Women constitute the majority of the poor, the unemployed and the socially disadvantaged, and they are the hardest hit by the current economic recession, with about 52 percent of rural women living below the poverty line. Gender inequality in disfavour of women features prominently in access to and control of land, credit facilities, technologies, education and health, and as a result, women are more vulnerable to poverty than men. Diet and nutrition are important factors in the promotion and maintenance of good health. In Nigeria, 60 percent of child deaths are related to protein energy malnutrition (PEM), making it the greatest single cause of child mortality. Despite government efforts, the health of women is undermined by multiple factors, such as lack of access to health services, poor sanitation and nutrition, and low levels of education and information. Food crises are not only experienced by women but also by men though women are more food insecure than men. Studies have shown that the incidence of food insecurity is higher for female-headed households (0.49) than for male-headed households (0.38). Women (more than men) spend their income on food thereby improving household food and nutrition security, especially in the development of children (IFPRI, 2008). Rural food shortage is becoming increasingly worsened by the scourge of climate change (IFAD, 2009).

- **Unemployment, social strife and unrest**

Unfolding events about the scourge of climate change is indicative that rural employment is already threatened. Crop farmers are increasingly being displaced from their communities due to climatic and weather challenges, thereby increasing migration rate. Strife between crop farmers, landless tenants and the nomadic Fulani is worsening. In Nigeria, conflict has become a very widespread occurrence; manifesting in all spheres of human endeavours. Land related issues especially over grazing fields, account for the highest percentage of conflicts between the Fulani pastoralists and farmers in Nigeria. In other words, struggles over the control

of economically viable lands cause more tensions and violent conflicts among communities. Conflicts between pastoralists and farmers have existed since due to competing use of agricultural resources. These have either increased or decreased both in frequency and intensity depending on some factors such as socio-economic, environmental and others. Expansion in the herd size, due to improved conditions of the cattle, oftentimes forces the Fulani pastoralists to seek for more pastures beyond their limited range (Blench, 2010). Climate change has constituted a great threat by putting greater pressures on the land and thus provoking more and regular conflicts between farmers and the pastoralists. Increase in social strife and unrest may generally make the environment unsecured for peaceful co-existence and human habitation.

Climate change coping strategies adopted by farmers in Nigeria

Farmers in Nigeria have developed practical strategies towards adapting to the impacts of climate change around them. A number of factors however undermine the adaptive capacity of small-scale farmers and these are attributed to social, governance and economic issues. These include land tenure and user rights, gender, local governance, poverty and in some cases culture and indigenous knowledge (IPCC, 2007). Kehinde and Adegunloye (2011) reported that support given to farmers to climate related disaster is uncommon, thus the business of adopting a climate risk management strategy (CRMS) is private. They reported CRMS to involve:

- Farmers systematic use of climate information to reduce the uncertainty that impacts planning and decision making
- Climate-informed technologies that reduce vulnerability to climate variability. These include crop diversification, water harvesting, irrigation, improved water use efficiency, breeding for heat or drought tolerance; and
- Climate-informed policy and market-based interventions that transfer some part of risk away from him.

Farmers in Nigeria are known to have little access to climate change information. The coverage of the issue of climate change in Nigeria is also still limited. Media owners and practitioners are more interested in issues that will boost their profit. Some climate-informed technologies that reduce vulnerability and transfer some part of climate change related risks away from farmers, and are adopted by farmers in Nigeria are discussed.

- **Irrigation and Irrigable Land**

Nigerian agricultural economy is highly dependent on natural rain and is consequently prone to climate change disaster. Rainfall is not equitably distributed in Nigeria. For instance, the southern rain forest zone of the country experience rains almost throughout the year whereas the northern semi-arid and savannah zones do not. To ensure that farmers can cultivate crops throughout the year in the north of Nigeria, dams with irrigation facilities and irrigable land (Fadama) were provided by government. More farmers in the north of Nigeria are engaged in Fadama agriculture than in the south as a way out of problems of short rainfall duration. Irrigation agriculture is gaining more popularity among farmers across Nigeria in the recent time because of the scourge of climate change. The World Bank Assisted Fadama I, II and III project is a right intervention in the right direction.

- **Enterprise Diversification**

There is never a time when climate does not change. Climate is expected to change, and it will continue. The dynamics of drought, flood and excessive heat will always trigger secondary stress such as the spread of pests, increased competition for resources and attendant loss of biodiversity. These will undoubtedly affect crop and farm productivity. To minimize the loss due to change in climate, enterprise diversification is being practiced by crop farmers. Farmers no longer or at least have minimized the practice of sole and mono cropping. Crop rotation practices, mixed cropping and mixed farming are now being seriously given consideration. Waste products from the enterprises are carefully being converted to wealth. Straw from crops are fed to livestock while livestock dung are applied as organic manure on farmland. Apart from cost reduction, the use of organic manure against conventional inorganic fertilizer to fertilize farmland enhances the ecology of the environment and minimizes the effect of climate change on farm productivity.

- **Agricultural Insurance**

Agricultural insurance is aimed at providing succor to farmers against all production risks. It is expected to help farmers mitigate the effect of climate change. Farmers insure their holdings with the high expectation that such insurance policy will offset the risk if claims from the insurance company are paid. Farmers are however skeptical about taking up insurance policy because of bottlenecks and stiff wall usually constructed by insurance company because of their unwillingness to pay claims.

- **Agricultural Research and Technology**

Technological development in agriculture has played a major role in helping farmers to cope with the scourge of climate change over the past decades. Agricultural research has been very effective in development of improved technologies adopted by farmers to cope with change in climate. The adoption of good farming practices and improved technologies by crop farmers has been helpful to mitigate the effect of climate. Many farmers do not know about improved varieties of crops. The adoption rate for improved seed and usage of other improved production inputs had improved among local farmers in Nigeria. In Nigeria varieties of hybrid seed released have characteristics that can be described as “climate change compliant” which range from high yielding, disease resistant, extra early maturing and also striga resistant. International Institute of Tropical Agriculture (IITA) in Nigeria has been playing a leading role in the production of improved agricultural technologies for farmers’ adoption. Research institutes should be further strengthened to develop technologies for soil fertility improvement, water harvesting and storage as well as improved postharvest storage facilities.

- **Water harvesting**

Oke et al (2011) identified the traditional sources of water supply in Sokoto and Kebbi to include rivers, lakes, pools, wells, seepages and springs. They reported surface water from rivers during the rainy season and water dug from shallow pits in the river alluvium or stagnant ponds in the dry season. In addition to these sources of water, water harvesting is done in most rural communities in Nigeria. Water harvesting is common in the savanna and arid zone in Nigeria. Water harvesting serves as insurance against drought. Efficient use of water resources should be promoted among the public and rural households.

Strategies for improving farmers coping mechanisms to climate change

Assisting farmers in Nigeria to improve climate change coping strategies is clearly an urgent issue. Improved coping strategies should be in line or at par with policies that seek to address vulnerability and poverty reduction among the rural and urban poor. With all seriousness, these strategies are suggested for implementation with dispatch.

- **Need for national response strategies**

There is an urgent need to institute National Climate Change Response Strategy in Nigeria. In case there is, this should take into account the socio-economic impacts of climate change on farmers, pay special attention to vulnerable groups in the agro-ecological zones in Nigeria and the resources upon which their livelihood are based. In line with this, there is the need for immediate policies to facilitate climate change coping response (CCCR). Such policies should be very simple and adaptable to regional and local situations in Nigeria. Implementation of such policies must not also be bedevilled with “administrative” bottlenecks as usual.

- **Responsive and reliable media strategies**

If farmers coping strategies to climate change should be made effective, the implication of climate change on crop farmers and Nigerians in particular need to be effectively communicated. Climate change needs to be given national recognition and treated as a national developmental issue that should be given first priority. A responsive and relevant media strategy particularly in the radio, television and other media where current affairs programmes frequently tie debates to topical national issues should be encouraged. Quite a number of radio and television stations should be encouraged to air public debate programmes on climate change. Access to information on media affects not only the farmers’ knowledge of innovation but also the whole process of diffusion and adoption of an innovation. Several studies on the use of some media such as radio (Kuponiyi, 2000; Omotayo et al, 1997, 1993); television (Omotayo and Arokoyo, 1993); and publications (Chikwendu et al, 2000), confirm the widely held views that these media are important either singly or in combination in the transfer of improved agricultural practices to farmers. These studies show that radio was particularly an important medium of innovation dissemination in Nigeria. Farmers faithfully followed scheduled farm broadcasts by the National Agricultural Extension and Research Liaison Services (NAERLS), and the ADPs on FRCN and other local radio channels in major towns. Studies also revealed that the most limiting factor in the use of publications in innovation dissemination was the low level of literacy among farmers particularly in the northern Nigeria even when some publications were produced in local languages and dialects.

This suggests that to improve media coverage on climate change issues, concerted media and communication strategies must as a matter of necessity be developed to provide a wide array of tools and key messages for different target groups across Nigeria. Non governmental organisations (NGOs), faith based organisations (FBOs) and community based organisations (CBOs) in Nigeria must be innovatively repositioned in various communities of their operation to raise awareness about climate change. Innovative approaches are needed to effectively create awareness. Capacity of local media operators also need to be constantly and effectively built to ensure impact sustainability.

- **Investment support to implement climate change policies**

There is the need to invest into capacity to implement climate change policies at both the regional and community level. The institution of national capacity in Nigeria should make provision for such supports at the regional and community level. NGOs, FBOs and CBOs should be supported both by farmers and government structures to effectively develop resilient adaptation strategies to climate change. Vulnerable groups with little coping capacity to climate change and who are currently facing intense socio economic challenges must be given special priority. Investment efforts should also aim at Promoting good land management and sustainable environmentally sound agricultural practices. New legislation on agricultural land use and management practices need also be enacted.

- **Need for public support**

Efforts are required at all levels to improve coordination, communication and seeking public support for the National Climate Change Response Strategy, particularly as adaptation responses would enhance development and service delivery at the local level. The public should back up the implementation of sound National Agricultural Policy.

- **Mainstream climate change coping strategies into development process**

An approach that seeks to mainstream climate change coping strategies into development processes will open up opportunity for participation and collective solution-seeking by all stakeholders, as opposed to that which is based purely on climate modelling exercises, which tends not to consider the opinion of ordinary citizens and policy makers. Therefore, a carefully monitored mix of top-down and bottom-up approach is needed to achieve integrated and very responsive national climate change coping strategy. The strategy needs to be revised to set the tone for provincial strategies that follow, while at the same time building the capacity of state and local governments to enable the integration of climate change adaptation into local development plans. Various resource users and interest groups need to participate in the development of climate change adaptation strategies.

- **Revitalization of irrigation and other agricultural infrastructure**

All irrigable land and irrigation equipments that have broken down especially in the Northern Nigeria need be revitalized and more irrigation facilities provided. Concerted efforts should also be made to provide the Southern Nigeria with irrigation facilities to reduce her dependence on rain fed agriculture. More state governments in south of Nigeria should take advantage of Fadama III and ensure that more farmers participate to improve upon their production practices as an opportunity for increased food production. With revitalization of irrigation facilities more farmland will be cultivatable while some crops such as cereal, pods and vegetables will also be produced throughout the year. Apart from promotion of improved crop, this will also promote improved livestock management practices. Food production which is a precursor to food security will then be guaranteed.

- **Revitalization of Agricultural Extension Services**

Government extension services are fast becoming moribund. Extension services personnel in government extension agencies are not working motivationally. Government also pays lip service to agriculture and where they look serious and determined, agricultural funds that are meant to be used to develop agriculture are mismanaged and oftentimes diverted to personal farms. Government agricultural policies are oftentimes not clearly defined, consistently applied and well executed. Government in Nigeria is politicizing agriculture and by extension toying with lives of people of Nigeria. Governments at all levels have been consistently inconsistent

with funding of agriculture. Private sector extension agencies and Non Governmental Organisations who had partnered with government to move Nigeria agriculture forward are being treated with disdain and suspicion. Most studies on the impact of different sources of information on adoption of agricultural innovations show that extension agents represent the most important and effective means of innovation dissemination (Omotayo and Arokoyo, 1993). The study which requires farmers to rank some sources of information on agricultural innovations in order of importance showed that the extension agent was consistently ranked as the most important by the majority of famers, closely followed by neighboring farmers and contact farmers. This finding suggests that extension agents will continue to play very important roles in the dissemination of innovations to farmers in Nigeria. There is therefore the need to reduce drastically the extension agent-farmer ratio, motivate extension agents and reposition them to provide farmers with firsthand technical information to effectively tackle challenges of climate change.

Conclusion

Fight against climate change can be made very effective. Collective effort of every Nigerian is required. How prepared are we to tackle the various threats posed by climate change to the development of Nigeria agriculture? We all generate some amount of waste daily. We are all involved in activities that can promote change in climate on a daily basis. We should be ready to conform to global tenets and practices in Nigeria. We all need change of attitude. We should all stop throwing waste into streams and rivers; and stop indiscriminately burning of bush. When we cut down a tree, we must endeavour to plant another in replacement. As a matter of necessity, we need to embark on recycling practices that will effectively convert our waste to wealth. Poultry waste, cow dung and other animal wastes should be cured, recycled and used as organic manure. Proven research results and workable technologies that can curtail excesses of climate change in Nigeria must be implemented. Government at all levels in Nigeria should be more responsive and serious with their promises to develop agriculture, provide abundant food, develop capacity of youths to be self reliant and support research and development in Nigeria.

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Indigenous Practices and the Challenges of Climate Change among Small-scale Farmers in Dekina Local Government Area of Kogi State, Nigeria

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Abstract

This study investigated indigenous agricultural practices and the challenges posed by climate change to small-scale farmers. A total of 120 respondents were randomly selected and interviewed. Important information on climate change and how they cope with its effect locally were solicited and data collected were analyzed using descriptive statistics. Indigenous practices regularly undertaken by farmers include, crop rotation, shifting cultivation, mulching, bush fallowing, use of organic manure, tillage, except that they claimed to rarely practice zero tillage. Over the last 10 years (2000-2011), farmers have experienced certain weather anomalies of which they claimed icluded increase temperatures, decline in rainfall and fluctuations in the intensity of harmattan, the intensity of sunlight, and change in their seasonal calendar and decline in crop yield over the last 10 years (2000 – 2011). It is obvious that some indigenous practices in a way ameliorate the effects of global warming by reduction of green house gas emission except for bush burning and deforestation. Hence farmers should be encouraged to improve and consolidate some of these indigenous practices, and as a matter of policy, extension workers should be made committed to this local campaign.

Introduction

Apart from the landless and urban poor, small farmers are among the most disadvantaged and vulnerable groups in the developing world. The share of surveyed smallholder households falling below the poverty line is close to 55% in most continents hence, the attainment of sustainable indigenous practices that are of food security friendly is pertinent Food and Agriculture Organization (FAO) (2000). Every farmer moderates available pool of Indigenous Knowledge (IK) to suite peculiar needs and micro-environment (Oyewole and Oyewole, 2010). Indigenous knowledge system is a diversified knowledge. It is specified to a locality and/or society. It often varies between countries, regions and societies/communities. IK also varies with the available resources and it includes a wide spectrum of areas in a farming system (Das Gupta and Saha, 2009). The rural populace has a better understanding of their environments in which they earn a living from than the well trained scientists who lack rural/local experience (Ifatimehin, 2009). They have fair knowledge of their local environment and the climate. This is why they are able to follow a particular seasonal calendar. Nigerian agriculture is actually characterized by small farm units, fragile soil, rain dependency with minimum inputs (Adedipe, Okuneye and Ayinde, 2004). Despite these features, the Nigerian resource-poor farmers have for ages sustained the national food supply through a considerable wealth of environment-related indigenous

knowledge in harnessing of natural resources and in the manipulation of socio-economic factors of production.

Global warming according to Intergovernmental Panel on Climate Change (IPCC) is the increase in the average temperature of the earth's near-surface air and oceans since the mid 20^{th} century and its projected continuation. Global surface temperature increased $0.74^{o}C \pm 0.18^{o}C$ ($1.33^{o}F \pm 0.32^{o}F$) during the last century (IPCC, 2007). The contributory factors to global warming include some human activities like deforestation, bush burning, oil spills, gas flaring, waste disposal and population growth (Adejo, Ibrahim and Onuche, 2010). The effect of global warming and climate change are of concern to both environment and human life. William (2007), in his study opined that unabated global warming will reduce global agriculture at least modestly by late this century (2080s), contrary to some estimates that it will benefit global agriculture over that period. The losses will be much larger if carbon fertilization fails to materialize, especially if water scarcity limits irrigation. Most climate change models predict that damage will be disproportionately borne by small farmers, particularly rain-fed agriculturalists in the Third World. In some African countries, yields from rain-fed agriculture - the predominant form of agriculture in Africa - could be reduced by 50% by 2020 (Altieri and Nicholls, 2004). Additionally, agricultural production in many African countries is projected to be severely compromised especially in dry lands. About 70% of Africans depend directly on dry and sub-humid lands for their daily livelihoods. And calculations reveal that policies supporting small farmer-centred agriculture, which also focuses on restoring soil fertility, would play a big role in resolving the worsening climate crisis. "In 50 years the soils could capture about 450 billion tonnes of carbon dioxide, which is more than two thirds of the current excess in the atmosphere (Anil, 2009). But that is only if agricultural sovereignty is returned to millions of small farmers and farming communities, and policies are formulated to support their livelihoods. Though, the indigenous people have always generated and transmitted knowledge or technology in an effort to cope with their own agro-ecological and socio-economic environment (Obiene, Ayawari and Timipere, 2010). Some of these technologies and practices include human and animal medicine, local weather predictions, soil and water conservation, shifting cultivation, bush fallowing, food production and processing, multiple cropping, pottery, building, bush burning, sand mining and smiting among several others.

Nigeria, like many countries within the semi-arid region of Africa has been beset by several climate anomalies during the last century. In particular, the weather variations experienced since the late 1960s through early 1970s to date have impacted on various environmental processes and human activities especially agriculture (Julius, Oyeleye, Oyamakim, Onikoro *et al*, 2009). According to Williams (2007), Nigeria is expected to witness an average of 15% reduction in agricultural production in the final three decades of this century (2080s) as a result of unabated climate change.

Indeed, climate change poses a direct threat to the livelihoods of many indigenous groups due to their traditional and continuing reliance upon resources harvested from their immediate environment. Indigenous peoples therefore deserve specific attention when considering this global threat.

Objectives of the Study

The objectives of the study were

(i) investigate the indigenous practices in farming;

(ii) determine the perception of farmers on climate change and its effect on farming system in the study area; and

(iii) identify traditional way of determining climate change.

Methodology of the Study

This research was carried out in Dekina Local Government Area, east of kogi State. The area falls between latitude $6^0.33^1$ and $8^0.44^1$, and longitude $5^0.22^1$ and $7^0.49^1$. The study area has a land mass of 2,461km^2 and a population of 260,312 heads at the 2006 census. The area is made up of 3 districts: Dekina, Okura and Braidu. The people of this area are predominantly small- scale farmers. They engaged themselves in both crop and animal production for domestic and commercial purposes.

A structured questionnaire was administered while oral interview complemented the questionnaire. A total of 120 respondents were randomly selected with forty (40) persons from each of the three (3) districts of the Local Government Area. Important information on indigenous agricultural practices in relation to their environment and climatic conditions were elicited from the respondents.

Data collected in this research were mainly subjected to descriptive statistics like frequency, percentage and mean scores.

Results and Discussions

Socio-economic Characteristics of the Respondents

Table 1 showed that 16.67% of the respondents fell under the ages of (20 -29) years old, 41.67% were between the class interval of (30 – 39) years, 25.83% fell within the ages of (40 -49) years and 15.83% were between the ages of (50 and above) years old. Most of the respondents fell within their youthful and middle ages, while a few of them were above middle ages. It is also reflected in Table 1, that 70.00% of the respondents were male while the rest of them (30.00%) were female. It shows that Farming generally is a male dominated one in the area, although the womenfolk are seen to have participated in post-harvest activities than their male counterparts. Table 1 also indicated the educational background of the respondents of which 31.67% of the respondents did not attain any form of formal education, 45.00% of the respondents attained primary school education, 15.83% of them went to secondary school, while only 7.50% of the respondents attended tertiary institutions. Socialization and civilization to a very large extent depend on the level of educational background of the individual that makes up the social system. Hence, the more educated one is, the more he/she becomes more civilized and informed and this will lead to bringing a balance between the traditional practices and scientific technologies.

Table 1 also revealed types of agricultural occupation of which 65.83% of the respondents participated in crop farming only, none of them were engaged in livestock production alone, while 34.17% of the respondents said they practiced mixed farming (both Crop and animal production). It is note-worthy here, that the occupation of the rural people is inseparable from their way of life. The life revolves round agriculture and crop production is the dominant farming system. This implies

that if Indigenous knowledge must be promoted and improved, there is need to acknowledge the significance of agriculture in the life of the people and act fast to improve and develop agriculture in the area. Table 1 reflected the farming/marketing experience of the respondents of which 8.33% had the experience of 1 - 5 years, 16.67% had 6 – 10 years of experience, 25.00% had 11 – 15years, and 37.50% had 16 – 20 years of experience while 12.50% had the experience of 21years and above. The implication of this result is that with these years of experience, the farmers were able to manipulate their agro-ecological environment and particularly the changing climatic conditions for the production of both crops and livestock. Hence, Ifatimehin, (2009), also opined that farmers over time have developed indigenous knowledge on how to manipulate their environment for their agricultural production.

TABLE 1: Socio-economic Characteristics of the Respondents

Variables	Frequency	Percentage
Age		
20 – 29	20	16.67
30 – 39	50	41.67
40 – 49	31	25.83
50 and above	19	15.83
Total	120	100
Gender		
Male	84	70.00
Female	36	30.00
Total	**120**	**100**
Educational Background		
Non-Formal	38	31.67
Primary	54	45.00
Secondary	19	15.83
Tertiary	9	7.50
Total	**120**	**100**
Farming Occupation		
Crop Production only	79	65.83
Livestock Rearing only	-	-
Mixed Farming	41	34.17
Total	**120**	**100**
Farming Experience		
1 – 5	10	8.33
6 – 10	20	16.67

11 – 15	30	25.00
16 – 20	45	37.50
21 and above	15	12.50
Total	**120**	**100**

Source: Field Survey, 2011

Indigenous Farming Practices

From Table 2, the respondents said that they agreed with the fact the following are their regular practices: crop rotation with 2.90 mean score , shifting cultivation (with mean score of 1.70, Mulching with 2.30 mean score , bush fallowing further confirmed by mean score of 1.97, use of organic manure with the mean score of 1.70, tillage has a mean score of 2.58, thinning with the mean score of 2.57, bush burning also further confirmed by a mean score of 2.57, and with the exception of zero tillage with a lower mean score of 1.47 signifying that it is rarely practiced by the farmers in the area. These results agree with Edoka, Adejo and Otitolaiye (2010) who study the soil fertility management techniques among rural farmers in Olamaboro Local Government Area of Kogi State.

TABLE 2: Indigenous Farming Practices in the Study Area

Traditional Practices	**Mean Score**
Crop Rotation	2.90
Shifting Cultivation	1.70
Mulching	2.31
Bush Fallowing	1.97
Use of organic	1.70
Tillage	2.58
Zero Tillage	1.42
Thinning	2.57
Bush Burning	2.57

Source: Field Survey, 2011

The Perception of the Farmers on Climate Change

Table 3 showed the perception of Farmers on the extent to which the weather elements have changed over time. Farmers (90.83%) said they have experienced fluctuations in Harmattan in the last 10 years owing to climate change effect. The Farmers (93.33%) agreed that there is an unusual increase in the temperature which explains the heat experienced by people these days. 91.67% of farmers in the area agreed that there is decline in the amount of rain in last 10 years as this has led to one planting season per annum as against the two planting seasons they normally have in a year. Julius et al (2009) also recorded an upward trend in temperature and a downward trend in the rate of change in rainfall. 94.16% of them indicated that they have experienced change in sunlight intensity, 82.50% of the farmers said they noticed decline in seasonal crop yield even though it favours

higher yield in some few tropical crops and 92.50% of the farmers said that as a results of all these changes they have to also alter their seasonal calendar. That is, it has made them to change some of their farming activities like planting dates, harvesting periods and time of cultivation.

TABLE 3: The Perceptions of Respondents on Climate Change (2000 -2011)

Indicators	Frequency	Percentage
Harmattan Intensity	109	90.83
Change in temperature (heat)	112	93.33
Change in the seasonal rainfall	110	91.67
Change in sunlight intensity	113	94.16
Change in seasonal crop yield	99	82.50
Variation in Seasonal Calendar	111	92.50

Note: Multiple Responses

Source: Field Survey, 2011

Conclusion

Agricultural practices whether indigenous or modern depend heavily on climatic conditions. Assessment of the effects of global climate changes on agriculture might help to properly anticipate and adapt farming to maximize food production. Therefore, to attain a sustainable food security against the inevitable effect of climate change on agriculture all the traditional practices especially those mentioned in this study should be upheld in order to cushion the effect of climate change on farming. Hence, the following recommendations should be given priority attentions:

1. Government of developing countries especially Nigeria, should focus its policy on how to harness indigenous knowledge and practices on key adaptations in agriculture aimed at changing agricultural practices to improving water efficiency and crop diversification.
2. It is also important to ensure the positioning of agro-metrological weather stations in all ecological zones of the country so as to raise awareness on climate change and its challenges among the local people. This can be chiefly achieved through geographic information systems and make it a participatory geographic information systems so that the local knowledge can be integrated into the systems.

3. IK should be fully integrated with ICTs. This should focus on building the local capacity for dissemination especially on television and radio broadcasts in local languages (folk media) in the rural areas and also establishing telecentres.
4. Development organizations and extension service providers should integrate IK practices in the design and implementation of development activities. This will require awareness raising among those who offer development advice; listening to and hearing clients to learn from local communities about what they know. Also, combining local knowledge with experience from around the world to find relevant and realistic solutions to the development problems of local communities.

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Indigenous Knowledge in Climate Change Adaptation Strategies among farmers in Kwara State, Nigeria

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Abstract

This paper highlights some indigenous adaptation strategies that have been practiced by farmers in Kwara State, Nigeria. Random sampling technique was used to select 176 respondents from 8 villages under the four agricultural zones of the Kwara State Agricultural Development Programme (KWADP). Data were collected through scheduled interviews and the results were analyzed using descriptive statistics.The results showed that70.45% of the respondents were male, 71.59% were married, mean age of the farmers was 46years and 87.5% were educated while 72.15% of them had not less than 14 years of farming experience. Farmers in this state, through their indigenous knowledge systems, have developed and implemented extensive adaptation strategies such as the planting of early maturing crops, offering prayers for good harvest, use of organic fertilizer, organic pesticides, adoption of hardy varieties of crops and selective keeping of livestock. Indigenous knowledge should be integrated into formal climate change adaptation strategies. This will add value to the development of sustainable climate change adaptation strategies that are rich in local content, and planned in conjunction with local people.

Keywords: Farmers, strategy, climate change, adaptation and indigenous knowledge

Introduction

All around the world, indigenous populations have lived in perfect harmony with nature. Over long period of time these populations have acquired knowledge about the inner workings of their immediate surroundings or environment. In the Sahel, local farmers have developed several adaptation measures that have enabled them to reduce their vulnerability to climate variability and extremes. One important step in reducing the vulnerability of a climatic hazard is the development of an early warning system for the prediction or forecast of the event (Ajibade and Shokemi, 2003). Accordingly, these populations have developed intimate knowledge on a wide array of topics ranging from environmental, biophysical, economic and social issues to spiritual knowledge, to a great extent, that many authors refer to this type of knowledge as traditional knowledge systems (Sand, 2002).

Under traditional systems, knowledge is being continuously acquired by men, women and children in a given society or community. Grenier (1998) and McGregor (2004) present traditional knowledge as a collective memory that is conveyed with speech from generation to generation through songs or tales and also through actions and observations. Otto (2008) defines local knowledge as knowledge outside of the formal scientific realm held by local people in a specific geographic area. The content of indigenous knowledge is not confined to one subject only but covers a wide range of diverse topics in a particular area. These include agriculture, animal husbandry, education, natural resources management etc. (Warren, 1991).

By virtue of the numerous topics that are included under the concept of indigenous knowledge and its use in local decision-making, it is deemed a vital resource for development initiatives and in many instances can be equal or superior to what is generally described as Western scientific knowledge (IIRI, 1996; Langill, 1999). Indigenous knowledge can provide currently constrained research and extension with low-cost solutions (Akegbejo-Samsons, 2009).

It is found from the literature that local people are aware of the changing climate and they devise their own adaptation measures based on their cultural practice and past experiences with dealing with environmental changes and natural disasters. These local knowledge and experience are used as a basis of decision making for food security, human and animal health, and resource management (Twinomugisha, 2005). Indigenous adaptation strategies are devised based on past experiences and handed down over generations as part of the culture of surviving harsh conditions. Traditional knowledge which is not based on facts is often dismissed my policy makers in favor of scientific methods (Mercer, *et al*. 2007). An example of this can be the case of adapting to a genetically modified seed instead of relying on traditional seed saving techniques. Although indigenous knowledge is not based on scientific facts, they are formulated on the basis of past observations and have been proven to be closely matched with scientific reality as indigenous measures do enable adaptation to harsh environment in many cases (Asheshwor, 2011). Indigenous knowledge is the resource that is most readily available to smallholder farmers

Problem Statement

Climate change issue has been a global challenge that the scientists have not been able to provide lasting solution to the menace. Therefore it is pertinent to think other ways out of the problem. In view of this, the importance of indigenous knowledge cannot be overemphasized

There is much to learn from indigenous, traditional and community-based approaches to natural disaster preparedness. Indigenous people have been confronted with changing environments for millennia and have developed a wide array of coping strategies, and their traditional knowledge and practices provide an important basis for facing the even greater challenges of climate change.

This general objective of this study is to identify indigenous adaptation strategies to climate change among farmers in Kwara State, Nigeria

The specific objectives include:

(i) to identify the personal characteristics of farmers in Kwara State

(ii) to identify the indigenous adaptation strategies used by farmers

(iii) to ascertain constraints to climate change adaptation by these farmers.

Methodology

This study was carried out in Kwara State, Nigeria. It is located in the agro-ecological zone of the country. With a population of about 2.37 million (Census, 2006), and is made up of four ethnic groups namely; Yoruba, Nupe, Fulani and

Baruba. The state is made up of four zones. It has about 260,528 farm families (KWADP, 2010) and about 36,820 hectares of farmland (FOS, 2005). The state lies between latitudes $7^0$45'N and $9^0$30'N and longitudes $2^0$30'E and $6^0$35'E. The annual rainfall pattern across the state extends between the months of April and October with minimum temperature ranging from 21.1^{0}C to 25^{0}C while maximum average temperature ranges from 30^{0}C to 35^{0}C. The population of the state is predominantly farmers that specialized in arable crops such as groundnut, shorgum, cassava, yam, cowpea, maize, yam and rice (KWADP, 2010).

The target population for the study was made up of the arable farmers in the selected local government area(LGAs) in the state. Four LGAs areas were selected from the four agricultural zones of the Kwara State Agricultural Development Programme (KWADP) in such a way that all the four zones were included.

Two (2) villages were then selected randomly from each local government area, making a total of eight (8) villages. Twenty two (22) farmers were selected from each village amounting to 176 farmers. The data for this study were obtained with the use of well-structured questionnaires augmented with personal oral interview. The use of interpreters was also employed, where necessary, to enhance better communication with the respondents. Dependent and independent variables were measured using statistics tools.

Simple descriptive statistics involving frequency counts, mean and percentages were used in the analysis of the data.

Results and Discussion

Demographic Characteristics

Data in Table 1 shows that 70.45% of the respondents were male while 29.55% were female. The reason for this likely stems from the fact that the male are more capable of doing tedious work, associated with farming, than the female. The modal age range is 41 – 50, with an average of 36years. This implies that most of the farmers are still within their active and productive age. 71.59% of the respondents were married, 87.5% of the respondents had formal education. Majority (52.84%) of the respondents from villages studied were mainly farmers. The modal farming experience is 11-15 years while the mean is 14 years. This likely indicates that the farmers have acquired relevant skills over time in coping with the effects of climate change over the years.

TABLE 1: Distribution of Respondents according to their Personal Characteristics

Characteristics	Frequency	Percentage
Age(Years):		
≤ 30	17	9.66
31 – 40	36	20.45
41 – 50	58	32.95
51 – 60	53	30.11
> 60	12	6.82
Total	176	100
Gender:		
Male	124	70.45
Female	52	29.55
Total	176	100
Marital Status:		
Single	16	9.09
Married	126	71.59
Divorced	9	5.11
Separated	11	6.25
Widowed	14	7.95
Total	176	100
Level of Education:		
No formal education	22	12.5
Adult education	23	13.07
Primary education	58	32.95
Secondary education	67	38.07
Tertiary education	5	2.84
Others	1	0.57
Total	176	100
Primary Occupation:		
Farming	93	52.84
Trading	19	10.80
Weaving	1	0.57
Civil Servant	4	2.27
Others	2	1.14
Farming & Trading	30	17.02

Farming & Civil Servant	15	8.52
Farming & Others	11	6.25
Farming & Weaving	1	0.57
Total	176	100
Farming experience(years)		
1-5	19	10.8
6-10	36	20.45
11-15	72	40.90
16-20	43	24.40
Above 20	6	3.41
Total	176	100

Source: Field Survey, 2011

Indigenous Adaptation Strategies

Results in Table 3 show that farmers use organic fertilizers, use of some plants to control pests, traditional erosion control , changing crop cycle ,use of organic fertilizer , use of flood resistant rice. Planting maize, fruits and vegetables in mountain region have changed their cropping.

Patterns to suit the climate as well as keep up with demand. Farmers have avoided planting crops that are easily damaged by water in areas prone to flooding. On the other hand, farmers in the mountain region are taking advantage of higher temperature and are trying crops like corn and vegetables. Farmers replaced rice crops with sugarcane so as to cope with uncertain rainfall. Indigenous methods to ensure protection of the environment ranges from offering prayers for good harvest to use of organic fertilizer, organic pesticides.

TABLE 3: Summary of Indigenous Adaptation Practices

Farming	F	%	Land Use	F	%	Flood	F	%	Water conservation	F	%
1.Use of organic fertilizers	100	57	Controlling forest fires Using marginal land for fodder farming	120	68	Storing seeds on upper level to avoid flood damage	140	80	Water conservation Preserving trees around water source	99	56
2. Use of some plants to control pests	80	46	Controlling erosion using traditional irrigation	145	82	Rearing cattle on higher grounds	35	20	Water harvesting from rain and river Irrigation	150	85
3.Traditionaerosion control	155	88	Owning land in two places	140	80	Capturing upland forest land Temporary migration upland	90	51			
Changing crop cycle	98	58									
Use of flood resistant rice	80	46									
Planting maize, fruits and vegetables in mountain region	120	68									
Plant crops demanding less rainfall Indigenous seed saving Mulching	110	63									

Source: Field Survey, 2011 no of respondent is 176, F=FREQUENCY

Constraints to adaptation:

The under listed were common constraints reportedly faced by farmers to efficient and sustainable adaptations to climate change. The data in table 3 indicate inadequate information on weather, limited access to land, limited access to credit, lack of money, limited mobility and lack of irrigation water as constraints to adaptation to climate change indicated by the farmers. However, the major constraint ranked first was lack of money and access to credit

TABLE 3: Constraints to adaptation to climate change

Constraints	Frequency	Percentage	Rank
• Inadequate information on weather	170	97	3rd
• Limited access to land	70	41	6th
• Limited access to credit	176	100	1st
• Lack of money	176	100	1st
• Limited mobility	120	68	4th
• Lack of irrigation water	100	57	5th

Source: Field Survey, 2011

Conclusion and Recommendation

It is found from the study that local people are aware of the changing climate and they had devised their own adaptation measures based on their cultural practice and past experiences with dealing with environmental changes and natural disasters. They employ traditional, local and indigenous knowledge based practices (though it differs according to location) in order to cope with the negative impacts of climate change. These include: knowledge of indigenous plants, food preservation techniques, seed selection to avoid drought, disease control in livestock, among others.

We need to rethink development with traditional knowledge and local indigenous knowledge being built into the process. Indigenous and local knowledge must not only be sought and recognized, but also integrate with western scientific knowledge for the design and implementation of best practices in climate change adaptation strategies. It should be understood, enhanced and exploited as part of climate change policy.

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Adapting Effective Environmental Extension Services for Propagating Climate Change Adaptation Strategies in Nigeria

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Abstract

Climate change is a global challenge but effective and efficient environmental extension services seem a potent weapon for tackling the hydra –headed problem. Almost all forms of modern day development efforts trigger off environmental degradation in addition to the age – long traditional practices such as deforestation and grazing, solid mineral exploitation, industrial waste releases, and air pollution through release of toxic gases from factories and refuse dumps. Uncontrolled population growth and poverty have also been directly linked with environmental degradation. Effective environmental extension service is the only viable option for combating environmental degradation in developing countries such as Nigeria. No wonder, therefore, that numerous international organizations, developed countries, the World Bank and non- governmental organizations (NGOs) support environmental extension service projects. It is concluded that as a result of the link between poverty, population growth and environmental degradation, climate change should be treated as an integral part of any environmental degradation control and climate change adaptation strategy. Also, possible control strategies should include education, enlightenment programmes, research efforts and workable legislation in order to estimate incremental levels of attainment.

Key words: Environmental degradation, effective extension services, adaptation strategies, climate change

Introduction

The world's climate is getting hotter. The 20th Century was the warmest the world has seen in 1,000 years, and the 1980s and 1990s were the hottest decades on record. Increasing temperatures have several effects on our planet's weather systems including changes in rainfall and wind patterns, the amount and distribution of precipitation, and the type and frequency of severe weather events, such as hurricanes and storms.

According to Oxford dictionary, environment is the geographical and physical location in which human beings live, work and produce and it is therefore location - specific. Current concern in the environment stems from evidence that natural processes are being disrupted by productive activities to such an extent that the quality of life or even life itself is being threatened. A definition of sustainable environmental therefore should depend on the balances between economic development and resource quality and availability in any given locality while environmental degradation is understood as a decline in resource quality and quantity in the structure of an ecosystem. A theoretical definition of environmental degradation implies a link between resource quality and the impact of resource decline on people and in particular the poor's livelihood and standard of living.

Throughout world history, one of the greatest and most persistent threats to human existence has been environmental degradation. It is no wonder, therefore, that all the countries of the world devote a lot of energy and resources in tackling this critical problem. Disturbed by the alarming rate of environmental degradation all over the world, the United Nation's Conference on Environment and Development (UNCED) met in Rio De Janeiro Brazil in June 1992 for the first time ever to address a common global issues relating to environment.

Most developing countries including Nigeria are faced with the problem of ensuring acceptable economic growth but are also confronted by deteriorating environment. The problem of environmental deteriorating is due to environmental degradation and its attendant consequences, such as poverty, unemployment etc. The improvement of quality of life poses one of the most critical and challenging tasks facing the Nigeria today. The tools for reversing this problem are effective and efficient environmental extension services and technological intervention that is economically viable, culturally adoptable, socially and ecologically sound and compatible. This paper examines the concept of climate and environmental extension, climate change in Nigeria, environmental degradation, role of environmental extension services and strategies for adaption to climate change among others.

The concept of environmental extension service

Effective environmental extension service is a conscious awakening of occupiers of certain environment to the recognition of the importance of the environment and the need to relate to it with due consideration. It can be described as a moving force that seeks to correct past misconducts against the environment and instil discipline into dependents of the environment concerning future uses. Attempts to stimulate global action to mitigate environmental degradation have been difficult mainly because of the lack of consideration for the variation in people's understanding of and relationship with the environment. The dialectical relationship between people and the environment necessitates that every adverse change in the environment whether natural or inflicted, would trigger off a reciprocal social adjustment to ensure the survival of the people in the environment.

Environmental degradation: Nigeria experience

Environmental degradation can be described as the gradual reduction in the capacity of the environment to satisfy some specific needs as a result of natural disasters or human mismanagement (Kuponiyi, 2001). Engagement in primary production activities such as agriculture, forestry, fishing and mining are dependent on environmental exploitation and these are antecedents to environmental degradation. Environmental degradation manifests in the forms of land degradation. Food and Agriculture Organization FAO (1990) reports that sub-Saharan African forest cover estimated at 679 millions hectares in 1980 has been diminishing at the rate of about 2.9 million hectares per annum due to increasing rate of deforestation. The report further notes that degraded soil loses its water absorption and retention capacities with adverse effect on vegetation growth.

The rising concern with environmental challenges in Nigeria as a result of climate change and the need to adopt a sustainable strategy to cope with the effect of this natural phenomena. According to Nwachukwu (2002), experience global change in climate as a result of human activities and nature. Although, Nigeria is blessed with

rich and diverse flora, fauna and habitat that are declining in both quantity and quality due to the uncontrolled exploitation and mis-use of natural resources as well as the effect of climate change. Human assault on the environment continue to have a far reaching consequences on the integrity of the planet and its living despite the implementation of the various international convention and protocols relevant to biodiversity, conservation, environmental protection and adaption to climate change to which Nigeria is a signatory.

Climate change has had significant effect on the environment which directly affect human activities most especially in the area of food crop production, livestock production water supply and choice of livelihood.

Environmental menace such as drought and desertification constitute natural hazards to Nigeria as it is associated with substantial loss of vital land or deterioration of land quality in the affected areas. The extensive disintegration of the soil through soil erosion as a result of excess rainfall, de-vegetation and rain storms, and leaching of the nutrients are aggravated by climate change which reduces the productivity of the land to the bearest minimum (Oyesola and Oladeji, 2002). The effect of climate change and eventual change in the environment has affected in no small measure livestock production in Nigeria. Drought for instance, affects water and food sources for livestock and human which lead to competition between the two and the latter is frequently the loser. For instance, under the prevailing nomadic pastoral system in Nigeria, starving animals have to travel great distance on the hoof in search of food and water. This usually results in mass death of livestock. For instance, the estimated losses of livestock (cattle, sheep and goat) in the four hardest hit state in 1998 to 2000 was between 1.2 – 2 million representing about twenty percent of the Nigeria total livestock population.

Also, an environmental challenge that arises as a result of climate change manifest itself in the area of water supply for human and animals. It has been observed that accelerated surface run-off as a result of heavy downfall induced by climate change and de-vegetation of the soil by human activities reduce water quality and increases the cost of water used in the country. Some of the most hitted states are Delta State and Ebonyi State,

Environmental degradation and the loss of natural habitat are (human - induced and it takes the concerted effort of people everywhere to provide solutions to many of our environmental problems. The levels and types of environmental degradation vary from country to country.

Furthermore, the traditional mechanism by means of which people were made environmentally conscious from generation to generation seems to have broken down under new and changed circumstances.

Causes of Environmental Degradation

Many studies have linked population increases with environmental degradation (Eboh, 1995, and Kuponiyi 2001). Some others directly link it with poverty (WCED, 1987, Titilola, 1994, Beak *et al*. 1997). While others see it as a direct consequence of development processes (Titilola 1994, Batie, 1992, Dasgupta and Maler 1990).

Titilola (1994) observed that the degradation of environment as reflected in deforestation, soil erosion and the misuse of land is promoted by population

pressures, poverty and the use of inappropriate technology. According to Eboh (1995) environmental degradation, population growth and poverty are closely intertwined. This is the situation in many countries of Sub - Saharan African where hundreds of millions of people live in abject poverty, surviving on less than $370 a year (World Bank, 1989). Some causes of environmental degradation include:

(i) Poverty

Poverty may be created by negative and unjust social conditions such as structural in-equality, ill health, poor nutrition, low morale and motivation, ignorance, non-availability of basic needs, which make life a bit more liveable (NEST, 1991). Poverty pollutes the environment, creating environmental stress in different ways. Those who are poor and hungry will often destroy their immediate environment in order to survive. They will cut down forests, their livestock will overgraze grassland, they will over use marginal land and in growing number, they will overcrowd into congested cities (The World Commission for Environment and Development WCED, 1987). The forces of poverty rather than perversity compel the poor to deplete natural resources. Batie (1992) reported that since poor households must ensure their survival they frequently have no choice other than to exploit and degrade their environment especially their land resources.

(ii) Population growth

Rapid and uncontrolled population growth stimulates higher and urgent need for increasing agricultural land. This in turn brings about shortening of fallow periods and migration into marginal land and forest reserves. Igbozurike (1990), Eboh (1993) and Okafor (1998) in separate studies found significant associations of higher population densities and shorter fallow periods and/or declining soil fertility in South - Eastern Nigerian. Igbozurike et al (1989) reported that as Nigeria population grows, as the present land uses become more intense, as new spaces and other resources are pressed into national service and as Nigeria's resource conversion capabilities rise, the size and complexity of land degradation definitely will increase in the country.

Climate change in Nigeria

Nigeria is one of the countries in the world that are most vulnerable to impacts of change because widespread poverty and low levels of technical development that limit adaptation capabilities. There is considerable evidence that climate change is already affecting Nigerians people and its environment. Much of the increase in GHGs is the result of human activities such as:

Deforestation for timber or clear land for farming, and the subsequent burning of wood, release carbon into the atmosphere that would otherwise be stored in the trees.

Many agricultural activities release GHGs. For example, methane is released by livestock during enteric fermentation (which takes in the digestive systems of ruminant animals). And nitrous oxide is used to make many fertilizers.

These activities have increased dramatically in recent years, as country burn fuels to power their economies and clears their forests to give way for settlements and farming. The rapidly rising country’s population is also increasing the demand for farmland and livestock products. This means GHGs emissions are likely to continue to rise.

The impacts of climate change are predicted to affect the livelihoods of Nigerians in many ways. For instance, by 2020, between 10 – 12 million people are predicted to be exposed to increased water stress due to climate change. Also, by 2020, yields from rain-fed agriculture in many part of the country could be reduced by up to 50 per cent, increasing food insecurity and hunger.

Climate-change is likely to affect the distribution patterns of infectious diseases; for example, there is likely to be an increase in mosquitoes which may spread dengue and yellow fever.

According to Nwachukwu (2002), there is severe evidence of climate change in Nigeria in recent time most especially in temperature and pattern of rainfall distribution which has affected all aspect of human life and their livelihood the most significant climatic changes predicted during the 21st Century will affect the temperature. There is some uncertainty about the extent of these changes, but models show that minimum and maximum temperatures could increase by around 5^0C in some parts of Nigeria. Daytime temperatures could reach levels unknown outside of hot desert regions. He went further to state that plants that require low temperatures at some stage of their life cycle may adapt and survive in the short term. But in the long term, many could become extinct. These changes will affect vegetation types, including crops. In his own contribution Adisa *et al* (2005) asserted that in the first half of the 21st Century, crop yields in West Africa could increase because of increased water availability, increased solar radiation and higher concentrations of atmospheric carbon dioxide. However, crop yield projections for the second half of the 21st century many show much lower yields, due to temperatures that are too high for crops to grow. Peasant households are particularly at risk from falling crop yields, due in part to their dependence on agriculture, and factors such as poor health and poverty.

Extended range weather forecasts are fundamental for all climate change adaptation strategies. Skilful weather forecasting will be particularly important for farmers, as prior knowledge of the weather in a growing season will enable them to plan with greater confidence to reduce negative impacts and exploit opportunities.

However, there is room for improvement in weather forecasting in Nigeria. Many existing forecasts are of limited use; they are for extensive zones or time periods, but farmers need information specific to the onset and end of growing seasons in each agro ecological zones.

Important approaches will include:

(i) Climate models provide forecasts in higher time and spatial resolutions. This can be achieved through making predictions using higher spatial resolution sea surface temperature measurements, and using more climate stations for regional forecasts.

(ii) Nigeria needs policies to make crop production systems less sensitive to climate variability and climate change, for example through the development of improved seeds and cultivars.

(iii) The country also needs strategies to improve the adaptive capacity of peasant households, in terms of poverty reduction, better education and improved public health.

Strategies for Adapting to Climate Change: The Need for Environmental Extension

Various strategies could be employed through effective environmental extension services meet to address the issue of sustainable adaptation to climate change. An interdisciplinary approach to the management of environmental challenges cause by climate change would be appropriate because the issue of climate change and its effect on the environment cut across various disciplines that are inter-related.

Local knowledge and traditional adaptation strategies to climate change should be harmonized by environmental extension service delivery team. The indigenous knowledge of the local people is of paramount importance in order to address the menace of the climate on their livelihood activities. This implies that environmental extensionist should study the post culture and their tradition way of handling environmental challenges and base on these a sustainable adaptation strategy will evolve.

Participatory strategy for attaining effective environment extension service. This implies that all stakeholders in an environment have to work together to arrive at an appropriate and sustainable strategy for adapting to effect of climate change. Farmers as part of the extension team are to work with others like the subject matter specialist, extension agent and community leaders to achieve a socially acceptable and economically viable ways of handling the effect of climate change on their livelihood activities.

Environmental Extension Services for Controlling Environmental Degradation and Adaptation to Climate Change

Current trends in environmental studies are obliging extension scientists to fundamentally reassess it approach to addressing environmental concerns. Environmental extension should now conceptualize the function of extension as facilitating the identification, mobilization and integration of different relevant types of knowledge so that new sustainable practices may emerge locally. This is in contradiction to the former conceptualization of extension as the transfer of knowledge, practices, technology or information. Environmental extension should therefore concentrate on the facilitation and improvements of the social learning processes, not technology transfer. This is through involving different groups dealing with environmental issues in the social learning process.

Environmental extension describes man's effort at protecting and enhancing the environment so as to preserve it from further exploitation leading to environmental degradation, and unless conscious efforts are made the degradation may deteriorate so much that the environment may be completed destroyed.

It is important to examine the indigenous environmental extension practices of the rural people, especially the farmers. Wilson (1993) observed that the rural people often have a special relationship with the natural environment by virtue of their direct and heavy dependence on such primary natural systems from forests, water and soil for survival and hence they have vested interests in sustainable environmental protection.

It is believed that the problem of environmental degradation can be solved by a combination of three things education, research and legislation Local people should be informed of the dangers that environmental degradation poses to life and they should be made aware of the need to accept and even demand control of the dangers. In addition to exposing the local people, especially farmers, to the benefits

of new technologies and practices such as pesticides, herbicides and fertilizers, extension workers should acquaint the people with their side effects.

The next measure in reducing environmental degradation with least damage to industrial efficiency, plant and animal coexistence is research. Problems of the people should be thoroughly investigated to obtain appropriate solution. Investigation into the problems of environmental degradation requires integrated approaches involving different professions. For instance such approaches may have to include the control of the naturally or artificially caused problems and those emanating from government policies. Environmental degradation problems that can be effectively and efficiently handled by local people should be identified and isolated from those that can only be attended to by government.

Legislation is another major measure for environmental degradation control. People may not comply with certain control measures unless they are compelled to do so through legislative acts, such act should be given high publicity and enforced. Others needed to protect life and the environment should be so enacted and enforced. While prohibiting some degradation enhancing activities of the people with legislative acts, it must be combined with research to offer the people alternatives so as to reduce the inconveniences and discomfort of such acts. These three measures (education, research and legislation) are interconnected. For instance, legislation can be made on research to find control of environmental degradation people need to be educated on the findings, and legislation for awareness and compliance is also essential.

People need to respond to the challenges posed by climate change but they have limited access to meteorological reports and are unprepared for anticipated climatic variations. Many farmers feel isolated and despair due to poverty and low income. Access to information on climate change should be the responsibilities of environmental extension practitioners and other stakeholders- especially farmers, researchers and governments in order to improve adaptation strategies and better environmental safety.

Conclusion and recommendation

Nature and man cause environmental degradation. It is known also to be detrimental to life. Environmental degradation could result to losses of aquatic resources and constitute danger to life. Three measures, namely education, research and legislation are recommended for the control of environmental degradation. Degradation cannot be totally prevented, but it can be minimized to some degree. The task of environmental degradation control should be left in the hand of experts who know what to do at the right time. Policy makers should listen to the experts and back up their advice with legislative powers as the needs arise; it also requires multi - disciplinary and inter-departmentally coordinated approaches. This is because there is no single discipline or department that could lay claim to the solution to the problems associated with environmental degradation. Consequently, this paper has simply presented and expressed views with the hope of sensitizing government and/or policy makers on the several causal factors of environmental degradation. Strategies, which will ensure adequate control of the environmental degradation, are also discussed.

Finally, the rate of environmental degradation could be halted by a new change of effective and efficient environmental extension services, which involve participation of all stakeholders at every decision level.

It is the submission of this paper to make the following recommend

(i) That the government at all levels should intensify efforts in enlighten the general public on the challenges created by climate change through the mass media.

(ii) Regular training and re-training of extension workers/change facilitators to empower them to cope with the challenges of their profession created by climate change in order to enhance better job performance.

(iii) Indigenous knowledge used by local people should be incorporated into the adaptation strategies used by extension workers throughout the country.

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Overview of the Effects of Climate Change on Agricultural Productivity in Nigeria: Adaptation and Mitigation Strategies

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Abstract

This paper is an overview of the effects of climate change on agricultural productivity in Nigeria. It defines the concept of climate change and examines the causes and effects of climate change on agricultural productivity. It also analyses indicators of climate change, adaptation and mitigation strategies. The paper ends with recommendations that more awareness campaign on afforestation, causes, effects and adaptation to climate change be intensified throughout the 36 states including the Federal Capital Territory, Abuja and the 774 Local Government Areas in Nigeria; information on climate change and adaptation strategies should be made accessible to rural farmers through the use of folk media and interpersonal diffusion channels; more meteorological research centers should be established and decentralized to all the 36 States of the Federation; telecommunications service providers should be encouraged to send short messages on climate change to their clientele at regular intervals; and a legislative policy framework with workable policy instruments should be put in place to checkmate human activities that abet emissions of green house gases in Nigeria.

Keywords: Climate change, effects, adaptation, mitigation, agricultural productivity.

Introduction

Africa is generally acknowledged to be one of the most vulnerable continents to climate change. And of the African countries, West African countries are the most vulnerable to the vagaries of the climate, as the space and the impacts of the climate variability over the last three to four decades have shown (IPCC, 2007). According to Hannah *et al*. (2009), Scientists are clear that climate change is real and is happening, and it is due to emissions of greenhouse gases produced largely by the industrialized countries. And that those likely to be worst affected are the world's poorest countries, especially poor and marginalized communities within these countries. Ironically, it is these poor countries and people who have contributed least to the problem of climate change that are suffering most from the consequences of greenhouse emissions. The industrialized countries have accepted that they have a responsibility to help the poor and vulnerable countries to adapt to climate change (UNFCCC, 1994). However, until recently, most adaptation efforts have been top-down, and little attention has been paid to the vulnerable countries and their efforts to cope with their changing environments.

Recent food crises in some West African countries such as Nigeria, the Democratic Republic of Congo, Somalia, Ethiopia, Uganda, Burundi, Rwanda, Sudan, Chad,

Zimbabwe, Liberia and Sierra Leone are clear indicators of the continued vulnerability of the region to the vicissitudes of climate conditions. This according to Spore (2004) is due to weak institutional capacity, limited engagement in environmental and adaptation issues, and non recognition and appreciation of the indigenous Knowledge Systems of the people.The issue of climate change has become more topical and threatening, not only to the sustainable development of socio-economic and agricultural activities of any nation, but to the totality of human existence (Adejuwon, 2004).

Nigeria has a teeming population of 140million people and a land mass of 923,769 square Kilometers (NPC, 2006). This population depends either directly or indirectly on agriculture and about 75 percent of this populace lives in rural areas, where they subsist on agriculture. It is evident that climate change has adverse impact on Nigeria, particularly in the areas of agriculture, land use, energy, biodiversity, health and water resources (IPCC, 2007). According to Abaje and Giwa (2007), the most devastating adverse impacts of climate change in Nigeria and other subtropical countries include frequent drought, increased environmental degradation, increased infestation of crops and livestock by pests and diseases, increased biodiversity loss, depletion of wildlife and other natural resource base, changes in the vegetation type, decline in forest resources, decline in soil conditions, increased health risks and the spread of infectious diseases.

According to IPCC (2007), Nigeria ought to be more concerned about climate change because of her high vulnerability due to her long (800 km) coastline with its confluence at river Niger in Kogi State that is prone to sea-level rise and risk of fierce storms. Moreso, about 68 percent of the land cover in Nigeria is prone to drought and desertification, especially in the northern parts of the country. Its water resources are under threat, which seems to affect energy sources like Kanji and Shiroro dams. Besides, rain-fed agriculture practiced and artisanal fishing activities are also under serious threat. Much of the Niger-Delta wetland areas in Nigeria are endangered due to climate change, as witnessed by the significant reduction of their sizes in recent years. According to BNRCC(2008), the maximum flooded are of the Niger-Delta, which is the second largest wetland area in Africa, has drastically dropped from approximately 37,000 kilometer square in the early 1950's to 15,000 kilometer square in 1990's, coupled with the environmental degradation which crude oil exploration has done to the Niger-Delta wetland areas.

Recent researches have revealed that the intrusion of salt water in the water table of coastal zones of Ayetoro Community in Illaje Local Government Area of Ondo State, in Nigeria has led to increased salinity of the soils. According to Apata (2006), the already encroaching water is making life very difficult, since it is very difficult now for food crops to grow on saline soils. According to this scholar, most of the coastal communities in Nigeria are afraid that one day, they would be swept away by rising sea levels or flood.

Agriculture places heavy burden on the environment in the process of providing food and fibre. According to Lobell *et al*. (2008), climate is the primary determinant of agricultural productivity. Climate change influences crop and livestock production, hydrological balances, input supplies and other components of agricultural systems. However, the nature of these biophysical effects and the human responses to them are complex and uncertain. Considering the fundamental role of agriculture in

human life, it has thus become pertinent to examine the potential effects of climate change on agricultural productivity in Nigeria.

Problem Statement

In recent time, Nigeria has been experiencing severe and extreme flooding, increased environmental degradation, frequent drought, increased loss of biodiversity, changes in vegetational cover and declined forest resources.

Efforts made by the Federal Government through remittance of Ecological funds to all the Governors of the 36 States, including the Federal Capital Territory (FCT), Abuja to control all these natural and anthropogenic phenomena have not yielded the desired results. This trend is worrisome.

Albeit a lot of research work on climate change has been done by many scholars, little or nothing has been done on mitigation and adaptation strategies to climate change.

Since nature adhores a vaccum, it has thus become imperative to fill this research gap.

From the foregoing, the following research questions are germane to this work:

1. What is climate change?
2. What are the causes of climate change?
3. What are the indicators of climate change?
4. What are the effects of climate change on agricultural productivity?
5. What are the strategies for mitigating climate change? and
6. How can farmers adapt to climate change in Nigeria?

Objectives of the study

The broad objective of this study is to review the effects of climate change on agricultural productivity in Nigeria.

The specific objectives of this work are to:

1. define the concept of climate change
2. describe the causes and indicators of climate change
3. examine the effects of climate change on agricultural productivity.
4. identify strategies for mitigating climate change, and
5. determine adaptation strategies to climate change.

The Concept of Climate Change

Climate change according to Mendelsohn *et al.* (2006) is an environmental, social and economic challenge on a global scale. The most general definition of climate change according to Houghton (2001) is a change in the statistical properties of the climate system over periods of decades, regardless of the cause. The term is sometimes used to refer specifically to climate change caused by human activity. The United Nations Framework Convention on Climate Change (UNFCCC) defines climate change as a change which is attributed directly or indirectly to human activity that alters the composition of global atmosphere and which is in addition to

natural climate variability observed over comparable time periods (UNFCCC, 1994). This latter definition is synonymous with global warming and it implies so.

According to Hannah *et al.* (2009), climate change refers to short, medium and long-term changes in weather patterns and temperature that are predicted to happen, or are already happening as a result of anthropogenic emission of green house gases such as carbon dioxide. These changes include a higher frequency of extreme weather events such as drought and floods, as well as greater unpredictability and variability in the seasons and rainfall. According to Hannah *et al.* (2009), overlying this increased variability are expected long-term changes such as temperature and sea-level rises, and low or higher rainfall.

Causes of climate change

Climate change is caused primarily by the release of "greenhouse" gases into the atmosphere. These gases accumulate in the atmosphere and this development leads to global warming. These green house gases include carbon dioxide (CO_2), methane (CH_4), and Nitrous oxide (N_20). The emission of these gases could be brought about by natural phenomena, human activities and agriculture. By global warming, it means that many dry areas are going to get drier, while wet areas are going to get wetter. The major causes of climate change can be subsumed under the following broad factors:

1. Natural causes of climate change

The earth's climate change is influenced by natural phenomena such as volcanic eruption, ocean currents, the earth's orbital changes and solar variations.

(a) Volcanic eruption: when a volcano erupts, it releases large volume of sulphur dioxide (SO2), water vapour, dust and ash into the atmosphere. Besides, green house gas, carbon dioxide is also produced. The large volume of gases and ash can influence climatic patterns for years by increasing planetary reflectivity that causes atmospheric cooling.

(b) Ocean currents: The oceans are a major component of the climatic system. Ocean currents make vast amount of heat across the planet. Winds push horizontally against the sea surface and drive ocean current patterns. Interactions between the ocean currents and the atmosphere can also produce phenomena such as change in the Pacific Ocean currents, a periodic change in the currents of the Pacific Ocean that occurs every five years and brings unusually warm water to the coast of Northern South America. This often leads to severe climate disruption to countries within and near the Pacific Ocean. The ocean currents play an important role in determining the atmospheric concentration of CO_2 and changes in ocean currents circulation affect climate change through the movement of CO_2 into and out of the atmosphere.

(c) Earth orbital changes: The earth makes one full orbit around the sun every year. It tilts at an angle of 23.5^0 to the perpendicular plane of its orbital path. Changes in the tilt of the earth can lead to small but climatically important changes in the strength of the seasons, as more tilt means warmer summers and colder winters, while less tilt means cooler summers and milder winters. It should equally be noted that slow changes in the earth's

orbit can lead to small but climatically important changes in the strength of the seasons over tens of thousands years.

(d) Solar variations: The sun is the source of energy for the earth's climate system. Albeit the sun's energy output appears constant on a daily basis, small changes over an extended period of time can lead to climate change. Since the sun is the main source of energy for the earth's climate, changes in the sun's energy output can engender climate change, all things being equal.

About half of the sun's energy reaching the top of the atmosphere penetrates to the earth's surface as short wave radiation. The rest is either reflected back into the space or absorbed by gases and dust particles. The solar energy that reaches the earth's surface warms the land and oceans. In turn, the land and oceans releases heat in the form of infrared radiation or long wave radiation. Green-house gases absorb some of this radiation, acting like a blanket and thus keeping the planet warm enough to sustain life. This is what is called the natural green house effect.

2. Human causes of climate change

Recent research findings have revealed that the warming of the earth is caused by human activities such as burning of fossil fuels and changes in land use, including agriculture and deforestation. Fossil fuels such as coal, petroleum and natural gas supply most of the energy needed to run vehicles and generate electricity for industries and households. Unfortunately, these fossil fuels can emit green house gases that can cause environmental pollution.

Green house gases such as carbon dioxide (CO_2), methane (CH_4), Nitrous oxide (N_20) etc allow the transmission of light reaching the earth's surface. They block the transmission of heat (infra-red radiation) trying to escape from the atmosphere, thus trapping the heat as in a "green house". It has been found that methane has the highest global warming potential than carbon dioxide and Nitrous oxide. The main gas sources are nitrogen fertilizers, flooded rice fields, soil management practices, land conversion, biomass burning, and livestock production and associated organic manure management practices.

Carbon dioxide emission occurs primarily through deforestation due to agricultural expansion and land use. Whenever natural vegetation is converted into agricultural land, a large volume of soil carbon can be lost, as plants and dead organic matter are removed. It has been found that changes in land use pattern, deforestation, land clearing, agriculture and other human activities can all contribute to emission of carbon dioxide, which is released during burning of crop wastes. Carbon dioxide is also released from the fossil fuels used in agricultural production.

Methane (CH_4) is the most important green house gas released within the agricultural sector. It is released from animals such as dairy cows, goats, pigs, buffaloes, camels, horses, sheep, donkeys and even poultry. Methane is also emitted during the process of oil drilling, coal mining, leaking gas pipelines, landfills and waste dumps. Most of the methane emissions come from paddy fields and less significantly from animal husbandry and burning of wastes. Livestock and associated organic manure management contributes about 16 percent of the total annual production of methane. These emissions are a direct result of the ability of buffaloes and cattle to utilize large amount of fibrous grasses that cannot be used

as human food, or as feeds for pigs and poultry. Buffaloes and cattle contribute about 80 percent of the global methane emissions from domestic livestock annually.

Nitrous oxide (N_20) emissions come mostly from nitrogen fertilizer usage, legume cropping and animal wastes. Some of these emissions are also released during biomass burning. Many farmers use nitrogen fertilizers on their farms to enhance soil fertility and crop growth. Crop plants take up most of the nitrogen, but some are leached into the ground waters and some are denitrified into the atmosphere, thereby contributing to global warming. However, the amount of nitrous oxide emission is much lower in volume than the amount of methane.

3. Agriculture as a cause of climate change.

According to IPCC (2007), the three main causes of the increase in greenhouse gases observed over the past decades have always been fossil fuels, land use and agriculture. Agriculture has been found to produce significant effects on climate change, primarily through the production and release of greenhouse gases such as carbon dioxide, methane and nitrous oxide. One way by which agriculture contributes to climate change is through land use, which alters the earth's land cover, which can affect its ability to absorb or reflect heat and light. Land use practices such as deforestation and desertification, together with the use of fossil fuels, are the major anthropogenic causes of climate change.

It should be noted that afforestation leads to absorption of carbon dioxide from the atmosphere, while deforestation brings about a build up of carbon dioxide in the atmosphere. Therefore, deforestation can be said to be a major cause of climate change, since it paves the way for agricultural and industrial activities, which often produce more greenhouse gases.

Indicators of climate change

Evidence for climate change according to Petit *et al*. (1999) can be taken from a variety of sources that can be used to reconstruct past climates. Indicators that reflect climate change according to them include increased or decreased vegetation cover, ice cores, dendrochronology, sea level change and glaciers. According to them, a change in the type, distribution and coverage of vegetation may occur given a change in the climate; and this is very obvious. In any given scenario, a mild change in climate may result in increased precipitation and warmth, resulting in improved plant growth and subsequent sequestration of airborne carbon dioxide. In contrast,, larger, faster or more radical changes, however, may lead to vegetation stress, rapid plant loss and desertification in certain circumstances (Petit *et al.,* 1999).

Dendroclimatology according to Petit *et al.* (1999) is the analysis of tree ring growth patterns to determine past climate variations. Wide and thick rings indicate a fertile, well-watered growing periods, whilst thin, narrow rings indicate a time of lower rainfall and less-than-ideal growing conditions.

In a nut shell, indicators of climate change include: increased drought, unpredictable wind movement, changes in seasonal temperatures, prolonged summer or winter seasons, marked delay in onset of rainfall, disappearance of wet lands, and declining reservoirs, increased or decreased vegetation cover, sea level changes, increased or decreased glaciers and dendrochronological changes.

Effects of climate change on agricultural productivity

Climate change has both positive and negative effects on agricultural productivity in Nigeria.

Negative effects:

Climate change affects agricultural production in Nigeria adversely in the following ways:

1. Variation in crop yields:

Climate change in forms of changes in the soil moisture, temperature, precipitation, cloud cover as well as increase in carbon dioxide concentration etc have adverse effects on crop yields. For instance, higher level of carbon dioxide leads to reduced crop plant uptake of Nitrogen, resulting to stunted growth and yellowing of leaves, especially in cereal crops. Variation in soil moisture content also affects crop production adversely. For instance, too much rain can leach soil nutrients beyond the reach of plant roots, and can abet soil erosion. Some crop plants can not thrive under water logged conditions due to lack of soil air. Low rainfall and high temperature can reduce soil moisture thereby reducing availability of water needed for seed germination and plant growth. Persistent drought and flooding are key determinants of crop yields. Whereas drought can lead to desertification and reduction in irrigation water and crop yields, flooding can lead to washing away of farm lands and displacement of people living along riverine areas. Crop yields can be affected adversely if dry periods occur during critical stages of crop development. In most growing crop plants, flowering, pollination and grain filling are adversely affected during dry season.

2. Effects on human beings:

According to Adamu (2011), Sokoto State was severely hit by floods last year (2010) and about 100 villages across the state were displaced and over 23,700 families were rendered homeless. According to him, about 32,853 hectares of cultivated farm lands were washed away. Besides, the bridge linking the Sokoto metropolis with Usman Danfodio University, Sokoto and the Niger Republic was swept away by the flood in 2010. As a result, this university was closed down for over six months.

3. Effects on livestock:

High ambient temperatures affect livestock production adversely. For instance, high ambient temperature can reduce appetite in farm animals, thereby reducing feed intake and consequently live weight. Animals that can not feed well can hardly produce much in terms of meat, milk and eggs. High ambient temperature can place a lot of stress on the farm animals, and this can affect reproduction in farm animals. Conversely, cold periods can lead to high mortality rate, especially in young animals.

The positive effects

Temperature has potential effects on flowering and growing period. Durations of crop growth cycles are related to temperature, since an increase in temperature can

speed up development of crop plants. An important effect of increase in temperature, particularly where agricultural production is currently limited due to low average temperatures, is the extension of the growing season for crop plants and the reduction of the growing period required for these crops to mature. Warmer atmospheric temperatures lead to a more vigorous hydrological cycle, including some more extreme rainfalls.

Soil fertility is also affected by global warming. While increase in temperature can induce a grater rate of mineralization, reducing or lessening the soil organic matter content, the atmospheric CO_2 concentration tends to increase. Because the ratio of carbon to Nitrogen is a constant, doubling the amount of Carbon in the soil implies higher nutrient elements for crop plants, with the resultant better yields.

Global warming causes increase in rainfall and this leads to increase in atmospheric humidity and the duration of the wet season. Higher rainfall leads to increased productivity and supply of more water for irrigation.

Strategies for mitigating climate change

Climate change in Nigeria can be mitigated through the following strategies:

1. Adoption of improved land use practices: Improved land use practices such as better management of rice paddies through intermittent soil drying and reduced land disturbances using zero tillage and mulching of the soil can reduce emissions of CH_4. In fact, changes in cultivation practices, such as a shift from transplanting to direct seeding and use of appropriate water management can contribute to reduction in CH_4 emissions.
2. Minimization of the use of inorganic fertilizers can decrease emission of greenhouse gases.
3. Use of high yielding varieties in place of local varieties.
4. Improving nutrition of traditionally managed ruminant animals can reduce emissions of methane.
5. Better management of animal dung or wastes and avoidance of biomass burning can reduce emission of methane.
6. Better application of organic and inorganic nitrogenous fertilizers can help reduce emissions of nitrous oxide (N_20).
7. Adoption of dry season farming through irrigation.
8. Use of carbon sinks to soak up carbon dioxide. This can be achieved through reforestation or planting of new forests. Forest can curb global warming through afforestation, reforestation, reduced deforestation, increase in the use of forest-based products such as bio-energy and durable wood products.
9. Foregoing of fossil fuels for biofuels by eliminating the burning of coal, petroleum and natural gas. This is perhaps the most daunting challenge considering the fact that majority of Nigerians eat, wear, work, play and even sleep on the products made from fossilized materials., and
10. By investing in improved infrastructural facilities, or upgrading existing highways and transmission lines can mitigate greenhouse gas emissions in Nigeria.

Adaptation to climate change

According to Hannah *et al*. (2009), International Climate Change negotiations, multilateral and bilateral agencies, donors and international governance and financial institutions such as the World Bank are paying increasing attention to adaptation and how best to help people adapt to climate change. More and more funding is available for adaptation. However, most efforts to help countries adapt focused on national planning and top-down approaches based on climate change modeling. Surprisingly, little or no attention has been paid to the ways in which poor countries have been coping with climate variability and extremes for decades, particularly in Nigeria. It is due to the foregoing that this paper seeks to examine bottom-top approaches that are likely to benefit poor countries such as Nigeria.

According to IPCC (2001), adaptation is identified as one of the policy options to reduce the negative effects of climate change. Adaptation to climate change can be defined as the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which mitigates harm or exploits beneficial opportunities (IPCC, 2001). Common adaptation approaches in agriculture include: use of improved crop varieties and/or breeds of livestock that can acclimatize to drier or arid areas, dry season farming using irrigation, crop diversification, mixed farming system and changing planting dates (Mendelsohn *et al*., 2006).

Besides, proximity to markets is an important determinant of adaptation, presumably because, markets serve as means of diffusing or exchanging information with other farmers (Mendelsohn *et al*., 2006).

Hannah *et al*. (2009), posited adoption of community-based adaptation to climatic change approach, (CBA), which is a community-led process, based on prioritized needs, knowledge and capacities of communities, which empower local people to plan for and cope with the impact of climate change.

Community-based adaptation approach(CBA) attempts to factor in the potential impact of climate change on livelihoods and vulnerability to disasters by using local and scientific knowledge of climate change and its likely effects. CBA may start by identifying communities in poor countries that are more vulnerable to climate change, or these communities may by themselves ask for assistance (Hannah *et al*., 2009).

Conclusion

Climate change is caused primarily by the emissions of greenhouse gases produced largely by natural phenomena, land use and agriculture in Nigeria. The emission of these gases has excruciating effects on crops and livestock productivity. Climate change has negative and positive impacts on agricultural productivity in Nigeria. The key indicators of climate change in Nigeria include increased drought, unpredictable wind movement, changes in seasonal temperatures, marked delay in onset of rainfall, flooding, decreased or increased vegetation cover, sea level changes, increased or decreased glaciers and dendrochronological changes.

Recommendations

In order to mitigate the excruciating effects of climate change on agricultural productivity in Nigeria and to enable Nigerians to adapt to climate variability, it is recommended that:

1. More awareness campaign on afforestation, causes and effects of climate change and adaptation to climate variability be intensified throughout the 36 States of the Federation including the Federal Capital Territory (FCT), Abuja and the 774 Local Government Areas in Nigeria.,
2. Information on climate change and adaptation should be made more accessible to rural farmers through the use of folk media and interpersonal diffusion channels.
3. More meteorological research centres should be established and decentralized to all the 36 States of the Federation.
4. Telecommunications service providers such as Glo, MTN, Zain etc should be encouraged to send short messages on climate change to their clientele at regular intervals. By so doing, it will facilitate rife diffusion of information among rural farmers.
5. Community-based adaptation approach (CBA) to climate change should be adopted by Nigerians., and
6. A legislative policy framework with realistic and workable objectives and instruments should be put in place to checkmate human activities that abet emissions of greenhouse gases in Nigeria.

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Farmers' Perception of the Impact of Climate Change on Agricultural Activities in Otukpo Local Government Area Of Benue State, Nigeria

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Abstract

The study was undertaken to ascertain farmers' perception of the impact of climate change on agricultural activities in Otukpo local government area of Benue state, Nigeria. Data were collected from 60 respondents, through the use of structured interview schedule, using multistage random sampling technique. Data were analyzed using percentage and mean statistic. Farmers were aware of the phenomena related to climate change such as rise in both day and night temperature (M= 1.83) and increased variability in rainfall (M= 1.78). The major perceived impacts of climate change on agriculture were decrease in agricultural productivity (M=2.63), decrease in area for cultivation as a result of erosion and deforestation (M=2.58), and increase in cost of production (M=2.53). The adaptive methods used to cushion the impact of climate change in the area included: planting of cover crops like melon and groundnut (95.0%), practicing of crop rotation (93.3%) and early harvesting of crops (93.3%). The paper recommended that farmers' adaptation capacities to climate change need to be urgently strengthened by the extension service and farmers organization through regular dissemination of information relating to climate change.

Keywords: Impact, climate change, agricultural activities, Benue state.

Introduction

Climate change is one of the most serious environmental threats facing mankind worldwide. It affects agriculture in several ways, including its direct impact on food production (Enete and Amusa, 2010). According to IPCC (2007), climate change is attributed directly or indirectly to human activity that alters the composition of global atmosphere and this is in addition to natural climate variability observed over comparable time period. This change in climate is a result of global warming which is caused by greenhouse gas such as carbon dioxide (CO_2) being trapped in the atmosphere (Ibiodun and Gbudegesin 2009). Green house gases include carbon dioxide, nitrous oxide (N_2O), methane (CH_4) Chlorofluorocarbons (CFC), and water vapour (Kregger, 2008). These gases trap the terrestrial radiations and re-radiate the heat. This change in climate manifests itself as a change in average global temperature as well as changes in how frequently regions experience heat, droughts, floods, storms and other extreme weather.

The main human activity that is most likely to have a large impact on climate is the burning of "fossil fuel" such as coal, oil and gas and these fuels contained carbon. Burning them produces carbon dioxide gas (African Institute of Applied Economics (AIAE), 2009). In addition, deforestation and agricultural activities such as slash and

burn, over grazing, continuous cropping practice were important potential factors in climate change. Consequently, the low yield will change the supply and demand pattern and thus the commodity prices, the profitability of farming, the affordability of food, food scarcity and human health.

The implication of this scenario for the attainment of the Millennium Development Goals (MDG) is obvious especially in the developing countries where system resilience is low (Ozor, 2010). Countries in sub-Sahara African including Nigeria are likely to suffer the most because of their geographical location, low income and low institutional capacity as well as their greater reliance on climate sensitive renewable natural resource sector like agriculture (AIAE, 2009). In the long run, climate change could affect agriculture in several ways (http://uleas.repec./p/femwpa/2006.6htm):

According to Ujah (2009), climate change increases poverty rate as a result of low productivity. The effects of climate change include flooding, drought erosion, desertification, sea level rise, heat stress, pest and diseases, erratic rainfall pattern among others (Ozor, 2010). Africa is highly vulnerable to the adverse impact of climate variability because of the continent's dependence on natural resources and its weak adaptive capacity or ability of a system, region or community to adapt (Anthony, 2005). According to the 4th Assessment Report of Intergovernmental Panel on Climate Change (2007) between 75 and 250 million people may be exposed to increased water stress due to climate change in African by 2020 and will adversely affect livelihood, in the region. The area suitable for agriculture, the length of growing seasons and yield potentials, are expected to decrease due to climate change. Yields from rain-fed agriculture in some countries could be reduced by up to 50%.

Onyedika and Okoronkwo (2009) have shown that several indicators or variables that increase greenhouse gases which are the major cause of climate change are very common and at a very high volume in Nigeria. The situation is not helped by the low level of awareness about climate change in Nigeria. As the planet warms, rainfall patterns shift, and extreme events such as droughts, floods, and forest fires become more frequent (Zoellick 2009), which results in poor and unpredictable yields, thereby making farmers more vulnerable, particularly in Africa (UNFCCC, 2007). Farmers (who constitute the bulk of the poor in Africa), face prospects of tragic crop failures, reduced agricultural productivity, increased hunger, malnutrition and diseases (Zoellick 2009). There is therefore the need to ascertain farmers' perception of the impact of climate change on agricultural activities and what the farmers are doing in tackling this menace.

Objectives of the study

The broad objective of the study was to assess farmers' perception of the impact of climate change on agricultural activities in Otukpo local government area of Benue state, Nigeria. Specifically, the study sought to

1. ascertained the farmers awareness of the evidence of climate change;
2. ascertain farmers sources of information on climate change;
3. assess farmers perceived impact of climate change on agriculture activities; and
4. identify adaptation measure used in cushioning the impact of climate change.

Methodology

The study was conducted in Otukpo Local Government Area (LGA) of Benue State. Otukpo is a town in Benue state, Nigeria located in the middle belt. The LGA headquarter lies between longitudes 7^0 13^1N and latitude 8^0 9^1E. The people are predominantly peasant farmers growing various types of food crops and also commercial farming especially yam, rice, guinea corn, maize, soya beans, cassava, beniseed, millet, pepper etc. (http://www.benuestate.gov.ng/index.php?option=com-content&ask).

All farmers in the LGA constituted the population for the study. Multistage sampling technique was used in selecting respondents. In the first stage, four communities were randomly selected which included: Adoka, Otukpo, Ugboju and Akpa. In the second stage, three villages from each of the four town communities were randomly selected. The villages were Adoka centre, Okpeje, Opa from Adoka community; Otukpo Icho, Otada, Ojakpama from Otukpo community and Ogobia, Ogoli and Ugboju Icho from Ugboju community, and Otobi, Allan and Adum from Akpa community. A list of 10 farmers involved actively in agricultural activities was collected from each of the selected villages through the help of the village head. From the list, 5 farmers were randomly selected using simple random technique from each of the sampled villages. A total of 60 farmers constituted the sample size for the study.

Data for the study was gathered through structure interview schedule. Information on socio-economic characteristics of the farmers such as age, level of education, farm size, household size, household size and income were examined. To ascertain the awareness levels of farmers in relation to evidence of climate change, farmers were asked to indicate their awareness of the phenomena related to climate change from the list provided. The response categories were aware = 2, somewhat aware = 1, and not at all = 0. The values were added and divided by 3 to obtain a mean value of 1.0. Any means score ≥ 1.0 was regarded as being aware of the phenomenon related to climate change, while mean score of ≤ 1.0 was regarded as not aware of the phenomenon relating to climate change.

To ascertain farmers' sources of information on climate change, a list of possible sources with a an option of "yes and no" was given to farmers to indicate their sources of information on climate change. To determine farmers' perceived impact of climate change on agriculture, a list of known variables on possible impact of climate change was provided on a 4-point Likert type scale of to a very great extent = 3, to a great extent = 2, to some extent = 1 and to no extent = 0. The values on the scale were added and divided by 4 to get the mean value of 1.5. Variables with mean score value ≥ 1.5 were regarded as possible impact of climate change while variables with a mean score of ≤ 1.5 were not regarded as possible impact of climate change on agriculture. To ascertain the adaptive measures adopted by farmers in cushioning the impact of climate change in agriculture, a list of possible adaptive strategies known through review of literature were made available to the respondents to tick from which one they had adopted in cushioning the impact of climate change. Data were analysed using frequency, percentage, chart and mean statistic. The statistical package for social sciences (SPSS) constituted the software used for the analysis.

Results and Discussion

Socio-economic characteristics of the respondents

The results in Table 1 show that, greater proportion of the farmers (31.7%) were within the age range of 31 – 40 years, with a mean age of 45.2 years. About 82% of the respondents were male, while higher proportions (48.3%) of the respondents were single. Majority (88.3%) had one form of formal education or the other. Majority (38.0%) of the farmers' years of farming experience was 5 and less while about 25% had between 6 and 10 years. The mean years of farming experience was 11.5years, indicating that they have been in farming for quite a long period of time. Majority (55.0%) of the farmers had 6-10 persons as household members. The mean household size was 7 persons, indicating large house hold size. The average farm size was 3.7 hectares. About 62% of the farmers sampled had been visited by extension agents to disseminate agriculture related information. Those that had been visited had an average visit of 2 times per year of extension contact. This is considered as very low. About 47% and 32% of the farmers belonged to religious and farmers groups respectively. Figure 1 shows that the major crops grown were cassava (81.6%) and yam (73.4%) while Figure 2 shows that goat (81.7%) and poultry (63.3%) were the major livestock kept.

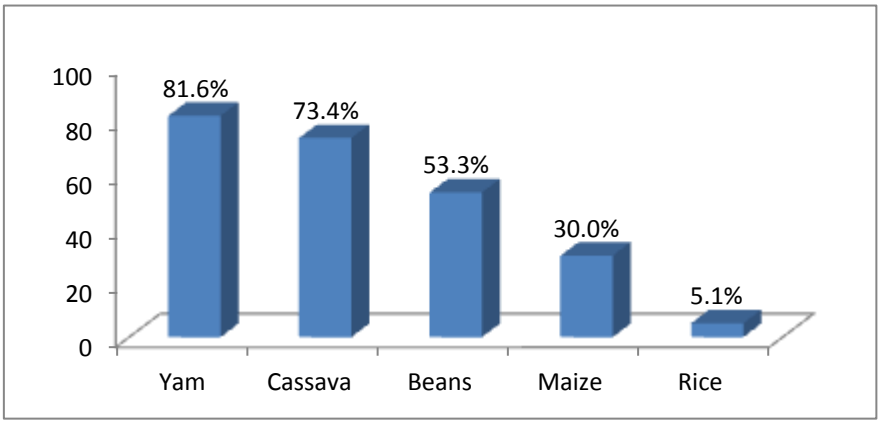


Figure1: Type of crop grown

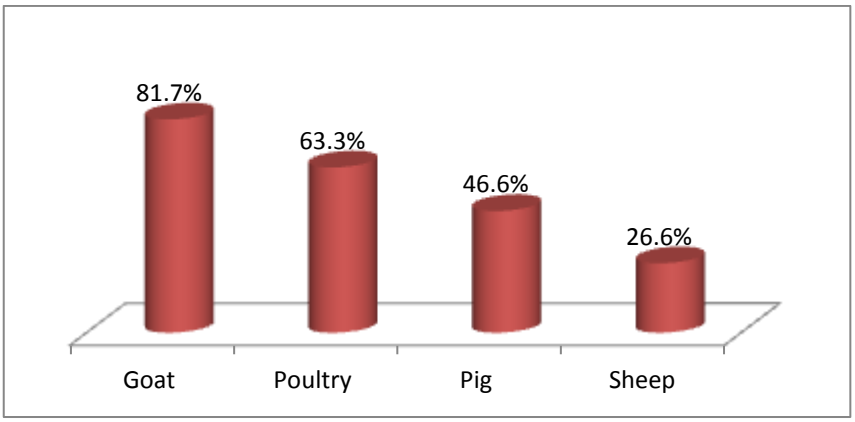


Figure 2: Type of livestock reared

TABLE 1: Distribution of respondents according to socio-economic characteristics (n = 60)

Socioeconomic characteristics	Frequency	Percentage	Mean
Age (Years)			
≤ 30	12	20.0	45.2
31-40	19	31.7	
41-50	9	15.0	
51-60	9	15.0	
60 and above	11	18.3	
Sex			
Male	49	81.7	
Female	11	18.3	
Marital status			
Single	27	45.0	
Married	29	48.3	
Divorced	6	10.0	
Academic qualification			
No. formal education	7	11.7	
Primary school attempted	3	5.0	
Primary school completed	7	11.7	
Secondary school attempted	4	6.7	
Secondary school completed	20	33.3	
OND/NCE	18	30.0	
HND/BSC	1	17.0	
Farming experience (years)			
≤ 5	23	38.3	11.5
6-10	15	25.0	
11-15	5	8.3	
16-20	6	10.0	
20 and above	11	18.4	
Household size			
≤ 5	19	31.7	7
6-10	33	55.0	
11-15	8	13.3	
Farm size			
≤ 2.0	20	33.3	3.7
2.1 – 4.0	21	35.0	
≥ 4.1	19	31.7	
Extension contact			
Yes	37	61.7	
No	23	38.3	
Membership of social organization			

Religious group	28	46.7
Farmers' group	19	31.7
Political group	6	10.0
Cooperative societies	4	6.7
None	3	5.0

Sources of information on climate change

Table 2 shows that fellow farmers (98.3%), friends (95%), radio (90%), television (78.3%) and extension (ADP) staff (61.7%) were the sources of information on climate change. The implies that interpersonal and group methods were perceived as the most frequent methods used by farmers in receiving information on climate change. Very few farmers (33.0%) got information on climate change through newspaper. The few that received information from newspaper are likely to be in the urban areas of the LGA.

TABLE 2: Percentage distribution of respondents according to the sources of information on climate change

Sources of information	Frequency*	Percentage
Fellow farmers	59	98.3
Friends	57	95.0
Radio	54	90.0
Television	47	78.3
Extension worker/ADP staff	37	61.7
Cooperative societies	20	42.0
Newspaper	13	33.0

**multiple responses*

Awareness of the evidence to climate change

Results in Table 3 show that farmers were aware of the various changes that were related to climate change. They were: rise in both day and night temperature (M=1.88), heavy reduction in agricultural production (M=1.78) and increased variability in rainfall (M=1.78). Others were reduction of number of species of forest trees (M= 1.70) and increase drought (M= 1.70). The implication is that farmers are aware that there are changes in the climate. Perceptions are considered to be important as farmers' perceptions are regarded as a critical determinant of and necessary precondition for adaptation.

TABLE 3: Distribution of respondents according awareness level of climate change

Phenomenon Related to Climate	Mean (M)	S.D
Rise in both day and night temperature	1.88*	0.415
Heavy reduction in agricultural production	1.78*	0.524
Increased variability in rainfall	1.78*	0.454
Reduction of number species of forest trees	1.70*	0.591
Increase drought	1.70*	0.892

**aware of the phenomena relating to climate change*

Perceived Impact of Climate Change on Agricultural Activities

Table 4 shows that, decrease in soil fertility due to soil erosion (M= 2.63) and loss of arable crop land as a result of flood were the major impact of climate change on agriculture as perceived by the farmers. This was followed by the hardening of seed

bed as a result of temperature increase (M= 2.57) as well as increase in the cost of cultivation (M= 2.52). Others were decrease in agricultural yield (M=2.52), increase in weed growth (M=2.52), reduction in number of livestock (M=2.52), increase in moisture loss due to exposed soil surface (M=2.45), increased in crop pests and disease infestation (M=2.43), decrease in quality of farm produce (M=2.40), decrease in income (M=2.40), delay ripening of some vegetation fruits (M=2.37), delay growths of crops (M=2.35), increased in mortality of livestock as a result of body heat (M=2.35), delaying the cropping season leading to scarcity of food (M=2.30), loose of medical plants (M=2.30), animal losing their habitants which may result to their death (M=1.82) and increase in labour cost as a result of weed growth (M=1.52).

This finding corroborates the assertion of United State Department of Agriculture (USDA) (2007) who stated that climate change has both positive and negative effects on farming but there could be a more negative influence in the long run, which may lead to food scarcity if no immediate efforts are to confront these problems. Crop yield are affected by many factors associated with climate change which include: temperature, rainfall, extreme weather events, climate variability and even Co_2 concentration in the atmosphere which is predicted to cause global warming that will have a significant impact on crop production.

TABLE 4: Mean score of perceived impact of climate change in agriculture

Perceived impact of climate change in agriculture	Mean (M)	Standard deviation
Decrease in soil fertility due to soil erosion and flood	2.63*	0.610
Loss of arable crop land as a result of flood	2.58*	0.645
Hardening of seed bed as a result of temperature increase	2.57*	0.810
Increase in the cost of cultivation	2.53*	0.747
Decrease in agricultural yield	2.52*	0.854
Increase weed growth	2.52*	0.892
Reduction in the number of livestock	2.52*	0.748
Increase in moisture loss due to exposed soil surface	2.45*	0.910
Increased in crop pests and disease infestation	2.43*	0.871
Decrease in quality of farm produce	2.40*	0.766
Decrease in income	2.40*	0.848
Delay ripening of some vegetation fruits	2.37*	0.843
Delay growths of crops	2.35*	0.799
Increased in mortality of livestock as a result of body heat	2.35*	0.804
Delaying the cropping season leading to scarcity of food	2.30*	0.869
Lose of medical plants	2.13*	0.853
Animals losing their habitats which may result to death	1.82*	1.017
Increase in labour cost as a result of weed growth	1.52*	0.770

**perceived impact*

Adaptation strategies used for cushioning the effect of climate change

The adaptive methods used to cushion the effect of climate change in the area included planting of cover crops like melon and groundnut (95.0%), practicing of crop rotation (93.3%) and early harvesting of crops (93.3%). Other adaptation methods used were early planting (91.7%), prompt weeding (91.7%) and mixed cropping (91.7%). Others were mulching to reduce water loss (88.3%), organic manuring (88.3%), use of improved animal species (86.7%), increase in frequency of weeding to reduce pest (86.7%), avoidance of bush burning (86.7%), controlled grazing (80.0%), planting of drought resistant crops (80.0%) and diversification of crop production (76.7%). This implies that various methods are being used in adapting to climate change impact by farmers.

TABLE 5: Adaptation methods used by the farmers in cushioning the effect of climate change on agriculture

Adaptive strategies	Yes (%)	No (%)
Plant of cover crops like melon, groundnut	95.0	5.0
Crop rotation	93.3	6.7
Early or prompt harvesting of maturing crops to reduce the incidence of pest and diseases	93.3	6.7
Processing of crops to minimize post harvest losses	93.3	6.7
Early planting	91.7	8.3
Prompt weeding	91.7	8.3
Mixed cropping	91.7	8.3
Mulching to reduce water loss	88.3	11.7
Green/organic manuring	88.3	11.7
Use of improve animal species	86.7	18.3
Increase in frequency of weeding to reduce incidence of pest	86.7	18.3
Forest regulation (avoid bush burning)	86.7	18.3
Diversification of enterprise from agriculture to other enterprise	86.7	18.3
Controlled grazing	80.0	20.0
Planting of drought resistance variety	80.0	20.0
Aforestation/planting of trees	76.7	23.3
Diversification in crop production	76.7	23.3
Fallowing	70.0	30.0
Planting across the slope (terracing)	61.7	303

Conclusion and Recommendation

Virtually all the respondents were, not only aware of climate change, but also aware that some of its variables like extreme weather events and uncertainties in the onset of farming season have been on the increase. In addition, they were also aware of the impact of climate change on agriculture. It is therefore recommended that

farmers' adaptation capacities to climate change need to be urgently strengthened by extension service and farmers organization through regular dissemination of information relating to climate change.

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Mitigating the Consequences of Climate Change among Cassava Producers in Ikwuano Local Government Area of Abia State, Nigeria

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Abstract

The study evaluated methods of mitigating the consequences of climate change on cassava production in Ikwuano Local Government Area of Abia State, Nigeria. The study identified and highlighted cultural farm practices that contribute to climate change; ascertained the consequences of climate change on cassava production in the study area; determined indigenous methods of mitigating the consequences of climate change. Data for the study was collected with the aid of structured questionnaire. Data analysis was achieved with the aid of descriptive statistics. Results reveal that majority of the cassava growers in the study area were aged between 30 to 59 years, implying that they were within their active and innovative years. More half of the sample population (57.5%) was male. A relatively high level of formal education among the respondents reported. Majority of the respondents were resource poor, peasant farmers who cultivated 0.7ha to 1.2 ha of land. Certain cultural farm practices employed by the farmers contributed to or encouraged climate change due to emissions of greenhouse gasses. Such cultural farm practices include land clearing and burning (28%), annual bush burning (19.2%), accumulation of residues (11.2%) as well as deforestation (19.4%). Results further revealed that consequences of climate change on cassava. Production includes reduction in yield, soil erosion with its attendant problems, build-up of pests and disease, among others. The study concluded that ignorance on the part of the farmers, especially those in the rural areas, is the major problem militating against their use of adaptation strategies aimed at mitigating the consequences of climate change. It was recommended that public enlightenment programmes be vigorously mounted with a view to educating the general public on climate change, its effects and mitigating factors.

Introduction

Onumadu (2010) describes climate as “average weather” together with the variabilities from this average. According to him climate change is the synthesis of the weather in a given place over a period of at least 30 years. He identified the main elements of the weather to include temperature, rainfall, dew, humidity, wind, sunshine, mist, haze and clouds. He contended that it is the collective pattern of expression and not just in one element of the weather.

Obioh (2002) also describes climate change as the permanent departure of climate patterns from mean value of observed climate indices. Climate change has also been described as a change in the statistical distribution of the weather over periods of time that range from decades to millions of years (Nwachukwu and Nnadozie, 2011). According to them, it can be a change in the distribution of weather events around an average. Furthermore, they described climate change as changes in

climate, especially when viewed in the context of environmental policy. Nwachukwu and Nnadozie (2011) likened climate change to the observations made in rainfall pattern and distribution in the southern part of Nigeria. The period of the rainy season in this region is known to be between April and October. In recent times however this trends is being altered. For instance, in 2012 the rains came as early in the year as the month of February in the Southeast and got sustained unlike what it used to be over the years. The local farmers experience these variations, but lack scientific explanation for them.

In Nigeria, even a casual observer would have noticed the increasing frequency, and sometimes intensity of unusual weather-linked phenomena in recent times (Eke-Okoro, Okereke and Okeke, 1999). According to them, disasters caused by unusually heavy down pours, wind storms, acid rain, flood, including bush fires have been reported in the world media more frequently than in previous decades.

Human activities on the planet earth environment have been identified as the major causes of climate change in Nigeria (Onumadu, 2010). The oil and gas sectors in the Niger Delta and offshore through gas flaring, deforestation through tree cutting for fuel wood and timber, expanding slash and burn agriculture as well as developmental projects, gas emission from cars, trucks and generators have been identified as contributing to climate change (Olatoye and Pelemo, 2008; Onumadu, 2010). Other causes according to Ajah (2006) are population explosion, depletion of natural resources (indiscriminate exploitation of renewable and non-renewable resources and environmental pollution (introduction of harmful substances into the environment). In like manner, Popoola (2010) identified growth in human population, increased consumption of earth's resources, enhanced technology, economic advances and changes in organization of human societies as drivers responsible for climate change.

Climate is the primary determinant of agricultural productivity (Adams, Hurd, Lenhart and Leary, 1998; Cumhur and Cresser, 2008). According to them, given the fundamental role of agriculture in human welfare, concern has been expressed by federal agencies and others regarding the potential effect and/or consequences of climate change on agricultural productivity.

Climate change is expected to influence crop and livestock production, hydrologic balances, input supplies and other components of agricultural systems (Adams et al., 1998). Cassava production is an integral part of the entire agricultural production system. It is expected to be influenced by climate change.

Cassava is one of the most important staple food crops in Nigeria and Africa as a whole (Nweke et al., 2002; Apu and Nwachukwu, 2011). It is generally regarded as the foremost food security and poverty alleviation crop for Nigeria and entire sub-Saharan Africa (SSA) because of its special attributes which include ability to make return of root yield even at extreme stress conditions, high tolerance to unfavourable conditions, requiring minimal external inputs, all year round availability, highly suitable to various farming and food systems in Africa as well as efficient production of food energy (Beeching et al, 2000; Awa and Tumanteh, 2001; Ekwe et al., 2008).

Although the cassava plant grows and produces well in the Nigerian environment, it shows different growth behavior and yield in different years as a result of differences in annual weather conditions (Eke-Okoro, 1999). This study was thus

designed to describe the indigenous methods of mitigating consequences of climate change on cassava production in Ikwuano Local Government Area of Abia state, Nigeria. It will also identify and highlight cultural farm practices which contribute to C.C.

Methodology

The study was conducted in Ikwuano Local government Area of Abia State, Nigeria.

Ikwuano Local Government Area (LGA) is about five minutes drive from the seat of the Abia State Government through the Umuahia-Ikot Ekpene Road (Onyemaobi, 2010). It is situated in the eastern boarder of Abia State occupying an area of approximately 32 square kilometers.

The 2006 national population census gave the population of Ikwuano LGA to be 137, 897, consisting of 70,509 males and 63,388 females.

The LGA is made up of four clans, namely, Oboro, Ibere, Oloko and Ariam. It lies within the rainforest zone of Nigeria with an undulating topography.

The population of the study consisted of all cassava growing farm families in the LGA. A multi-stage random sampling procedure was used in selecting one hundred and twenty respondents, which constituted the sample size for the study.

The stages were:

(i) One autonomous community was selected from each of these four clans in the LGA.

(ii) Two villages (communities) were randomly selected from each of the four autonomous communities, using simple random sampling technique. This gave a total of eight communities in all.

(iii) Fifteen (cassava growing) farm families were randomly selected from each of the eight communities giving a total of one hundred and twenty samples. This constituted the sample size for the study.

Data collection was achieved with the aid of structured questionnaire, which was validated and administered to elicit information from the respondents.

Descriptive statistics such as frequency counts and percentages were used to analyse the data.

Results and Discussion

Socio-economic characteristics of the household heads of the cassava growing farm families are presented in table 1.

TABLE 1: Socio-economic characteristics of Respondents N=120

Age (years)	Frequency	Percentage
20-29	10	8.3
30-39	21	17.5
40-49	30	25.5
50-59	27	22.5
60-69	21	17.5
70-79	11	9.2
Gender		
Male	69	57.5
Female	51	42.5
Level of formal education		
No formal education	22	18.3
Primary education	34	28.3
Secondary education	44	36.7
Tertiary education	20	16.7
Farm Size (ha)		
0.02-0.18	9	7.5
0.19-0.32	25	20.8
0.36-0.52	24	20
0.53-0.69	11	9.2
0.7-0.86	29	24.2
0.87-1.03	10	8.3
1.04-1.20	12	10
Farming Experience (years)		
1-10	40	33.3
11-20	31	25.8
21-30	22	18.3
31-40	18	15.0
41-50	9	7.5

Source: Field Survey, 2011.

Majority of the sampled population (65.5%) were aged between 30 to 59 years, implying that they were still within their active and innovative years. More than half of the sampled population (57.5%) were males (table 1).

The study found a high level of formal education among the sampled population (table 1). About 18.3 percent had no formal education. The others had varying levels of education ranging from primary through tertiary education. Thus majority of the sampled population can read and write and are therefore better equipped to observe and appreciate variations in weather conditions occasioned by climate change.

Results also revealed that an insignificant proportion of the sampled population (10.0%) had farm sizes ranging between 1.04 ha to 1.20 ha and above. This implies that majority of the cassava producers in the area are resource poor farmers.

Results showed that a reasonable proportion of the sampled population (33.3%) table 1 had farming experience ranging between one and ten years. Majority of the respondents (59.1%) had varying farming experiences ranging between eleven to forty years. This means that the farmers are very well experienced in farming as to

appreciate the effects and or consequences of climate change on their farming Endeavour.

TABLE 2: Cultural farm practices that contribute to climate change

Farm practices	Frequency*	Percentage
Annual bush burning	82	19.2
Land clearing/burning	120	28.0
Accumulation of residue	48	11.2
Soil excavation	27	6.3
Continuous cropping	17	3.97
Mono-cropping	07	1.6
Use of insecticides	28	6.5
Deforestation	83	19.4
Fertilizer application	16	3.7

Source: Field survey, 2011.
** Multiple responses recorded.*

The table revealed that certain cultural farm practices contributed to climate change. Such cultural farm practices included land clearing and burning (28%), annual bush burning (19.2%) as well as deforestation (19.4%). This result is in tandem with Cumhur and Cresser (2008) who stated that the agriculture sector both contributes to climate change as well as will be affected by changing climate. The cultural farm practices all contributed to the accumulation of green house gas emissions leading to global warming.

TABLE 3: Consequences of climate change on cassava production in the study area

Problem	Frequency	Percentage
Drought	2	0.4
Erosion	87	18.6
Flood	18	3.8
Pest and disease	61	13.0
Water logging	16	3.4
Yield reduction	96	20.5
Unsteady rain	54	11.5
Excess rain	67	14.3
Insufficient harmathan	*68*	*14.5*

Source: Field survey, 2011
**Multiple responses recorded*

Results indicate that problems encountered by cassava producers which are associated with the consequences of climate change included reduction in yield (20.5%), soil erosion (18.6%), excess rainfall (14.3%), insufficient harmattan (14.5%) as well as build up of pests and diseases (13.0%). The implication is that the consequences of climate change on cassava production often leads to reduction in yield of the crop, it also leads to soil erosion with this attendant problems on crop production in general and cassava production in particular, among others.
Indigenous method (adaptation strategies) of mitigating the consequences of climate change is presented in table 4.

TABLE 4: Indigenous methods (Adaptation Strategies) of Mitigating the consequences of Climate Change in the Study Area

Strategies (method)	Frequency	Percentage
Use of terraces	75	25.3
Crop rotation	66	22.2
Use of ash against pest	45	15.2
Use of drainage	32	10.8
Use of improved cassava varieties	28	9.4
Mulching	16	5.4
Use of insecticides	23	7.7
Varying planting and harvesting dates	12	4.0

Source: Field survey, 2011
**Multiple responses recorded.*

Results indicate that the indigenous methods (or adaptation strategies) of mitigating the consequences of climate change in the area included the use of terraces (25.3%), crop rotation (22.2%) and the use of wood ash against pests (15.2%). This implies that the rural farmers have their own responses to the problems emanating from the ever changing climate. In other words, these represent some of the strategies with which the farmers are able to cope with the problems associated with or arising from climate change. Terraces are known to be used effectively against soil erosion, especially across sloping grounds. Crop rotation is known to ensure maximum utilization (by crops) of soil nutrients (resources). Wood ash is known to be used against certain crop pests.

Conclusion

It was concluded that ignorance on the part of farmers especially those in the rural areas is a cardinal problem militating against their use of adaption strategies aimed at mitigating the consequences of climate change. Although, farmers in the study area were reasonable educated, the need for constant public enlightenment on the causes, effects and consequences as well as adaptation measures of climate change in agriculture cannot be over emphasized.

Consequently, the agricultural extension agency and other relevant government agencies should regularly embark on vigorous public enlightenment campaigns aimed at educating and sensitizing the general public on climate change, its causes, effects/consequences as well as adaptation and mitigating factors.

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Farmers' Perception of Climate Change and Effects on Crop Production in Ogun State, Nigeria

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Abstract

The study investigated the perceived changes in climate, crop yield and examined the coping strategies of farmers. Through a three-stage sampling technique, 192 farmers were randomly selected as respondents. Data collected by means of structured interview schedule were analyzed using percentages, frequencies, and Pearson Correlation statistics. The result of the study revealed that 41.7% of the respondents were between 31-40 years with an average age of 36.07 years. More than half of the famers strongly agreed that the amount of rainfall in recent time is on the decrease while 47.8% of the respondents strongly agreed that the timing of the rainfall is not favourable for the cultivation of arable crops. Also, 55.7% of the respondents noticed a shorter rainy season accompanied by flood while 40% of them observed a gradual spread of drought in the state. In addition, about half of the respondents reported an increase in the ambient temperature. Most of the respondents (67.5%) strongly agreed that there was a reduction in crop yield. Therefore it was recommended that the farmers should intensify the use of fadama with irrigation facilities while research should concentrate on massive production of pests, disease and drought tolerant species of crops which are currently in short supply.

Key Words: Climate change; emergence of pests; reduced yield; inadequate coping strategies.

Intrduction

In the past centuries and at present there is a widespread cultural belief among the rural community that drought and famine are acts of God against humans (McKee, 2008; and Mestin, 1991). However, Ayoade (2004) defines climate change as a long time shift, alteration or change in the type of climate prevailing over specific location, region or entire planet. It is obvious from the definition that change is an inherent attribute of climate, the change is caused by both human activities (anthropogenic) and natural process bio-geographic). The human factors that cause climate change include industrialization, technological development, urbanization, deforestation, burning fossils fuels, water pollution among others (Okali, 2007a). These activities are going on in Nigeria unfettered as most of the agencies responsible for their control are generally ineffective especially the flaring of gases in Nigeria through which emission of greeehouse gases (GHG) carbon dioxide (70% from flaring of gas) is released. Other sources are methane, nitrogen oxide caused by deforestation and agricultural activities particularly by the use of pesticide. Current efforts to combat global warming focus on reducing the emission of heat-

trapping gases, but do not fully address the substantial contribution of land use to climate change.

Climate change and agriculture are interrelated processes, both of which take place on a global scale (IPCC, 2007a). Global warming is projected to have significant impacts on conditions that affect agriculture, including temperature, carbon dioxide, glacial runoff, precipitation and the interaction of these elements (Fraser, 2008). According to him, these conditions determine the carrying capacity of the biosphere to produce enough food for the human population and domesticated animals. The overall effect of climate change on agriculture will depend on the balance of these effects. In Nigeria, for instance the practice of shifting cultivation by the small scale farmers, bush burning and over grazing by livestock can change land's ability to absorb or reflect heat and light, thus contributing to radioactive processes. However, there is slow growing recognition of local adaptation to the changing environment (both environmental and policy changes) in terms of efficiency, effectiveness and sustainability. Recognition of local adaptation is seen as an early point to strengthen the resilience of local people to climate change. Similarly, the concept of community based adaptation (CBA) is based on recognition of the competence of grass root communities to solve their own problems. (IPCC, 2007b).

Thus assessment of the effects of global climate change on agriculture might help to properly anticipate and adapt farming to maximize agricultural production.

Problem statement

Global warming and human activities, for example deforestation, are responsible for low agricultural productivity in Nigeria (Ayoade, 1995). Desertification is encroaching in Nigeria at 350,000 hectares/annum or at 600 meters/annum (Oyetade, 2007). Ogun State is one of the highly industrialized and educational advanced states in the country. Establishment of industries, many educational institutions and exodus of pastoralists from the northern parts of the country are likely to aid deforestation and also reducing cultivable land for farming. In addition a small change of 100 square kilometers in urban development or deforestation can change rainfall pattern and trigger other climate disruptions (BNRCC, 2008).

Furthermore farmers' access to improved seeds is poor while drought tolerant seeds are also in short supply (Layi, 2011). Quality seed is responsible for 50% of crop yield (Fajana, 2002). In Nigeria, Omotayo (2010) reported incidence of new crops diseases and low crop yield due to climate change. IPCC (2001) predicted a global temperature rise of 4^0C in Africa. In North Africa, where Nigeria belongs, a temperature increase of 8^oC is anticipated. High temperature has deleterious effects on crops' physiological processes.]

Farmers' ability to perceive climate change is a key precondition for their choice to adapt. There is therefore the need to generate information that will assist policy makers, donors, Non-Governmental Organizations (NGOs) to develop strategies to mitigate the effects of climate change on crop production. It will also assist researchers to develop cost effective technologies on how to improve crop production in the country while extension institutions will develop appropriate technical massages that will assist the farmers to cope with the perceived effects of climate change on crop production.

Therefore, the study attempted to provide answers to the following research questions.

1. What are the socio- economic characteristics of the farmers in the study area?
2. What are the perceived noticeable changes in the climate of the study area?
3. What are the perceived effects of climate change on crop production?
4. What are the coping strategies of crop farmers with climate change?

Objectives

The objectives of the study were to:

1. investigate perceived changes in the climate of the study area,
2. identify the perceived effect of climate change on yield of crop and
3. examine the coping strategies of crop farmers to climate change

Methodology

The study area

The study was carried out in Ogun state, Nigeria. Ogun state lies between longitude 2^{o} 45' and 3^{o} 55'East of Greenwich Meridian and latitude 7^{o} 01' and 7^{o} North of the Equator. It covers a land area of approximately 16,406.226 square kilometers that is 16,406,226 hectares. The state is bounded in the West by the Benin Republic, in the South by Lagos State and the Atlantic Ocean, in the East by Ondo State and in the North by Oyo and Osun States. The population of the state is 3,728,098 comprising 1,847,243 males and 1,880,855 females (NPC, 2006). The state has twenty Local Government Areas (LGAs). The State is naturally endowed with food and cash crop production. Agricultural production is the major means of livelihood of the people of the state. The major food crops include rice, maize, cassava, yam and banana. The main cash crops include cocoa, kolanut, rubber and oil palm. Ogun State is one of the largest producers of kolanut in the country. It also produces timber and rubber on a large scale.

The population of the study is made up of all farmers in Ogun State. The farmer's population in Nigeria was reported to be in the range of 60-70% of the country's population (Nigeria's Agriculture and Food Security Challenges, 2011). A presentation outline. Therefore the farmers' population was estimated to be 2,236,858.For administrative convenience, Ogun State Agricultural Development Project (OGADEP) divided the state int four zones, namely Abeokuta, Remo, Yewa and Ijebu-Ode zones. Samples were drawn from these zones. The study used a multi- stage sampling technique to select the respondents. Stage one involved a random selection of 2 zones namely Abeokuta and Yewa. The second stage was the random selection of four (4) extension blocks in ease zone. This gave a total of 8 extension blocks out of which 4 cells per block were selected. This gave a total of 32 cells. The final stage was the random selection of six (6) farmers per cell. This gave a total of 192 farmers which were used as respondents. The primary data were collected with the aid of structured interview schedule. Data collected were analyzed with percentages, frequencies and Pearson Correlation statistic.

The Socio-economic characteristics of the farmers, for example, the age was measured in years. Farmers were asked to indicate their age as at December, 2010. The respondents were requested to indicate their gender by ticking male or female in the space provided on the questionnaire. Farmers were asked to indicate the highest level education attained by ticking the type of highest educational attained ranging from No formal education, adult, primary, secondary, tertiary or no education attained. Respondents' income was measured

in naira, yield, yield per tonnes/hectare and farm size in hectares or heaps. Farmers were asked to state perceived changes in climate especially in rainfall pattern, temperature, incidence of new pests and diseases, flood, drought, deforestation and their effects on crop yield. The farmers coping strategies was ascertained by access to irrigation facilities, planting of drought, disease and pests tolerant varieties of crops, cropping in fadama area, etc.

Results and Discussion

Socio-economic Characteristics of Crop Farmers

Table 1 reveals that 41.7% of the respondents were between 31-40 years of age while 5.2% of them were over 50 years of age. The mean age of the respondents was 36.07 years. This confirms African Development Bank (2002) that lifespan of the people located in the West African sub region is about 55 years. At this age bracket, respondents are expected to be venturesome, able to take risk and easily adopt innovations. As a result, this age bracket can have a positive effect on their productivity and can suitably replace the aged farmers whose population and productivity described as low due to inadequacy to carry out tedious farming activities. The result also revealed that 58.8% of the respondents were married. The wives may contribute to the labour requirements on the farms as most of the farm operations are labour intensive (Ismailla et.al. 2010). Thus wives and children can serve as cheap source of labour which may lead to increase in their farm size, adoption of innovations and the overall level of farm productivity. This can translate into higher level of incomes to the farmers. However 25% of the respondents were either separated or divorced. A good proportion (31.2%) of this group were females who turned into farming as their means of livelihood. More than half (55.8%) of the respondents had formal education. Nweke (1982) reported that education provides a favourable atmosphere for awareness of innovations. In addition Sharada and Knight (2000) reported that schooling provides external benefits by shifting production frontier outwards and that education is important to the timing of adoption. Educational attainment also has implications on their involvement in agricultural development activities and awareness of issues such as climate change. However, 5.2% of the respondents had tertiary education. This shows that the educated elite in the country are now venturing into agriculture as a means of livelihood rather than depending on white collar job. The result also showed that more than half (62.7%) of the respondents cultivated less than 1 hectare of farm land while the average farm size of the respondents was 1.8 hectares. This is an appreciable increase over the national average of 0.57 hectares reported by Ingawa (2005). An increase in hectarage of farmland would lead to a higher level of income resulting from higher level of production ceteris paribus. In addition about half of the respondents (49%) had 11-20 years of farming experience with an average farming experience of 17.69 years.

TABLE1: Socio-economic characteristics of the crop farmers

Characreristics	Frequency	Percentage	Mean N=192
Age (Years):			
<20	5	2.5	
21-30	42	21.9	36.07
31-40	80	41.7	
41-50	55	28.7	
>50	10	5.2	
Gender:			
Male	132	68.8	
Female	60	31.2	
Marital status			
Single31	31	16.2	
Married	113	58.8	
widowed	29	15	
Divorced	19	10	
Household Size(in Numbers)			
≤5	139	72.5	
6-10	48	25	6
11-15	5	2.5	
Educational level:			
No formal education	20	10.4	
Adult education	34	17.5	
Quranic education	31	16.3	
Primary School	52	27.1	
Secondary school	45	23.5	
Tertiary education	10	5.2	
Years spent in crop production:	35	18.2	
1-10	94	49	
11-20	41	21.1	17.69
21-30	19	10.2	
31-40	3	1.5	
≥41			
Farm size:	120	62.7	
≤1	45	23.4	1.8
1-3	16	8.3	
3-5	16	5.8	
≤6			

Source: Field survey, 2011

Perceived changes in the climate of Ogun State, Nigeria

Table 2 summarizes the noticeable changes in the climate of the study area as perceived by the respondents. The results revealed that about half (47.1%) of the respondents strongly disagreed that temperature was not on the increase in the state. The prevailing high ambient temperature will can hinder physiological activities of the crops which will be accompanied

with yield losses (Jones and Thornton, 2003). Also more than half of the respondents (53.3%) strongly agreed that the amount of rainfall in recent time was on the decrease. This could hamper physiological development of many crops grown in the state.

Furthermore about half (47.8%) of the respondents strongly agreed that the timing of the rainfall was not favourable to the cultivation of arable crops grown in the state. More than half (55.7%) of the respondents noticed a shorter rainfall season accompanied with flood. In addition 40% of the respondents observed a gradual spread of drought in the state while 71% of them strongly disagreed that deforestation was on the decrease in the state.

Majority (87.2%) of the respondents noticed incessant incidence of thunder and lightning during the rainfall. These findings agree with Vidal (2005) who reports that climate change has become predictable with incidence of flood and drought that are reported in many parts of the world. The perceived climate change also agreed with the report of BNRCC (2008) that a small change in urban development or deforestation can change local rainfall pattern and trigger other climate disruptions. Flood and drought can lead to outright crop failure while high ambient environmental temperature can impair the physiological and metabolic activities of the plant system. Farmers' perceptions of climate change in Ogun State confirm the report of BNRCC (2008) that the effects of the climate are spreading to all the ecological zones of the country.

TABLE 2: Perceived changes in the climate of Ogun State, Nigeria

Perceived effects of climate change	SA	A	U	D	SD N =192
There is a general decrease in rainfall pattern in recent time	102	53	25	7	5
	53.3%	**28.5%**	**13.1%**	**3.8%**	**1.3%**
The timing of rainfall, mostly delayed, not favourable to most arable crops	92	41	17	36	6
	47.8%	**21.2%**	**9%**	**18.5%**	**3.5%**
Shorter rainfall season accompanied with flood	107	39	21	17	6
	55.7%	**20.3%**	**11.2%**	**9.3%**	**3.5%**
Drought is not a common occurrence in your location	24	33	10	48	77
	12.5%	**17.5%**	**5%**	**25%**	**40%**
Deforestation is on the decrease	27	23	5	106	31
	14%	**12.2%**	**2.5%**	**55%**	**16.3%**
Temperature is not increasing in recent time	18	17	7	60	90
	9.1%	**8.8%**	**3.8%**	**31.2%**	**47.1%**
Thunder and lightning are common occurrences	100	58	5	19	10
	52.5%	**30.2%**	**2.5%**	**9.8%**	**5.0%**

Source: Field survey, (2011). SA=Strongly Agreed; A=Agreed; U=Undecided;D=Disagreed; SD=Strongly disagreed.

Perceived effects of climatic change on crop yield

Table 3 summarized the perceived effects of climate change on crop yield. The result revealed that most of the respondents (67.5%) strongly agreed that there was a reduction in crop yield on their farms. Also, 68.3% of the respondents disagreed that the severity of the prevailing temperature had no adverse effects on crop yield. Furthermore 40% disagreed that drought had no effect on crop yield. These agreed with the report of Layi (2011) that heavy reliance on non- drought tolerant local seeds reduce yield of maize and the report of Jones and Thornton (2003) who predicted an overall reduction of 10% in maize production in the year 2055 in Africa and Latin America.. While about half (45%) and (46%) of the respondents agreed that there was an emergence of new pests and diseases respectively. Consequently, more than half (52.5%) of the farmers disagreed that food is available in their locality throughout the year. In addition 36.9% of the respondents agreed that soil erosion was noticed on their farms. The results of the study agreed are in consonance with the findings of Vidal (2005) that increase in temperature and rainfall differences are more favorable for the proliferation of insect pests, the rising incidents of diseases, pests, crop failure, environmental degradation and conflict in many regions of the world. The findings also agreed with the report of Barclays (2008) that there is a remarkable decline in agricultural productivity arising from severe drought that experts linked with climate change.

TABLE 3: Perceived effects of climate change on crop yield

Perceived effects of climate change	SA	A	U	D	SD
There is noticeable reduction in crop yield in Recent time	130 (67.5)*	46 (24.2)	5 (2.5)	6 (3.3)	5 (2.5)
The severity of prevailing temperature has no negative effect on crop yield	39 (38.8)	22 (27.5)	5 (20.1)	74 (11.2)	53 (2.4)
Flood occurrence hinders crop growth	32 (16.6)	28 (14.6)	2 (1.2)	96 (50.0)	34 (17.6)
Drought has no effect on crop growth in your location	24 (12.5)	33 (17.5)	10 (5.0)	48 (25.0)	77 (40)
Food is readily available throughout the year	28 (15.0)	22 (11.2)	5 (2.5)	101 (52.5)	36 (18.8)
There is emergence of new pests in our locality	22 (31.2)	17 (45)	7 (3.8)	60 (11.2)	86 (8.8)
There is emergence of new diseases	62 (32.5)	89 (46.5)	5 (2.5)	26 (13.5)	10 (5.0)
Increase is soil erosion	71 (36.9)	47 (24.5)	13 (6.8)	24 (12.5)	37 (19.3)

Source: Field survey, (2011). Figure in parentheses represent percentages

The coping strategies of crop farmers to climate change

Coping strategy is an adjustment or self insurance pursued by the farmers to ensure future food availability, income generation from crop production. Most of the farmers (65%) agreed that cropping in the fadama area could ameliorate the adverse effects of climate change on crop production. Fadama has the capacity to hold water for dry season crop production. Majority (85%) of the respondents reported that early maturing varieties of crops were unavailable for cultivation. Also 53.5% of farmers reported that disease tolerant varieties were not accessed for cultivation. The findings confirmed the report of Fajana (2002) that quality seeds were grossly inadequate in the country. Consequently the farmers depend on late maturing varieties of crops that are prone to drought, pests and diseases. In addition, majority (71%) of the farmers reported that irrigation facilities were not used by them for crop production, thus 57% 0f them resorted to mixed cropping as a safeguard to crop failure. About half (51%) of the respondents strongly disagreed on reduction of farm size as an option to mitigate the adverse effects of climate change on crop production. Farm size determines to some extent farm productivity *ceteris paribus.*

TABLE 4: Coping strategies of the pastoralists to climate change

	SA	A	UD	D	SD
Cropping of fadama is influenced by the adverse effects of climate change	125 (65%)	41 (21.3%)	5 (2.5%)	17 (8.8%)	4 (2.4%)
Accessed early maturing varieties of arable crops (maize, rice etc.)	5 (2.5%)	15 (7.5%)	10 (5%)	122 (63.8%)	40 (21.2%)
Practiced mixed cropping as a safeguard to crop failure	40 (20.8%)	110 (57.5%)	8 (4.3%)	27 (13.9%)	7 (3.5%)
Planting of tree crops for food, income and to serve as wind break is on going	22 (11.7%)	34 (18%)	4 (2.1%)	21 (11.2%)	111 (58%)
Disease tolerant varieties of crop are grown	27 (14.3%)	13 (6.5%)	6 (3.2%)	103 (53.5%)	43 (22.5%)
Irrigation facilities were accessed by the Farmers	14 (7.5%)	22 (11%)	2 (1.2%)	18 (9.3%)	136 (71%)
There is adequate provision for erosion control	16 (8.5%)	13 (7%)	4 (2.2%)	42 (21.8%)	116 (60.5%)
Reduction of farm size	26 (13.5%)	24 (12.7%)	5 (2.5%)	98 (51%)	39 (20.3%)

Source: Filed Survey, 2011

Conclusion

Climate change is no longer a phenomenon localized to the savannah belt of the country. The changes in climate are now fully established in the forest belt of the country as evident in Ogun State, Nigeria. The farmers of various ages and educational background were able to acknowledge the indices of climate change which include drought, excessive precipitation and shorter rainfall period, the rising incidents of diseases, pests, reduced crop yield, deforestation and increased soil erosion. It was also concluded that there were inadequate provision for erosion control and irrigation facilities. Farmers' access to early maturing and disease tolerant varieties of crops were reportedly inadequate. Mixed farming is the simplest coping strategies available to many of the farmers.

The extension services should encourage the farmers to increase the tempo of tree planting through the cultivation tree crops. This has the potential to control the deforestation element of anthropogenic factor of climate change. Farmers should cooperate with other stakeholders in the use of fadama resources. However, the

government should be in the fore in the provision of irrigation facilities, early maturing, pests and disease resistant varieties of crop to the farmers.

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Farmers' awareness of the effects of climate change on agriculture in Delta State, Nigeria

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Abstract

The effects of climate change significantly impact on agricultural production especially in sub-Sahara Africa where agricultural production activities is carried out by small-scale farmers and predominantly dependent on climatic conditions. It is envisaged that these effects will have dire consequences on food production and thereby further worsen the precarious food security status of many households in the region. The study assessed farmers' awareness of the effects of climate change on agriculture. Data for the study were collected from 140 randomly selected farmers using structured interview schedule. Data were analyzed using frequency counts, percentages, mean scores and Pearson product moment correlation. Findings indicated that 54.3% of the respondents were above 50 years, 62.9% were male and 45.7% had no formal education. The respondents were mainly aware of oil exploration (52.1%), oil spillage and gas flaring (45.7%), as the main causes of climate change. Furthermore, the respondents were aware of the change in rainfall pattern (36.4%) as one of the effects of climate change. Flooding ($\bar{x}$ = 3.45), increased wind ($\bar{x}$ = 3.35) and change in rainfall pattern ($\bar{x}$ = 3.19) were some of the major effects of climate change experienced by the respondents. Result shows that there was a positive though not a significant relationship between the age of the respondents and their experience of the effect of climate change ($r = 0.03$; $p > 0.05$). It was recommended that deliberate efforts should be made towards the enlightenment of farmers' on the causes and effects of climate change through different media accessible to the farmers in addition to the means of mitigating these effects.

Keywords: Climate change, Farmers, Awareness, Agriculture.

Introduction

Climate of a place is referred to as a long term average condition or the typical annual cycle of weather event of that place (Ojo and Oni, 2001). In addition Ayoade (2004) asserts that it is the characteristic conditions of the atmosphere which is as a result of repeated observation over a long period of time which is about 30 – 35 years. The atmospheric conditions include temperature, humidity, rainfall, wind and

sunshine amongst others. A noticeable change in atmospheric conditions is referred to as climate change. The Intergovernmental Panel on Climate Change (IPCC, 2001) posits that climate change is any statistically significant variation in the weather conditions that prevails for some time. These changes have been observed on global and regional scales since the pre-industrial era and this is attributable to numerous human related activities which are due to increasing sophistication and mechanized lifestyles (Gwary, 2007).

The changes impact significantly on agricultural production especially in sub-Sahara Africa where agricultural activities is predominantly dependent on climatic conditions. This will have dare consequences on food production and further worsen the precarious food security status of many poor households in the region. In lending credence to this assertion FAO (1997) posits that increase in temperature will likely decrease crop yields, lead to recurrent drought in many regions and affect soil moisture and nutrients. This condition at the same time can have detrimental effects on the health, growth and reproduction ability of livestock animals. Pet Zoldt and Seaman (2005) posit that this may also lead to the establishment of new diseases, change in feeding practices, change in ecological conditions in which livestock are reared and possible migration. The Nigeria Environmental Study Action Team (NEST, 2004) opines that the effect of climate change will be more felt in those areas in Nigeria where oil exploration and gas flaring activities are carried out because these conditions favour changes in the climate due to green house gases that are emitted and oil spills that follow exploration activities on cultivated land areas and aquatic environment.

It therefore becomes apparent that farmers' awareness of the consequences of this phenomenon is ascertained and the extent to which its effect is being felt be examined.

Objectives of the study

The broad objective of the study was to ascertain farmers' observed effects of climate change on agriculture in Delta State of Nigeria. In specific terms the study was to:

1. determine farmers' awareness of the causes of climate change;
2. ascertain farmers awareness of the effects of climate change on agriculture; and
3. investigate farmers observed effects of climate change.

Hypothesis of the study

The hypothesis of the study was stated in the null form that:

1. There is no significant relationship between selected farmers' personal characteristics and observed effects of climate change.

Methodology

The study was conducted in Delta State of Nigeria between the months of July and September, 2008. The state is located between longitude $5^0$00' and $6^0$45' East and latitude $5^0$00' and $6^0$30' North. It covers a landmass of about 18,050 km2, with a wide coastal belt interlaced with rivulets and streams. The vegetation of the area varies from mangrove swamps along the coast to evergreen forests in the inter

land. Purposive sampling was used to select Warri-South and Uvwie Local Government Areas out of the twenty five (25) Local Government Areas (LGAs) because of the high oil exploration and gas flaring activities in these areas. This was based on the assumption that these activities have adverse effects on the climate. A systematic random sampling technique was used in selecting 87 respondents out of a total of 359 Agricultural Development Programme (ADP) registered farmers, while 53 unregistered farmers were also sampled using the snowball sampling technique to have a total of 140 respondents. A structured interview guide was used to elicit response from the respondents after it was content and construct validated by professionals in the field of agricultural communication. Awareness of the causes of climate change was ascertained by asking the respondents whether they were aware or not of some causes of climate change such as oil exploration, gas flaring, and deforestation amongst others. Awareness of the effects of climate change was determined by asking the respondents to indicate whether they were aware or not of some effects of climate change such as change in rainfall pattern, increase in temperature and flooding. Farmers observed effects of climate change was ascertained using a four point rating scale of “very often” (4 points), “often” (3 points), “rarely” (2 points) and “never” (1 point) on a list of climate change effects. Data were analysed using descriptive statistics such as frequency count, percentage and mean. Pearson Product Moment Correlation was the inferential statistics used.

Results and discussion

Personal characteristics of respondents

Personal characteristics of respondents as indicated in Table reveals that 54.3% of the respondents were within the age bracket of 50 years and above. This shows that most of the farmers are elderly, which is similar to the findings of African Networks for Environment and Economic Justice, (ANEEJ, 2004) that noted that farmers in Nigeria are mostly above 50 years. Also, 45.7% of the respondents had no formal education. This indicates a high level of illiteracy among respondents of the study which is similar to the findings of Okali and Eleri (2004) that reported a large percentage of illiterate rural farmers in Nigeria. Furthermore, Table 1 reveals that 62.9% of the respondents were male, with 71.4% having over 10 years of farming experience. This shows that most of the respondents have been involved in agricultural activities for sometime and should be familiar with climatic conditions prevalent in their area. Furthermore, 52.1% of the respondents were involved in fishing as their major farming activity. This is expected because the area has a lot of creeks and a wide coastline. Awosika (1995) had earlier opined that majority of the agricultural activities in the Niger Delta region of the country is fishing because the area is mainly surrounded by rivers, estuaries, streams and lakes.

TABLE 1: Personal characteristics of respondents

Characteristics	Frequency	Percentage
Age (Years)		
20 to 30	14	10.0
31to 40	50	35.7
Above 50	76	54.3
Total	140	100.0
Educational level		
No formal education	64	45.7
Primary	39	27.9
Secondary	23	16.4
Tertiary	14	10.0
Total	140	100.0
Sex		
Female	52	37.1
Male	88	62.9
Total	140	100.0
Farming experience (Years)		
Below 5	4	2.9
6 to 10	36	25.7
Above 10	100	71.4
Total	140	100.0
Major farming activity		
Fishing	73	52.1
Crop farming	48	34.3
Animal husbandry	19	13.6
Total	140	100.0

Awareness of the causes of climate change

Results in Table 2 indicate that 52.1% of the respondents were aware of oil exploration as a cause of climate change. This may be attributed to the high level of oil exploration activities going on in the area which is inline with prior expectations. Also, 87.9% and 77.9% of the respondents noted that they were not aware of fermentation of cattle dung and inorganic fertilizers as causes of climate change respectively. This is similar to the findings of Iwuagwu (2008), who reported that most farmers are not aware of the implication of the use of inorganic fertilizer as they emit gases such as methane and nitrous oxide which are trapped in the atmosphere, thereby facilitating climate change. This implies that the farmers are not aware of other causes of climate change except the very obvious such as oil exploration and this may be adduced to the fact that these other causes are not harped upon in the discuss on climate change.

TABLE 2: Respondents' awareness of the causes of climatic change

Causes	Aware*	Not aware*
Oil exploration	73 (52.1)	67 (47.9)
Oil spillage	64 (45.7)	76 (54.3)
Gas flaring	64 (45.7)	76 (54.3)
Deforestation	49 (35.0)	91 (65.0)
Fermentation of cattle dung	17 (12.1)	123 (87.9)
Inorganic fertilizer	31 (22.1)	109 (77.9)
Fossil fuel burning	39 (27.9)	101 (72.1)

**Multiple responses. Figures in parenthesis are percentages*

Awareness of the effects of climate change

Respondents' awareness of the effects of climate change as shown in Table 3 indicates that 36.4% of the respondents were aware that change in rainfall pattern is an effect of climate change. Furthermore, findings in the Table 3 indicates that 81.4% of the respondents are not aware of reduced water quality, bush fire and sea level rise as some of the effects of climate change. This implies that the respondents are not aware of many effects of climate change which can be attributed to the low level of information about these effects except the obvious effects.

TABLE 3: Respondents' awareness of the effects of climate change

Effects of climate change	Aware*	Not aware*
Flooding	47 (33.6)	93 (66.4)
Acid rain	44 (31.4)	96 (68.6)
Soil Erosion	44 (31.4)	96 (68.6)
Increase in temperature	39 (27.9)	101 (72.1)
Presence of residue on leaves	31 (22.1)	109 (77.9)
Increase in pest and disease infestation	31 (22.1)	109 (77.9)
Decrease in crop yield	39 (27.9)	101 (72.1)
Reduced water quality	26 (18.6)	114 (81.4)
Increased wind	34 (24.3)	106 (75.7)
Imbalance in soil nutrient	27 (20.3)	113 (80.7)
Bush fire	26 (18.6)	114 (81.4)
Sea level rise (reducing farm land area)	26 (18.6)	114 (81.4)
Reduced natural vegetation	36 (25.7)	104 (74.3)
Change in rainfall pattern (timing and amount)	51 (36.4)	89 (63.6)
Increase in soil and water acidity	42 (30.0)	98 (70.0)

**Multiple responses. Figures in parenthesis are percentages*

Observed and experienced effects of climate change by respondents

Some of the observed and experienced effects of climate change by the respondents as indicated in Table 4 include flooding ($\bar{x}$ = 3.45), increase in wind ($\bar{x}$

= 3.35) and change in rainfall pattern ($\bar{x}$ = 3.19). Uyigue and Agho (2007) had reported that there has been a drastic increase in erosion and flooding experienced in the Niger Delta region of Nigeria in the past decade which may be an explanation for the answers by the respondents. Also, since many of the respondents are into fishing as their major occupation as indicated in Table 1 may explain the reason for observing increase in wind while on their fishing expedition.

TABLE 4: Respondents' experience of the effect of climate change

Experience of effects of climate change	Mean	Standard Deviation
Flooding	3.45*	0.74
Increased wind	3.35*	0.66
Change in rainfall pattern (amount and timing)	3.19*	0.73
Soil Erosion	2.90*	1.05
Acid rain	2.84*	1.46
Increase in temperature	2.84*	1.29
Reduced water quality	2.70*	1.08
Sea level rise	2.69*	0.79
Decrease in crop yield	2.65*	0.98
Increase in pest and disease infestation	2.46	0.95
Presence of residue on leaves	1.83	1.15
Reduced natural vegetation	1.77	1.03

Scale: Very often =4, often =3, rarely =2, never =1.

**Means are greater than 2.50 and therefore important*

Relationship between selected personal characteristics and observed effects of climate change

The result of the relationship between selected personal characteristics and observed effects of climate change is presented in Table 5. Findings reveal that there is a positive though not significant relationship between respondents' age (r = 0.03; p>0.05) and their experience of the effects of climate change.

TABLE 5: Relationship between selected personal characteristics and observed effects of climate change

Variables	r value	P level	Decision
Age	0.03	0.66	Not significant
Farming experience	-0.02	0.76	Not significant
Educational level	-0.01	0.99	Not significant

Conclusion and recommendations

The study has shown that respondents in the study area are aware of oil exploration as a major cause of climate change and change in rainfall pattern as an important effect of climate change. Furthermore, the effects of climate change mainly observed by the respondents were flooding and change in rainfall pattern. It was recommended that deliberate effort should be made towards the enlightenment of farmers' on the causes and effects of climate change through different media accessible to the farmers. Farmers should also be enlightened on the means of mitigating the effects of climate change being experience by them.

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Soil Conservation Practices among Arable Crop Farmers in Enugu – North Agricultural Zone, Nigeria: Implications for Climate Change

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Abstract

The study examined soil conservation practices used by arable crop farmers in Enugu – North agricultural zone of Enugu State. One hundred and twenty randomly selected arable crop farmers were interviewed. Data were analysed by use of percentage and mean score. The study revealed that respondents used organic manure (87.5%), planting of cover crops (87.5%), crop rotation (86.7%), mulching (85.8%), inorganic manure (76.7%), contour bonds(75.8%), liming (61.7%), and terracing (60.8%) for soil conservation in the zone. However, organic manure (M= 3.32), use of inorganic manure (M= 3.08), crop rotation(M=2.86), and mulching (M=2.82) were most preferred by the respondents The major reasons indicated for use of most soil conservation practices included enhanced productivity, high quality products, long term nutrient value and others. While most of the preferred conservation practices hold great potential for increased production, income for farmers and enhanced food security for the nation, some are implicated as causes of climate change. The more environment friendly and climate change sensitive practices are less popular among the farmers. The paper recommends concerted efforts to promote among farmers the conservation practices that aid mitigation and adaptation to climate change and at the same time enhance production. Researches and a corresponding creation of awareness on the most efficient and environmentally safe way of using practices that contribute to climate change should be intensified, since the pressure on ensuring food security remains a formidable challenge in the nation.

Key words: soil conservation, climate change, farmer, potential, threat.

Introduction

Achieving food security in its totality continues to be a challenge not only to developing nations but also to the developed world (Angela, nd). According to FAO (2006) an estimated 854 million people worldwide are still undernourished and almost 33% or close to 200 million people in Africa are chronically undernourished. The situation in Sub-Saharan Africa is particularly dire with the number of hungry people increasing by 20 percent since 1990 (Braun, 2005). In Nigeria the situation is not different. Kumolu (2010) reported that about 40 million people in Nigeria are believed to be hungry and a large percentage of the population lack access to adequate food.

Land degradation is one of the biggest threats to sustainable development of agriculture, food security and poverty reduction in the world and Nigeria in particular. According to Barbier, (2003), land degradation is the result of a combination of social, economic, cultural, political and biophysical forces operating across a broad spectrum of temporal and spatial scales but essentially arises from bad land management that encourages soil erosion by wind and water, bad irrigation management leading to salinization, excessive use of fertilizer that leads to soil acidification and formation of acid sulfate soil resulting in barren soil, over grazing of rangeland and more widely and insidiously through loss of soil organic matter and loss of biodiversity.

World Watch (2012) reports that according to a study conducted for the International Food Policy Research Institute, each year an estimated 10 million hectares of cropland worldwide are abandoned due to soil erosion and diminished production caused by erosion. Another 10 million hectares are critically damaged each year by salinization, in large part as a result of irrigation and/or improper drainage methods. This loss amounts to more than 1.3 percent of total cropland annually. Primarily, farmers depend on rich topsoil for production of crops but about 1.9 billion tons of topsoil washes or blows away each year with 1.3 billion tons of excessive erosion (www.planetwire.org/files.fcgi/291.agricult.pdf). Consequently, most of the additional cropland needed to replace yearly losses comes from the world's forest areas.

According to World Bank report of 1990, the long term loss to Nigeria from environmental degradation was estimated to be about $5 million annually (Ezeaku, 2012). With gully erosion widespread in southern Nigeria, the federal government spent almost 91.0 billion naira on the periodic rehabilitation aid and replacement project of the Bar Beach in Lagos (UNCSD, 1997) .World Bank reported that in 1990, gullies occupied 4% of the land area of Anambra, Imo, Abia, and Enugu States. Ogbonna, Onyenweaku and Mbanasor *(*2007) remarked that the situation of soil degradation that requires immediate soil conservation attention is more precarious in the southeastern states of Nigeria especially in Enugu State. Therefore, use of sustainable soil conservation techniques is of paramount importance to achieving increased production and food security of the country.

Soil conservation according to Ezeaku (2012) is a set of management strategies for prevention of soil being eroded from the earth's surface or becoming chemically altered by over use, salinization, acidification, or other chemical soil contamination. It comprises the combination of all methods of management and land use to guard against soil depletion or deterioration by natural or man-induced factors. In the opinion of Dumaski, Peiretti, Benitis, McCarry et. al., (2006), soil conservation efforts of farmers promote minimum disturbance of the soil by tillage, balance application of chemical inputs which are only required for improved soil quality for healthy crop and animal production with careful management. Thus, effective soil conservation practices reduce land and water pollution; reduce long-term dependency on external inputs which often times led to increased cost of production, enhance environmental management, improved water quality and water use efficiency, reduced emission of green house gases through lessened use of fossil fuel and finally improved agricultural productivity with minimum cost (Smith and Smithers, 2006).

Traditionally, farmers employ several soil conservation practices ranging from simple agronomic practices, soil management and use of mechanical methods of soil management. Though the use of these practices has considerably sustained production at least on subsistence level, but their impacts (long and short term) in relation to adapting, mitigating or exacerbating the problems of climate variability should be of concern. It is generally believed that agriculture ranks high as one of the major contributors to climate change and a sector most vulnerable to climate change (IPCC, 2007). Organic Agriculture Association (2008) states that agricultural land use is responsible for approximately 15% of all green house gas (GHG) emission. Specifically, agricultural processes comprise of 54% of methane emissions, roughly 80% of nitrous oxide emission, and virtually all carbon dioxide emissions tied to land use (Niggli, Fliessbach, and Hepperly, 2008). On another hand, agriculture stands as the most vulnerable sector because of its heavy reliance on sustainable use of natural resources. Another paradox is the notion that it has potential for mitigating to climate change. This calls for a rethinking on the current soil conservation practices employed by farmers for agricultural production. Therefore examining the current soil conservation practices employed by arable crop farmers in relation to climate change phenomenon is an imperative .The study aimed to;

- ascertain and examine soil conservation practices used by famers;
- examine farmers' preference of soil conservation practices and reasons for the preference; and
- identify constraints to the use of soil conservation practices.

Methodology

The study was conducted in Enugu – North Agricultural Zone of Enugu State, Nigeria. Enugu North Agricultural Zone consists of eight (8) blocks which includes: Nsukka 1, Nsukka II, Igbo-Eze I, Igbo-Eze II, Udenu, Igbo-Etiti, Uzo-Uwani I, and Uzo-Uwani II. Arable crop farmers in the zone constituted the population. Multistage random selection technique was used. The first stage involved random selection of six blocks from the zone by simple random technique. The second stage was the selection of two cells from each block using simple random selection techniques, giving a total of twelve cells for the study. Lastly, ten arable crop farmers were selected from list of arable crop farmers provided by extension agents using simple random selection technique . A total sample size of 120 respondents was used. Data were collected by the use of structured interview schedule. Respondents were asked to indicate the methods of soil conservation employed in the farm (example mulching, planting of cover crops, conservation-tillage crop rotation, organic manures, inorganic manure and others), their preference and reasons for preference of soil conservation used. The respondents indicated their preference on a four point Likert type scale of highly preferred (4), preferred (3), less preferred (2), and least preferred (1). Respondents were also asked to indicate among listed variables, problems encountered while using a particular soil conservation practice. Data collected were analyzed using descriptive statistics. (frequency distribution, percentage, mean and standard deviation). Preference was determined using the mean cut off point ≥ 2.5 as most preferred and < 2.5 as less preferred.

Results and Discussion

Soil conservation practices used

Table 1 shows that respondents employed organic manure (87.5%), cover crops (87.5%), crop rotation (86.7%), mulching (85.8%), inorganic manure(76.7%), and terracing (60.8%) to conserve the soil. Only 30% and 0.8% of the respondents practiced planting of windbreak and conservation-tillage in their farms, respectively. Generally, respondents used both agronomic, soil management and mechanical strategies of soil conservation. Either practices are important because they variously affect chemical, physical and boilogical properties of soil. For instance, agronomic soil conservation practices(cover crops,mulching,crop rotatio, fallowing and others) use the effect of surface covers to reduce erosion by water and wind in order to conserve the soil, protect the soil from direct sun rays and enrich soil by the decay of their fallen leaves (Olaitan and Omamia, 2006) and some reduces the risk of serious pest and disease outbreaks. Also highlighting on its importance, Agele, Iremiren, and Ojeniye (2000) pointed out that the crop residues released reduce the soil temperature by some degree in the upper centimetes of the top soil and priovide better moisture conservation by reducing the intensity of radiation, wind velocity and evaporartion. It is these attributes that enhanced its potential for climate change adaptation and mitigation. Infact, Enete, Madu, Onwubuya, Onyekuru et al. (2011) identified some of the practices as indigenous adaptation practices used by farmers in south east Nigeria. It boosts adaptation to erosion, effect of direct sun rays on the soil, increase pest and diseases, loss of soil biomass and reduce soil fertility associated with climate change. The mitigation potential is provided by its ability to significantly contribute to soil carbon sequestration (carbon uptake from the atmosphere) through increase organic matter content of the soil.

In the same manner, soil management practices which include conservation tillage, the use of organic and inorganic manure holds great potentials for climate change adaptation and mitigation. Specifically, conservation tillage (zero tillage, minimium tillage ,ridge tillage etc.) particularly zero tillage mitigate against release of CO_2 and N_2O caused by intensive tillage and burning of fossil fuel. It only becomes a threat where farmers use slash and burn for zero tillage. Similarly, the use of inorganic (fertilizer) and organic manure(animal dung/droppings) increases vulnerability (threat) by release of nitrous oxide and methane into the atmosphere. According to Organic consumer Association (2008) they are the two main sources of nitrous oxide. Nevertheless, these soil conservation practices are highly recommended by climate change scholars with emphansis on appropiate management that depend less on use of inorganic manure and that enhance mitigation against release of nitrous oxide. (Ozor, Madukwe, Onokala, Enete et al., 2010; and Nzeh and Eboh , 2011)

Mechanical soil conservation practices namely the use of terrace, vegetative barriers/planting for wind break, contour bonds etc. are not very popular among the farmers. According to Junge, Deji Abaidoo, et al. (2009) they are effective soil conservation technologies as they reduce soil loss, but because the installation and maintenace is usually labour intensive, they are not likely to be adopted by farmers. However, they are both adaptive and mitigation measures to climate variability. When used, exessive soil and wind erosion, loss of degraded lands, and silting up of the field are reduced. The mitigation potentials are achieved through carbon

sequestration (absorption of carbon from the atmosphere) by tree planting or vegetative barrier.

TABLE 1: Precentage distribution of repondents by soil conservation practices used

Conservation practices	%
Conservation tillage	0..8
Organic manure	87.7
Mulching	85.8
Inorganic manure	76.7
Planting cover crops	87.5
Crop rotation	86.7
Contours bonds	85.8
Terracing	60.8
Planting windbreak	30.0

Multiple response

Preferences of Soil Conservation Practices

The mean scores in Table 2 show that organic manure (M= 3.32; S.D= 1.13), inorganic manure (M= 3.08; S.D= 1.16), Planting of cover crops (M= 3.05; S.D= 1.15) and mulching (M=2.82; S.D= 1.08) were the most preferred soil conservative practices. The less preferred soil conservative practices included terracing (M= 2.39; S.D= 1.37), Contour bond (M= 1.88; S.D= 1.18), planting windbreak (M= 1.68; S.D= 0.74), and conservation tillage (M= 1.39; S.D= 0.82) .The high standard deviation of responses of the most preferred practices portrays varying opinion and probably the frequency of use by the respondents. Respondents are more homogenous in the perception of less preferred conservation practices and this suggests that these practices are yet to be welcomed and adopted as one of the effective soil conservation practices, perhaps due to location specificity of some of the practices. The integration of these practices especially in erosion prone areas is expedient in the present reality of climate change and the call for effective adaptation and mitigation measures. However, respondents' reasons for the preference are discuss as follows:

TABLE 2: Mean score based on respondents' preference of the soil conservation practices

Variable	Mean	S.D
conservation tillage	1.39	0.82
Organic manure	3.32*	1.13
Mulching	2.82*	1.08
Inorganic manure	3.08*	1.16
Planting cover crops	3.05*	1.15

Crop rotation	2.86*	1.42
Contours bonds	1.88	1.18
Terracing	2.39	1.37
Planting windbreak	1.68	0.74

**Most preferred soil conservative practices*

Reasons for using soil conservation practices

Conservation tillage

Table 3 shows that respondents used conservation tillage' because it reduces production cost (50.4%), is less labour intensive (20.9%), and that it is less expensive (19.4%). About 11%, 8%, and 6% stated that it has no environmental pollution, it is easily accessible, conserve soil moisture and controls erosions, respectively. The results show that reduced cost of production is the major factor influencing use of conservation-tillage. The respondents seem to be unaware of other benefits. For example Nalewaje, (2001) reported that avoiding tillage averts disruption of soil aggregate, protect soil organic matter from accelerated decomposition and restore several soil biological processes. Above all, it is an emergent crop production technique which can increase the amount of water in the soil and decrease erosion. Thus, Bellarlly, Foereid, Hasting and Smith (2008) and Niggli, Fliessbach and Hepperly. (2008) identified it as one of the sustainable agricultural practices beneficial to reducing the effect of climate change.

Organic manure

The respondents preferred organic manure because it enhances productivity (90.7%), high quality products (83.7%), long term nutrient value (80.6%), increase water filtration (72.1%), availability and accessibility (64.3%), increase soil biological activities (59.7%), aid soil aeration (57.4%),and control erosion (55.9%) (Table 3). Other reasons include less environmental pollution (48.1%), conserve soil moisture (45.0%) and less expensive (45.0%). This is in agreement with the conservation properties of organic manure. Hence, it's importance for carbon sequestration and improvement of ecosystem resilience. However, appropriate management particularly during fermentation and/or when animal waste comes in contact with water and slurry (decomposition) is necessary to reduce potential threats to the climate.

Mulching

Table 3 shows that the respondents practiced mulching because it reduces the effect of heat from the sun (87.6%), conserve soil moisture (86.8%), has no environmental pollution (63.6%), and enhances productivity (53.5%), while 48.8%, 37.2%, 31.8% and 30.2% practiced mulching because of ease of accessibility, less expensive, increase soil microbial activities and increases water infiltration, respectively. This agrees with FAO (2006) that mulching protects against erosion, suppresses weeds, increase water infiltration and promotes soil biological activities.

Also crop residues reduces the soil temperature by some degrees in the upper centimeters of the topsoil and provide better moisture conservation by reducing the intensity of radiation, wind velocity, and evaporation (Agele, et al., 2000). These characteristics effect of mulching constitute its potential for adaptation to climate change indicators such as increased temperature, erosion etc.

Inorganic manure

Majority (86.8%) of the respondents used inorganic manure because it enhances productivity, while 55.8% and 55.0%, used it for higher quality product and long term nutrient values; respectively (Table 3). Other reasons namely less labour intensive (18.6%), accessibility and availability (16.3%), aid aeration (14.0%), others were lowly perceived as reasons for use of inorganic manure. The result revealed that economic benefit is the key driver for application of inorganic soil conservation practice. The low perception of other reasons seem to suggest that the respondents are aware of its limitation in engendering long term improved physical, chemical and biological property of the soil. Frequent use of inorganic manure (fertilizer) has been associated with land degradation, increase in soil acidification and the formation of acid sulfate soil resulting in barren soil which eventually leads to decrease in agricultural productivity (Barbier, 2003)). Above all, the doubling of green house gas (GHGs) production during the last 35 years was associated with a 6.9 fold increase in nitrogen fertilizer, a 3.5 fold increase in phosphorus fertilizer and a 1.7 fold increase in irrigated land (FAO, 2008). This makes it a threat instead of resource in adapting or mitigating climate change, especially where application is highly intensive.

Cover crop

Table 3 shows that (89.9%) of the respondents practiced cover cropping because it supresses weeds (89.9%), conserves soil moisture (86.0%), reduces heat from the sun (84.5%), and had no environmental pollution (53.5%), A significant proportion used it for enhanced productivity (45.0%), control erosion (45.0%), aid soil aeration (39.5%), increases soil biological activities (34.9%) and increases water infiltration (31,0%). Relatively, the reasons are in line with FAO (2006) which maintained that permanent soil cover protects against erosion, suppresses weeds, increase water infiltration and promotes soil biological activities. This is further substantiated by Olaitan and Omomia (2006) who stated that cover crops are mainly planted to protect the soil from direct sun rays, reduce erosion, and enrich the soil by the decay of fallen leaves. These attributes makes it potentially a resource for both adaptation and mitigation against climate variability and global warming.

Crop rotation

The respondents indicated that the reasons for practicing crop rotation were to enhance production (79.1%), had no environmental pollution (72.9%), gives higher qaulity products (65.9%), and control erosion (60.5%) (Table 3). About 46% ,43%, and 21% applied crop rotation because it increases water infiltration, conserve soil moisture and it is less expensive, respectively. Characteristically, soil rotation reduces the risk of serious pest and disease outbreak, check erosion, improve soil fertility, and balance nutrient removal from the soil among others. In this way it increases resilience and reduces vulnerablity of production system to climate change. .

Contour bond

Majority (59.7%) of the respondents practiced contour bond because it enhanced productivity, while 44.2%, 38.0% and 30.2% indicated that it has no environmental pollution, contols erosion and conserves soil moisture, respectively(Table 3). A lesser proportion (22.5%) used it to increase water infiltration. Other reasons indicated by the respondents were because contour bond is less expensive (10.9%), availabilty/ accessibilty (10.9%), give higher quality products (9.3%) and others The low perception expressed over resason for use confirms low preference and use of contour bond as indicated in the previous results. It could be that the respondents either have constraints to its use or they are not very knowledgeable of its application/benefits. Unfortunately it is supposed to be a common erosion control measure particularly in erosion prone areas. Thus, it is relevant for adaptation to climate associated problems like erosion.

Terracing

The respondents indicated that terracing was practiced in their farm to enhance productivity (39.5%), control erosion (29.5%), conserve soil moisture (26.4%), has no environmental pollution (24.0%), and increases water infiltration (21.7%) (Table 3). Relatively, the reasons expressed agree with Conservation Technology Information (2002) report that terrace prevent gully erosion and decrease sediment pollution in water. However, the perception of the respondents suggests that use of terracing for soil conservation is not a common practice. This is not surprising because according to Igbokwe (1996) high labor intensity, time- consuming regular inspection, high consumption of scarce farmland, and the large amounts of construction material required stop farmers from installing or maintaining terracing. Nevertheless, it is important for adapting to changes caused by climate variability (erosion).

Planting of Wind break

Table 3 shows that respondents plant Windbreak because it controls erosion (67.4%), reduce the effect of heat from the sun (44.2%), suppresses weeds (41.9%) and has no environmental pollution (39.5%). Other reasons for planting windbreak include; it enhanced productivity (23.3%), increase water infiltration (12.5%), and others. This is true of tree planting but it is surprising that is still not a common practice among farmers. Rather indiscriminate felling of trees seems to be more widespread in communities. Planting of trees in farms, and surroundings is essential for adaptation (against heat from sun, wind erosion etc) and mitigation (carbon sequestration and ecosystem resilience)

TABLE 3: Percentage distribution of respondents by reasons for preference of soil conservation practices

Reasons	Conservation tillage	Organic manure	mulching	Inorganic manure	Cover crop	Crop rotations	Contour bunds	terracing	Planting wind break
Less expensive	19.5	45.0	37.2	8.5	9.3	20.9	10.9	3.9	-
Availability/accessibility	7.8	64.3	48.8	16.3	8.5	5.4	10.9	10.9	3.1
Long term nutrient value	-	80.6	6.2	55.0	7.8	8.5	-	-	-
Aid soil aeration	-	57.4	14.0	14.0	39.5	7.0	-	10.9	-
conserve moisture	6.2	45.0	86.8	6.2	86.0	43.4	30.2	26.4	9.3
higher quality product	-	83.7	5.4	55.8	16.3	65.9	9.3	18.6	-
Less labour intensive	-	8.5	4.7	18.6	8.5	2.3	2.3	-	-
Has no environmental pollution	10.9	48.1	63.3	11.6	53.5	72.9	44.2	24.0	39.5
Increase water infilteration	-	72.1	30.2	5.4	31.0	45.7	22.5	21.7	12.5
Increase soil biological activities	-	59.7	31.8	8.5	34.9	5.4	-	-	-
Control erosion	6.2	55.8	17.1	7.0	45.0	60.5	38.0	29.5	67.4
Reduce effect of heat	-	6.2	87.6	7.0	84.5	3.9	-	-	44.2
Suppress weeds	-	2.3	24.0	2.3	89.9	8.5	-	7.8	41.9
Reduce production cost	50.4	14.0	13.3	1.6	8.5	9.3	3.9	7.0	-
Enhanced productivity	-	90.7	53.5	86.8	45.0	79.1	59.7	39.5	23.3

Multiple response

Constraints to use of soil conservation practices

Conservation tillage

Results show that use of soil conservation practices are constrained by several factors. Majority (70.8%) of the respondents perceived that conservation tillage method encourages weed growth, while 15.0% and 10.0% indicated that it increases pest infestation and inhibibits soil microbial activities (Table 4). Similarly,

greater proportion (55.8%, 41.7% and 40.8%) of the respondents perceived that bulkiness of material, encouragement of weed growth and environmental pollution limit the use of organic manure for soil conservation, respectively. Other constraints perceived by the farmers were that organic manure increases pest infestation (32.5%), high cost of material (21.7%), requires multiple applications (20.8%), inadequate capital (16.7%) and others. Also use of inorganic manure was largely constrained by inaccessibility (87.5%), inadequate capital (79.2%), high cost of material (68.3%), unavailability (62.5%), multiple application (49.2%), causes environmental pollution (41.7%) and others, while inadequate capital (53.3%), and size of farm land (23%) were indentified as major limiting factors to use of crop rotation for soil conservation.

Furthermore, Table 4 shows that high labour involvement constrained use of cover crops (51.7%), contour bonds (62.5%), and terracing (39.2%). About 52% and 42% of the respondents expressed that bulky nature of material and poor access constrained use of mulching as soil conservation practice. Only 30.0% of the respondents perceived that planting windbreaks constitute nuisance during cultivation. Largely concern on the cost of use is more outstanding as constraint than environmental issues related to application of some practices. The perceptions suggest that while some practices have gained popularity (inorganic manure, organic manure etc.), others like planting of wind break, crop rotation, contour bonds and others are less commonly used. Unfortunately, some of these practices constitute adaptation/mitigation measures recommended against climate-related land degradation and problems. (FAO, 2008 and Ozor, Madukwe, Onokala, 2010). Above all, lack of information, knowledge of application and benefits; and location specificity that characterized some soil conservation practices may have influenced the low perception of the constraints.

TABLE 4: Percentage distribution of respondents by constraints to use of soil conservation practices

Constraints	Conservation tillage	Organic Manure	Mulching	Inorganic Manure	Cover Crops	Crop rotation	Contour bunds	terracing	Planting of Wind break
Increase pest infection	15.0	32.5	-	11.7	-	0.8	-	-	20.8
Inadequate capital	2.5	16.7	14.2	79.2	11.7	53.3	-	-	
Unavailability of raw material	-	17.5	15.0	62.5	-	-	-	-	15.8
High cost of material	-	21.3	14.2	68.3	-	-	-	-	-
Environmental pollution	-	40.8		41.7	-	-	-		-
Bully nature of material	-	55.8	51.7	9.2	-	-	-		-
Encourage weed growth	70.8	41.7	15.8	20.8	-	-	-		-
Require multiple application	-	20.8	-	49.2	-	-	-	-	-
Delay/ inhibits microbial activities	3.3	-	6.7	-	-	-	-		
High labour involvement	-	-	26.7	17.5	51.7	-	62.5	39.2	10.0
Not accessible on time	-	-	41.7	87.5	-	-	-	-	-
Reduction in soil fertility	6.7	-	-	-	-	-	-	-	-
In adequate size of farm land	-	-	-	-	-	23.3	19.2	15.0	-
Constitute nuisance to planting	-	-	-	-	-	-	-	-	30.0

Multiple response

Conclusion

The study shows that arable crop farmers used different soil conservation practices namely conservation tillage, organic manure, inorganic manure, mulching, use of cover crops, crop rotation, coutour bond, and others. However, the respondents preferred organic manure, planting of cover crops, inorganic manure, and mulching. Economic benefits in terms of the cost,labour, timely access,and productivity were central to the reason for prefernce of the practices. Relatively the respondents were less concern about the environmental implications and long term impact on the soil. Overall, because of the chemical, biological and physical effect on the soil, most of the practices hold great potential for adaptation and mitigation to climate change execpt the use of inorganic manure which characteristically exacerbates the problem of climate change and increases vulnerability of production system.

On another hand some of the practices which hitherto provide adaptation/mitigation benefits, example use of organic manure could aid climate change especially when it is not appropiately managed. Above all the use of these practices are constrained by several factors such as cost, logistics, and others The study therefore recommends that extension and stakeholders should intensify efforts on creation of awareness on climate change in farming communities and re-orientate farmers on climate implications of the soil consevation practices used. Farmers should be

trained and encouraged to increase dependance on practices that present high potentials for adaptation/mitigation to climate change. Regulatory measures should be put in place to regulate use of some of the practices such as inorganic manure which are detrimental to climate, increase vulnerability and reduce resilience of farming system and communities. Researches and training on the best management practices for soil conservation that has dual effects on the climate is expedient.

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Role of Sustainable Land Management for Climate Change Adaptation and Mitigation in Sub-Saharan Africa: A Review

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Abstract

Climate change and land degradation are major threats to the survival and livelihoods of millions of people in sub-Saharan Africa (SSA). Major new opportunities exist to help improve the livelihoods of African smallholder farmers, pastoralists, and other resource users while mitigating emissions of greenhouse gases, reducing land degradation, and addressing other environmental problems in the context of the current negotiations to develop a climate change framework. International, national, and local efforts are needed to promote sustainable land management (SLM) and conserve biodiversity. The paper addresses the role of SLM in climate change adaptation and mitigation. It recommends that efforts of policy makers, development practitioners and other stakeholders are needed in order to harness the potentials inherent in SLM for climate mitigation and adaptation as well as ensuring land productivity and sustainability.

Keywords: Sustainable land management, climate change, adaptation, mitigation, sub-Saharan Africa

Introduction

Sustainable land management (SLM) may be defined as the adoption of land use systems through appropriate management practices which enable land users to maximize the economic and social benefits from the land while maintaining or enhancing the ecological support functions of the land resources (FAO, 2000). According to TerrAfrica Partnership (2006) SLM is a key entry point for improving land resource resilience and productivity within the context of the potentially devastating effects of climate change in sub-Saharan Africa, bridging the needs of agriculture and environment. The United Nations Framework Convention on Climate Change (United Nations Framework Convention on Climate Change (UNFCCC), 2007) defines climate change as a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods. Mitigation refers to a human intervention to reduce the sources of green house gases (GHGs) or enhance the sinks that remove carbon dioxide from the atmosphere while adaptation refers to adjustments in human and natural systems to respond to actual or expected climate change impacts (International Panel on Climate Change (IPCC), 2008). Sub-Saharan Africa is uniquely vulnerable to climate change because it already suffers from high temperatures, less predictable precipitation and substantially greater environmental stresses than other continents (IPCC, 2007). Africa also shares with other developing countries the fact of being especially vulnerable to climate change because of their geographic exposure, low

incomes and greater reliance on climate sensitive sectors such as agriculture (Robertson, 2005).

The degree to which a particular farm, locality, agro-ecosystem, country or region in sub-Saharan Africa (SSA) will be affected by climate change depends on a range of local, regional and global scale factors (FAO, 2007) including the magnitude of the change, probability of the change, rate of change, duration of the change and tolerance and capacity characteristics of the system (ability to adapt).

According to Denton (2002), unpredictable climatic conditions have heightened the vulnerability of smallholder producers to shocks from extreme climate events. Climate change has significantly undermined the efforts to sustain and manage agricultural land in sub-Saharan Africa. Many climate models predict negative impacts of climate change on agricultural production and food security in large parts of SSA. Higher temperatures throughout SSA will cause shorter growing periods, drying of the soil, increased pest and disease pressure, and shifts in suitable areas for growing crops and livestock. Mean rainfall is predicted by most models to decline in many areas of SSA, especially in southern Africa, while rainfall is more likely to increase in parts of eastern and central Africa and predictions are more variable in western Africa. Beyond the impacts on mean trends, climate change is expected to cause more extreme weather events. Even in many areas where rainfall is expected to increase, higher temperatures will reduce growing periods. These changes are predicted to reduce the area of land suitable for rain-fed agriculture by 6 percent (averaged across several projections) and reduce total agricultural gross domestic product (GDP) in Africa by 2-9 percent. Agricultural losses are expected to be as much as 50 percent in sub-Saharan Africa during drought years (Malhi, 2002).

Climate change has undermined efforts in the sustainable management of agricultural land in sub-Saharan Africa. Climate change has altered the rainfall patterns, amplified the drought cycle and increased agricultural pests and diseases. The maladaptation to climatic changes has increased with the impact of climate change derailing community's efforts to sustainably manage agricultural land. Land degradation in sub-Saharan Africa is an environmental and social problem. The dependence on rain- fed agriculture; combined factors of variable rainfall, high temperatures, and poor soil fertility heighten the vulnerability of farmers to hardships from extreme climatic conditions (Scholes and Linder, 1998).

According to Gisladottir and Stocking (2005), severe land degradation caused mainly by conversion of forests, woodlands and bush lands to agriculture, overgrazing of rangelands, unsustainable agricultural practices on croplands, and excessive exploitation of natural habitats is reducing primary productivity on as much as 20 percent of the land in SSA, with the most severe impacts in dry lands and forest margins. Climate variability and change can contribute to land degradation by exposing unprotected soil to more extreme conditions and straining the capacity of existing land management practices to maintain resource quality, contributing to de-vegetation, soil erosion, depletion of organic matter and other forms of degradation. These changes can cause land management practices that were sustainable under other climate conditions to become unsustainable, and induce more rapid conversion of forest or rangeland to unsustainable agricultural uses. At the same time, land degradation increases the vulnerability of agricultural production and rural people to extreme weather events and climate change, as the

fertility and buffering capacities of the land and livelihood assets are depleted (Gisladottir and Stocking, 2005).

Climate change can offer new opportunities for productive and sustainable land management (SLM) practices, such as reforestation, improved water management, integrated soil fertility management, conservation agriculture, agro forestry, improved rangeland management and others as a result of changing biophysical or market conditions. Agriculture, forestry and land use (AFOLU) practices in SSA can play an important role in mitigating GHG emissions by reducing agricultural emissions of GHG and sequestering carbon in vegetation, litter and soils. The IPCC estimates that improved agricultural and land management practices in SSA, including improved cropland and grazing land management, restoration of peaty soils, restoration of degraded land and other practices, could reduce GHG emissions by 265 mt CO_2e per year by 2030 (at opportunity costs of up to $20 per t$CO_2$e). Afforestation in Africa could sequester 665 mt of CO_2 per year, while reduced deforestation and forest degradation (REDD) in Africa could reduce emissions by 1,260 mt CO_2e in 2030 (at opportunity costs of up to $100 per t$CO_2$). These potential emission reductions in Africa represent about 6.5 percent of global GHG emissions in 2000; a substantial potential impact even if it would not solve the climate problem by itself (Green Belt Movement (GBM), 2009).

Many SLM practices can simultaneously achieve both adaptation and mitigation goals, especially those that increase soil organic carbon. Sustainable Land Management represents a preventative approach to climate change that can reduce the need for costly *ex post* coping measures, like changing crops and livelihoods, clearing new lands for agriculture and migration. The predicted negative yield impacts of climate change are often dwarfed by proven positive yield impacts of improved land management. In addition to positive impacts on average yields, many SLM practices reduce the variability of agricultural production (for example, soil and water conservation and organic practices that improve soil moisture holding capacity or integrated pest management practices that reduce vulnerability to pests), while others can help to diversify agricultural income (for example, agro forestry with non-timber tree products or crop rotations). A combination of SLM practices can be used to combat the different manifestations of climate change (GBM, 2009).

Sustainable land management practices are adopted on only a small percentage of agricultural land in SSA. Degradation of agricultural land and expansion of agriculture into forests, woodlands and bush land are continuing at a rapid pace.

The paper therefore reviews climate change mitigation and adaptation through afforestation and reforestation; and examines impacts of SLM for climate change mitigation and adaptation. The paper relied heavily on current literature in the study area and observations.

Climate change mitigation and adaptation through afforestation and reforestation

Reforestation is planting new trees in previously forested areas (where old tress have been recently cut or burned). Afforestation involves planting stands of trees on land that is not currently classified as forest. Both reforestation and afforestation can include shelterbelts, windbreaks and woodlots. Afforestation applies to areas that have not been forested for at least 50 years while reforestation applies to land that

used to be forested but was turned over to another land use. There is a debate on the importance of addressing the reduction of emissions from deforestation and land degradation (REDD) (Kumar and Nair, 2004).

Forests are home to 300 million people around the world and they contribute to the livelihoods of many of the 1.2 billion people living in extreme poverty (women constitute 70% of the poor worldwide). Forests provide global food security and resources, food, fodder, fuel and medicine. However, the way people use and manage forests depends on the socio-economic and socio-cultural environment, age and gender (FAO, 1989). Forest ecosystems play an important role in the global carbon cycle. Reforestation and afforestation have been integrated as forestry-based mitigation schemes into the international climate change regime. Both practices entail converting non-forested land to forested land through planting, seeding and/or the promotion of seed banks and sources. Gas emissions are due to deforestation and similar types of land degradation; effective REDD strategies could be used to promote the protection of current forests (Schoeneberger, 2005).

Within the complexity of the services that forests provide for climate change mitigation, it is crucial to understand women's role in these processes. Strategies are now changing to understanding and taking into account the different benefits that women and men derive from forestry services; recognizing gender differences in access to, control and knowledge of forest resources; and identifying the significant differences in access of women and men to forest-related decision making, institutions and economic opportunities (TerrAfrica, 2007). Relating this situation to the case of deforestation, Federal Republic of Nigeria (FRN)/Federal Ministry of Women Affairs and Social Development (FRN/FMWASD), 2006) reported that men and women are differentially and often disproportionately harmed by loss of forest resources. Women usually have a stronger interest in forest preservation, while men have a greater likelihood to benefit in the immediate or short term from deforestation in many forms, through jobs in timber industry or commercial use of cleared land while women generally tend to allow trees to grow for the herbs and oils to be derived.

Mitigation and adaptation strategies for increasing food security in the face of climate change encompass specific resource management options that focus on water and terrestrial carbon pools. To deal with the increasing frequency and magnitude of water-related disasters and their impacts on food security, for instance, aquatic ecosystem management, conservation and water allocation mechanisms may in many areas restore lost food and ecosystem capacity (e.g. environmental flows and wetland restoration could provide a base for adaptation). Likewise, reducing emissions and managing terrestrial carbon pools may in a number of areas be achieved through specific forest management options. Integrated approaches are needed to bridge the trade-offs between improved livelihoods and stopping deforestation, resulting in reduced impacts of land-use change and the greenhouse gas emissions it causes. Work under this theme would include the development of standardized, widely accepted and scientifically sound methodologies for compensating reduced emissions from deforestation and other land-use change (Ramani, 2002).

Impacts of SLM for climate change mitigation and adaptation

Climate change in the 21st century is brining a new set of weather patterns and extremes that are well beyond what sub-Saharan communities are capable of dealing with, especially when coupled with the many non-climate constraints that undermine the adaptive capacity of these communities. External help and advice is necessary to rebuild or enhance the ecological resilience of rural communities (United Nations Development Programme (UNDP), 2009).

Predictions of the magnitude of changes in temperature and precipitation are subject to considerable uncertainties, but scenarios for Africa indicate future warming across the continent ranging from 0.2°C per decade to more than 0.5°C per decade (Kandji and Verchot, 2007). This warming will be greatest over the interior of semiarid margins of the Sahara and central southern Africa, with the median projected additional increase in average annual temperature in comparison to present day conditions likely to reach between 3ºC to 4 ºC by 2100 (Easterling, 1996).

Implementing SLM practices that increase carbon sequestration in soils will contribute to adaptation to climate change. Increasing soil organic carbon (SOC) is well known for its multiple benefits for the soil including: enhancing fertility through nutrient retention; increasing rainfall infiltration rates; increasing water holding capacity; and improved conditions for soil fauna and related macro-pores such as earthworms, termites and root channels to serve as drainage channels for excess water. Thus, stabilizing a much improved soil structure increases the resilience of the land (Lal, 2007). The surface mulch or plant cover established under several SLM practices will also protect the soil from excess temperatures and evaporation losses. In addition, reducing crop water requirements by up to 30 percent could prove critical in many sub-Saharan countries with climate change (FAO, 2007).

Human activities have increased the atmospheric concentration of CO_2 by 31 percent since 1750 (Lal, 2007). The conversion of natural systems to cultivated agriculture which results in losses of between 20 and 50 percent of pre-cultivation SOC stocks in the surface metre of soil has been of prime importance (FAO, 2007). Continuing, they note that SOC stocks have then been further reduced by soil degradation through inappropriate practices (e.g. burning rangeland and crop residues, repetitive tillage and use of fertilizers without restoring soil organic matter). Most current mechanized agricultural practices use significant quantities of fossil fuels as a source of energy for on-farm activities and yet more in food processing, packaging and transportation. The adoption of restorative land use systems through SLM practices has the potential to reduce the rate of enrichment of atmospheric CO_2 and other GHGs and to increase the sequestration of carbon.

The agriculture sector accounts for about 60 percent of all nitrous oxide (mainly from fertiliser use/misuse and manure) and about 50 percent of methane (emitted mainly from natural and cultivated wetlands and enteric fermentation). Alarmingly, methane and nitrous oxide emissions are projected to increase by a further 35 to 60 percent by 2030, driven by growing nitrogen fertilizer use and increased livestock production in response to growing demand for food (TerrAfrica, 2006).

Farmers traditionally recognize that diverse crop rotations are effective in maintaining soil fertility and health in arable systems. Economic and demographic pressures have reduced the practice of crop rotations in land management, as farmers have developed management systems that obtain and sustain higher yields by continuous cultivation, often of a single crop. This is at high financial and environmental cost, requiring frequent tillage (with high labour or tractor and fossil fuel costs) and the application of large quantities of agrochemicals (fertiliser, pesticides and herbicides) which are expensive to produce in terms of dollars, energy and GHG emissions. Restoration of the practice of crop rotation can increase the rate of accumulation of SOC at various depths in the soil profile, as different crop species have different rooting forms and depths, which in turn

promote the distribution of organic matter throughout the soil profile (contributing to mitigation). The use of rotations is also beneficial as it reduces the build-up of pests and diseases in farming systems given that most pests and diseases are crop specific. Change of crop breaks the lifecycle of the pest and disease organisms. This reduces the need for carbon costly pesticides and herbicides, contributing further to climate change mitigation (Agarwal, 2002).

Increasing rotation complexity also reduces the risk of the harvest being insufficient in subsistence farming systems, as failure of one crop-type, for example due to a pest, is less likely to ruin the entire harvest, contributing to adaptation. Increasing rotation complexity in most situations will increase crop yields and in turn food security.

According to FAO (2007), the increased concentration of greenhouse gases in the atmosphere are causing disruptions in climate systems and the broad impacts can be divided into two main groups, namely: biophysical and socio-economic impacts. Biophysical impacts include:

- Physiological effects on crops, pasture, forests and livestock (quantity, quality);
- Changes in land, soil and water resources (quantity, quality);
- Increased weed and pest challenges;
- Sea level rise, changes to ocean salinity; and
- Sea temperature rise causing fish to inhabit different geographical ranges.

Continuing, FAO noted that socio-economic impacts include:

- Decline in yields and production (exacerbating food insecurity);
- Reduced marginal GDP from agriculture;
- Fluctuations in world market prices;
- Changes in geographical distribution of trade regimes;
- Increased number of people at risk of hunger and food insecurity; and
- Migration and civil unrest.

Foody (2003) reported that many SLM practices can also contribute to making large scale commercial farming systems more sustainable and resilient to climate change. This necessitates working with private sector suppliers to make available adapted equipment and inputs, such as direct seeding equipment and drip irrigation technologies instead of ploughs and sprinkler/furrow irrigation systems, or seeds/germplasm of drought resilient crop varieties and cover crops. According to Woodfine (2009), training and cost-benefit analysis with large-scale farmers will also be required to encourage them to shift to improved practices (*inter alia* conservation agriculture, reduced traffic, precision agriculture and organic agriculture).

Conclusion and Recommendations

Sustainable land management contributes greatly to climate change mitigation and adaptation. Appropriate management of forests should include avoiding forest fragmentation, improving the connectivity between forest patches that could result in genetic isolation of tree, plant and animal species. Local people will benefit most through sustainable use, including actively managing alien invasive species and maintaining natural disturbance regimes such as fires, while preventing conversion to high-intensity forestry that often excludes local people from the benefits of forest products. SLM practices in sub-Saharan Africa that contribute to adaptation will be

implemented at the local scale, often by poor individual land users and groups of users, its impacts benefit the wider society at large.

Promoting the development of carbon markets that will eventually include the full range of land-use options that provide real and measurable climate and livelihood benefits. Land-use carbon accounting tools must be advanced that reliably measure those benefits from soils, trees, grasses and other components of the landscape. Integrating SLM fully into national and international strategies for reducing GHG emissions and enhancing carbon sequestration within landscapes. Scaling up investments for land management and climate change by building on existing policy frameworks and platforms remains paramount. Local, national and regional African farmer organizations should be supported with logistics in order to overcome barriers to adopt SLM technologies and accessing the carbon market. Initiators of SLM programmes need to develop cost-efficient methodologies for farmers to access carbon markets and their income benefits, and reduce barriers to adoption of sustainable land management practices which enhance land productivity and sustainability.

Knowledge sharing and increased public awareness of land degradation are required to facilitate closer cooperation among stakeholders involved in sustainable land management. Enhancing awareness among farmers, development agency and policymakers to discuss climate change, soil quality, and to adopt sustainable SLM practices is necessary.

If land degradation is to be minimized, continued investment in capacity building and training of personnel are needed. Investments to enhance the use of biological resources through incentives for increased adoption are needed for sustainable land management. Sustainable land management practices present an important basis for facing greater challenges posed by climate change. There arises the need for national climate change policy, national climate change adaptation strategy and action programme (NCCASAP) to identify priority activities to combat climate change impacts in the region, including general awareness raising, technical capacity building, and implementation of projects in vulnerable regions with a special focus on sustainable land management. Formal climate change response institutions are also imperative at the state and local government levels. The national and state research and extension systems; and state ministries of environment or state environmental protection agencies and local government environment focal points could be utilized as climate change response institutions at their respective levels to implement sustainable land management through tree planting campaign as well as other programmes that will help to mitigate and adapt to climate change.

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Climate Change Effects on Cassava Processing and Marketing in Kogi State, Nigeria

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Abstract

The research work examined the awareness and food security implications of climate change effects on processing and marketing of cassava products in Kogi State, Nigeria. The study sought to: describe the socio economic characteristics of cassava processors/marketers; identify and describe the level of awareness of climate change effects on cassava processing/ marketing technologies; describe the different processing/marketing channels of selected value chains in cassava processing/marketing; and describe the constraints of cassava processing/marketing in the study area. Multistage, purposive and random sampling techniques were used to select 120 cassava processors/marketers that provided the data through a set of structured questionnaire. Descriptive statistics and Mean were employed to analyze data collected. Results of the study showed that, 73% of the respondents were predominantly females. All the farmers were aware of climate change through evidences such as high temperature, late onset of rainfall and heavy wind. Majority (57%) of the respondents experienced more of high temperature compared to other climate change evidence. Majority (58%) of the respondent's processed cassava to garri and adopted the peeling-washing-grating-dehydration-fermentation-frying processing channel (referred to in the text as processing channel '1'). On marketing channels, majority (70%) were cassava flour marketers and they adopted a marketing channel which comprised of packaging- transportation-wholesaling-retailing and final consumers (referred to in the text as marketing channel '1'). The constraint experienced by the respondents includes lack of capital and weather problems. Processed cassava products such as garri, cassava flour and fufu aid food security in Kogi State.

Key Words: Cassava, Processing Technologies, Food Security, Climate Chang

Introduction

The prospect of global climate change has emerged as a major scientific and public policy issue. Possible current consequences of climate change include increased frequency of extreme temperature, heightened storm and sea-level rise. These changes, in turn can have significant effects on the functioning of ecosystems and agricultural productivity such as cassava products like garri and cassava flour (Pender 2008). Farmers in the North Central Nigeria are among the Nigeria work force that is affected by climate change. This group of people engages in profitable production of agricultural food such as cassava products, yam, maize etc in a large quantity.

Cassava (Manihot spp) is believed to have originated from Brazil and was introduced into West Africa countries by the Portuguese (Antonio, 2002). Benue and Kogi States in the north central zone of Nigeria are the largest producers of cassava in the country (IITA, 2004). Cassava's comparative advantage compared with other food crops lies in its efficient production of cheap food energy. In addition, cassava

is available all year round as well as tolerant to extreme conditions. These qualities contribute in alleviating African food crises (Nweke, Dixon, Asiedu and Folayan, 1994). This accounts for why Philip (2005) referred to cassava as the "**famine security crop**". The market for cassava can be divided into two categories, the traditional food-oriented market and the new emerging market for industrially processed cassava. The vast majority of the cassava grown in Nigeria is processed and sold through the traditional market channels which are fairly well known. In 2002, cassava suddenly gained national prominence following the pronouncement of a Presidential Initiative. The intent of the Initiative was to use cassava as the engine of growth in Nigeria through value addition to the cassava products. Value chain addition is a method for accounting and presenting the value that is created in a product as it is transformed from raw material input to a final product consumed by the end users. Cassava remains a major source of food and income for a large populace of the people in Kogi State who are involved in its production, processing and marketing. It is in realization of this fact that the Federal and Kogi State Governments are partnering to establish a three billion naira multi-purpose cassava processing industry in the State (Graphics News, 2008). However, for the purpose of this research work, the cassava processors are also the marketers because that was the usual practice in the study area.

Furthermore, two important suggestions can be advanced for food security from this development. One way is to popularize NCGA. If this is successfully carried out, the Nigerian cassava Growers' Association will enjoy easy access to high stock planting, loans, equipment and other material gains as a cooperative union. This another way of taking advantage of our inexhaustible arable land. The other issue is that village communities, women groups, LGAs and other indigenous NGOs can be sensitized and mobilized to form similar cassava Growing Associations across the country to facilitate food security and work as a bridge between farmers and institutions doing cassava related research work in Nigeria.

The research on climate infects, has long revealed that only a limited fraction of the market economy is vulnerable to climate change: agriculture, coastal resources, energy, forestry, tourism, and water (Pearce, 1996). These sectors make up about 5 percent of the global economy and their share is expected to shrink over time. Consequently, even if climate change turns out to be large, there is a limit to how much damage climate can do to the economy. Most sectors of the global economy are not climate sensitive. Of course, the economies of some countries are more vulnerable to climate change than the global average. Developing countries in general have a larger share of their economies in agriculture and forestry. They also tend to be in the low latitudes where the impacts to these sectors will be the most severe. The low latitudes tend to be too hot for the most profitable agricultural activities such as cassava processing/marketing and any further warming will further reduce productivity. Up to 80 percent of the damages from climate change may be concentrated in low-latitude countries (Maddison, 2006).

Climate change is one of the greatest environmental challenges facing the world today. It is already well recognized that climate change and its associate extreme events will have a wide range of effects on the environment, and on socio-economic and other related sectors especially agriculture and food security. The World Summit (1996) defined food security as when all people at all times have physical

and economic access to enough food that is affordable, safe, healthy and is produced in a way that is environmentally sound and socially just.

The demand for cassava products is on the increase as Nigeria's population continues to grow rapidly without control which can result to food insecurity. Bridging the rapidly increasing demand and supply gap in cassava processing and marketing calls for value addition as the products are being processed as a means to food security in Nigeria. Meanwhile, poor processing is one of the major factors that cause post harvest loss in the world with special emphasis on developing countries like Nigeria (FAO, 1995). Nigeria produces more cassava than any other country in the World (Nwosu 2006). Moreover, available data reveal that Nigeria lags behind in the world export market in cassava production as it contributes a very small proportion of about 0.001% of the world export market as against Thailand which accounts for 50%. This variation in market share could be as a result of small value addition among cassava processors and marketers in Nigeria.

One of the sectors most sensitive to global warming is agriculture. Under a business scenario, agricultural productivity in general could decline between 10 to 25 per cent in the nearest future. For some parts of the country, the decline in yield in rain fed agriculture could be as much as 50 percent. Such trends clearly threaten the achievement of the Millennium Development Goals (MDGs). Rural households engaged as subsistence and smallholder farmers in cassava processing and marketing are most vulnerable to the impacts of climate change on agriculture. They may be affected in the following ways:

- Increased likelihood of cassava crop failure;
- Increased livelihood insecurity, resulting in assets sale, indebtedness, out-migration and dependency on food aid; and
- Downward spiral in human development indicators, such as health and education.

Such impacts will further aggravate the stresses already associated with subsistence production, such as isolated location, small farm size, informal land tenure, low levels of technology and narrow employment options, in addition to unpredictable and uneven exposure to world markets that smallholder farmers particularly risk-prone in the face of climate change. Indirect effects of climate change on agriculture include the effects on pests and diseases and the impacts of these on cassava processing and marketing, the impacts on health, and the impacts on agro-related socio-economic activities. Although, some studies have been carried out on cassava processing and marketing such as Kaine (1995), Oyewole and Phillip (2006) among others, not much has been done to investigate the climate change effects on cassava processing and marketing in the study area.

Objectives of the Study

The broad objective of the study was to ascertain climate change effects on cassava processing and marketing in Kogi State, Nigeria. Specifically, the study sought to:

(i) describe the level of awareness of climate change effect on cassava processing/marketing;

(ii) identify the different processing/marketing channels of selected value chains in cassava processing/marketing in the study area; and

iii) ascertain the constraints in cassava processing/marketing in the study area.

Methodology

The study area is Kogi State. The state is located in the north central zone of Nigeria, approximately between latitude $6^0.33'$and $8^0.44'$ N and longitude $5^0.22'$ and $7^0.49'$ E. The state was created along with eight others during the state creation exercise of 22nd August 1991. The State has a population of about 3,278,487 people (NPC, 2006). Kogi State has twenty-one Local Government Areas which are divided for administrative purposes into four (4) agricultural zones namely: Zone A, consisting of Ijumu, Kabba/bunu, Yagba-east and Yagba-west local government, having Aiyetoro-gbede as the zonal headquarters. Zone B, consisting of Dekina, Bassa, Ankpa, Olamaboro, and Omala local government, with Anyigba as it headquarters. Zone C, consist of Adavi, Ajaokuta, Koton-karfe, Kogi, Okene and Okehi local government with Koton-karfe as its headquarters. Zone D consist of Idah, Ofu, Ibaji and Igala-mela Odolu local government having Aloma as its headquarters.

A combination of purposive and multi-stage random sampling techniques was employed in selecting respondents. This is because the study area is contiguous in terms of cassava processing and marketing. First, one (1) local government area was purposively selected based on cassava output from each of the four agricultural zones giving rise to four (4) Local Government Areas. Second, three (3) communities were randomly selected from each local government to give twelve communities. Third, two (2) villages were randomly selected from each community to make up twenty four villages. Fourth, five (5) cassava processors/marketers were randomly selected from each village amounting to a total of one hundred and twenty (120) respondents.

Primary and secondary data were used for the study. The primary source involved the use of structured questionnaires to collect information on respondent's socio-economic characteristics such as sex, source of cassava roots etc and secondary sources of data include existing publications of the National Root Crop Research Institutes (NRCR), Kogi State Agricultural and Rural Development Programme (KADP), journals and internet papers as well as unpublished materials relevant to this study.

To describe the level of awareness of climate change and the effect of climate change on cassava processing and marketing, the phenomenon relating to climate change were given to respondents to respond to by ticking. To ascertain the constraints encountered by the respondents, a three point Likert type scale of not serious = 1, serious =2 and very serious =3 was used. The values on the Likert type scale was added up to 6 which was divided by 3 to get the mean score of 2.0 Variables with mean score of ≥ 2.0 was regarded as a serious constraints while variable, with < 2.0 was not regarded as a constraints.

Objectives (i), (ii) and part of objective (iii) were realized using descriptive statistics such as frequency distribution, percentage and mean statistic

Results and Discussions

(i) The Level of Awareness of Climate Change

The major awareness about climate change in Kogi State was the incidents of high temperature, late onset rainfall and heavy wind destruction. Awareness of climate change has to do with the climatic change condition experiences by the cassava processors/marketers in the cause of their processing/marketing activities.

TABLE 1. **Distribution of respondents according to awareness of climate change**

Climate	Frequency	Percentages
High Temperature	68	57
Late onset of rainfall	36	30
Heavy wind destruction	16	13
TOTAL	120	100

Source: Field Survey, 2011

Table 1 shows that 57% of the respondents experience more of high temperature in Kogi State compared to other climate change evidences such as late onset of rainfall which is 30% and heavy wind destruction of crops that is 13%.

The effects of climate change experience in Kogi State by the cassava processors/marketers are the incidence of outbreak of diseases, a drop of water level and drought in some areas.

TABLE 2: Distribution of respondents according to effect of climate change on cassava products

Effect of Climate	Frequency	Percentages
Out break of diseases	64	53
A drop of water level	43	36
Drought impact	13	11
Total	120	100

Source: Field Survey, 2011

Table 2 shows that 53% of the respondents experience outbreak of diseases while 36% have the impact of drop of water level and 11% experience drought. The outbreak of diseases such as meningitis affect the processors/marketers family

hence reduces manpower while the drop of water level reduces the cassava product output and drought has general impact on the cassava productivity.

(ii) The Processing/Marketing Channels

Processing Channels

Techniques for Garri Processing

The results of the study showed that there are three distinct processing channels or different stages in transforming cassava to garri product in the research area. The first channel is depicted thus: Peeling-Washing-Grating-Dehydration-Fermentation-Frying. While the second channel is depicted as Peeling-Washing-Grating-Dehydration-Fermentation-Oiling-Frying and the third channel is Peeling-Washing-Grating-Dehydration-Frying.

TABLE 3: Distribution of respondents According to Garri Processing Techniques

Channels		Frequency
Percentage		
Processing channel 1	69	58
Processing channel 2	46	38
Processing channel 3	5	4
TOTAL	120	100

Source: Field Survey, 2011

The frequency distribution of respondents according to their channels of processing cassava into garri is shown in **Table 3**. The result shows that majority (58%) of the respondents adopted channel '1' of the processing stages in the transformation of fresh cassava to garri. Meanwhile, 38% of the respondents adopted channel '2' in their processing of cassava to garri while 4% of the respondents adopted channel '3' in the transformation process. This implied that the majority of the respondents preferred processing channel '1' probably due to the demand for fermented garri, its taste and the cost implication of adding oil to their garri during processing period. The channel '2' has more respondents than channel '3' due to its nutritional value of vitamin 'A' contents in oil palm. This channel was better in terms of value addition in the processing stages.

Marketing Channels

Channels for Cassava Flour Marketing

The results of the study showed that there are three major marketing channels of different stages in moving the cassava flour products to the final consumers. The first channel is Packaging-Transportation-Wholesaling-Retailing-Final Consumers. While the second channel is depicted as Packaging -Wholesaling-Retailing-Final Consumers and third channel is Packaging-Retailing-Final Consumers

TABLE 4: Distribution of respondents according to Cassava Flour Marketing Channels

Channels	Frequency	Percentage
Marketing Channel '1'	84	70
Marketing Channel '2'	23	19
Marketing Channel '3'	13	11
TOTAL	120	100

Source: Field Survey, 2011

The frequency distribution of respondents according to their cassava flour marketing channels is shown in **Table 4**. This indicated that 70% of the respondents adopted marketing channel '1' in the marketing of cassava flour product. Meanwhile, 19% of the respondents adopted the marketing channel '2' while 11% of the respondents adopted the marketing channel '3' and this implied that some of the respondents are not involved in selling their cassava flour product at home to retailers and final consumers but rather preferred transporting the cassava flour to the market where they can sell their products to wholesalers, retailers and final consumers in order to make more profit via sale to larger buyers.

(iii) Constraints Encountered by Cassava Processors/Marketers

The processors/marketers in the study area were faced with numerous constraints both as a result of climate change effects like the weather condition and socio economic factors like irregular power supply and inadequate capital for expansion. A five (5) point likert rating scale was applied to rank the constraints in order of their mean sizes. This was necessary to enable us identify which of these constraints were major and posed serious challenges to the cassava processors/marketers.

TABLE 5:of Constraints On Cassava Processing/Marketing Activities

1	Weather Problem	4.08*
2	Irregular Power Supply	4.56*
3	Inadequate Capital for Expansion	4.61*

Source: Field Survey, 2011

Weather problem was one of the effects of climate changes as a constraints faced by the cassava processors/marketers in the study area. Although, it was very serious (VS). This was as a result of drought in a particular seasons and flooding in other seasons. And sometimes temperature and humidity irregularities affect the processing and marketing activities of cassava products in the study area.

Irregular power supply was also one of the major socio economic constraints of cassava processors/marketers in the study area. This was observed to be very

serious (VS). The problem of irregular power supply also stands out due to lack of adequate transformers in the rural areas to accommodate the population increase in the study areas.

Inadequate capital for expansion was one of the major socio economic constraints militating against the cassava processors/marketers in the study areas. This was very serious (VS) because majority of the respondents solely relied on not much available loans from banks, personal saving and their immediate family members which is usually small and cannot support meaningful expansion.

Conclusion and Recommendations

Based on the observations and findings of this research study, there are some important and vital policy implications for improving and revitalizing food security via cassava processing/marketing activities. Some of the major and vital policy recommendations that deserved attention that directly and indirectly promote this agricultural business sector are:

The Kogi State Government should find out where funding interventions are needed. This is because, the issues of non-availability of capital was highly emphasized as a major problem militating against cassava processing/ marketing activities in the study area. Therefore, it is recommended that interventions in term of funding at the production and processing/marketing stages is very essentials. Hence financial institutions like the Nigeria Agricultural Credit and Rural Development Bank (NACRDB) should be establish in all the Local Government areas. And the financial institutions should make soft loan available to farmers in order to improve food security especially through cassava processing/marketing activities and there is need to introduce intervention programme in the rural areas. Such programme should cover loan facilities, input distribution and capacity building. Such intervention programme should also encourage group formation and other social activities which will help in the spread and sharing of information on climate change and therefore raise the adaptive capacity of the people. A strong link should be established with foreign governments and research institutes and organizations like the American National Aeronautics and Space Administration (NASA) so as to facilitate the sharing of information and knowledge on climate change as most of these agencies have superior knowledge and equipment to predict the climate considering the global nature of climate change.

Food security is a guarantee for sustainable development and democracy. Food security is greater than national security because a well fed population is better prepared to guarantee national security. Most of the national problems emerged because of the failure of governments to meet the basic necessities of life, of which food is paramount. In this regard, if Nigerian democracy is to survive, the various tiers of government must be more committed to food and agricultural productivity to feed the teeming population and cassava products such as garri, and cassava flour are one of the staple food in Nigeria that can enhance food security because cassava's comparative advantage compared with other food crops, lies in its efficient production of cheap food energy. In addition, cassava is available all year round as well as tolerant to extreme conditions (climate change). These qualities contribute in alleviating Nigerian food crises (Nweke, Dixon, Asiedu and Folayan,

1994). This accounts for why Philip (2005) referred to cassava as the "**famine security crop**".

The Federal government should secure for all Nigerians a quality environment adequate for their health and wellbeing. It should help to conserve and use the environment and natural resources for the benefit of present and future generations and raise public awareness and promote understanding of essential linkages between environment and development and to encourage individual and community participation in environmental improvement efforts such as the planting of trees and practicing of irrigation farming.

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Assessment of Livestock Production Systems under Climate Change among Farm-Families in Nsukka Local Government Area of Enugu State

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Abstract

Livestock production is an important segment of agriculture. Apart from providing food, it serves as a source of employment and income to rural farm families. This study assessed the livestock production systems under climate change among farm families in Nsukka Local Government Area of Enugu state. Data for the study were collected from 100 respondents, through the use of structured interview schedule. Data were analyzed using percentage and mean statistic. Most frequently kept livestock was chicken (100.0%). They kept this because of ease of management (82.0%) and low initial capital outlay (64.0%). In terms of household decision making roles in livestock rearing, men were more involved in construction of housing for the livestock (92.0%) and the initiation of livestock raising (88.0%) while women were more active in marketing of the finished products. Children were found to be more involved in feeding of livestock (52.0%). Inadequate finance (M=2.9) and instability in government policy on livestock production (M=2.8) were the major constraints associated with livestock production in the area. Despite this constraint, there exists high level of awareness of the available veterinary extension services in the study area. The study recommended that, to reduce hostility rate of birds and other animals, farmers should inoculate their animals with appropriate drugs.

Key words: assessment, livestock and climate change.

Introduction

Agricultural production based on natural resources is the main source of livelihood for more than 800 million malnourished and food-insecure people. Agriculture is therefore the main instrument to be used in lifting the rural poor out of poverty in developing countries. Livestock production is an important segment of agriculture. Livestock may be raised for subsistence or for profit (www.qhsport.com/english/about/html). The livestock industry provides a good source of animal protein which is very much needed for a balanced diet. According to Ugwu (1990), animal protein is highly palatable and at the same time, essential for normal physical growth and mental development in young children. Apart from providing food, livestock serve as a source of employment and income to the rural farm families. Dungs / droppings from livestock serve as manure which helps in soil fertility maintenance and hence, the possibility of obtaining substantial increase in crop yields. Provision of manure also helps to reduce the degree of dependency on in-organic fertilizers by farmers. Livestock feature prominently in economic and socio-cultural life of many Nigeria. They also serve as insurance against other business failure (Idachaba and Olayide, 1981).

In many rural communities, livestock is often the only asset the poor have, but it is also highly vulnerable to climate variability and extremes. The possible effects of climate change on food production are not limited to crops production. Climate change will have far-reaching consequences for dairy, meat and wool production, mainly arising from its impact on grassland and rangeland productivity. Heat distress suffered by animals will reduce the rate of animal feed intake and result in poor growth performance (Rowlinson, 2008). Lack of water and increased frequency of drought in certain countries will lead to a loss of resources. Consequently, as exemplified by many African countries, existing food insecurity and conflict over scarce resources will be exacerbated. Based on the above scenario, it is important to assess the livestock production patterns under climate change variability among farm families in Nsukka local government area of Enugu state

Purpose of the study

The purpose of this study was to assess the livestock production systems under climate change among farm families in Nsukka Local Government Area (LGA) of Enugu state. Specifically, the study was designed to:

1. characterize livestock production among rural households;
2. determine household decision-making in livestock production;
3. ascertain the level of awareness of the available veterinary extension services; and
4. ascertain the constraints associated with livestock production.

Methodology

The study area was conducted in Nsukka LGA. It is one of the seventeen LGAs in Enugu State, which covers about 463km^2. Nsukka LGA has 17 town communities namely Nsukka, Obimo, Edem, Ede-Oballa, Opi, Obukpa, Ibagwa-Ani, Alor-uno, Lejja, Ibagwa-Agu, Ehalumona, Umabor, Ehandiagu, Anuka, Okutu and Okpaligbo. The LGA lies within longitude 6^{o}45$^{'}$N and 7 ^{o}00$^{'}$N and latitude 7^{o}12.5$^{'}$E and 7^{o}36$^{'}$E (Ofomata, 1995). The LGA is bounded in the north by Kogi State and Igbo-Eze South LGA, in the southeast by Udenu LGA, in the southwest by Igbo-Etiti LGA and in the northwest by Benue State. It has population of 309,633 (NPC, 2007).

The climate is typically with low relative humidity for most part of the year, the annual rainfall ranges from 1680mm to 1700mm and the temperature of the area ranges from 29^{0}C and 44^{0}C (Ahukanna, 1995). There are two seasons, the wet and dry season. The wet season extends from April to October, while the dry season is between November and March. The topography is generally undulating and of low grade slope, the vegetation is mostly dried savannah zone, characterized by incomplete canopy cover which effect soil moisture adversely. Farming constitutes their economic activity, although some of them do engage in petty trading especially in the urban areas. Some of them rear animal such as sheep, goat, cattle, pig, duck, fowl, and poultry etc.

Rural households in the LGA constituted the population for the study. Out of the 17 town communities in the LGA, Five (5) town communities were randomly selected using simple random technique. From each of the communities selected, a list containing 30 livestock farmers was collected from each of the town communities through the help of an informant, from the list, 20 farmers were randomly selected from each of the selected communities

using simple random sampling technique. Thus, a total of 100 farmers constituted the sample size. Data were collected through the use of structured interview schedule. Information on socio-economic characteristics of the farmers such as age, level of education among others were examined. In order to characterized the livestock production among rural households, issues such as type of livestock reared, reasons for rearing, sources of livestock reared and management system adopted were ascertained.

To determine household decision-making in livestock rearing, livestock management activities were listed for the respondents to indicate who among the households (husband, wife and children) performed each of the task/activities. The activities included initiation of livestock raising, feeding of livestock among others. To ascertain the constraints associated with livestock production, a list of possible constraints was made available. Respondents were asked to indicate the level of the seriousness of each constraint on a 4- point Likert-type scale (3= to a great extent, 2 = to some extent; 1 = to a very little extent and 0 = no extent). The values on the scale were added and divided by 4 to get a mean value of 1.5. Any variable with mean score greater than or equal to 1.5 was considered a constraint to livestock production, while variable with a value of less that 1.5 was not considered a constraint. Data were analyzed using descriptive statistics – frequency, percentage, charts and mean statistics.

To determine the level of awareness of the available veterinary extension services, a list of possible constraints was made available. Respondents were asked to indicate the level of the awareness of each variable on a 3- point Likert- type scale (2= aware and participated; 1 = aware but never participated and 0 = not aware). The values on the Likert-type scale were added and divided by 3 to get a mean value of 1.0. Any variable with mean score greater than or equal to 1.0 implies that the respondents were aware of the veterinary extension service, while variable with a value of less than 1.0 implies the respondents were not aware of such veterinary extension service.

Results and Discussion

Personal characteristics of respondents

Results in Table 1 show that, higher proportions (38.0%) of the respondents were between the ages of 51 and 60 years, while 21.0% were within the age range of 40-49years. The mean age of the respondents was 55 years. This implies that, the farmers were mature. Table 1 also reveals that 73.0% of the respondents were male, while 27.0% of them were female. About 73.0% of the respondents were married, while 17.0% of them were widows/widowers. A greater proportion (42.0%) of the respondents had no formal education, while 28% of them attended primary school.

Table 1 reveals that 37.0% of the respondents had been engaged in livestock production for 9-20 years, while 28% of them had been engaged in livestock production for 21-30 years. Also, 23.0% of them had been engaged in livestock production for 31-40 years, 11.0% of them had been engaged in livestock farming for 41-50 years. The mean of farming experience was 15 years. This indicates that majority of the respondents had long farming experience and could have over the years experienced changes in the climate in the area. Table 1 further shows that higher proportion (35.0%) of the respondents had 7-9 persons in their household, while about 34% of them had 4-6 persons in their household. The average household size was 7 persons. This shows a fairly large household size in the area and could probably reduce the demand for hired labour. Household size has a great role to play in the provision of family labour (Sule, Ogunwale and Atala, 2002).

TABLE 1: Percentage distribution of the respondents by personal characteristics (n = 100)

Variables	Frequency	(%)	
Age (years)			
21 – 30	6	6.0	
31 – 40	12	12.0	
41 – 50	21	21.0	55
51 – 60	38	38.0	
61 – 70	17	17.0	
71 – 80	6	6.0	
Sex			
Male	73	73.0	
Female	27	27.0	
Marital status			
Single	10	10.0	
Married	73	73.0	
Widow	7	7.0	
Level of education			
No of formal education	42	42.0	
Primary school level	28	28.0	
Secondary school level	18	18.0	
OND / HND holders	5	5.0	
University degree holders	7	7.0	
Occupation			
Civil servant	21	21.0	
Farming	53	53.0	
Trading	22	22.0	
Artisan	4	4.0	
Farming experience (years)			
9 – 20	37	37.0	
21 – 30	28	28.0	
31 – 40	23	23.0	15
41 – 50	11	11.0	
51 – 60	1	1.0	
Household size			
1 – 3	12	12.0	
4 – 6	34	34.0	
7 – 9	35	35.0	
10 – 12	16	16.0	
13 – 15	2	2.0	7
16 – 18	1	1.0	

Characterization of Livestock Production among Rural Household

Type of livestock kept

Figure 1 shows that all (100.0%) of the respondents reared chicken. About 88% kept goats, while 23.0% reared sheep. This implies that most of the livestock

owners in the area reared more of chicken than any other types of animal. Okonkwo (2001) reveals that about 10% of Nigerian population are engaged in poultry production mostly on subsistence and small or medium size farms.

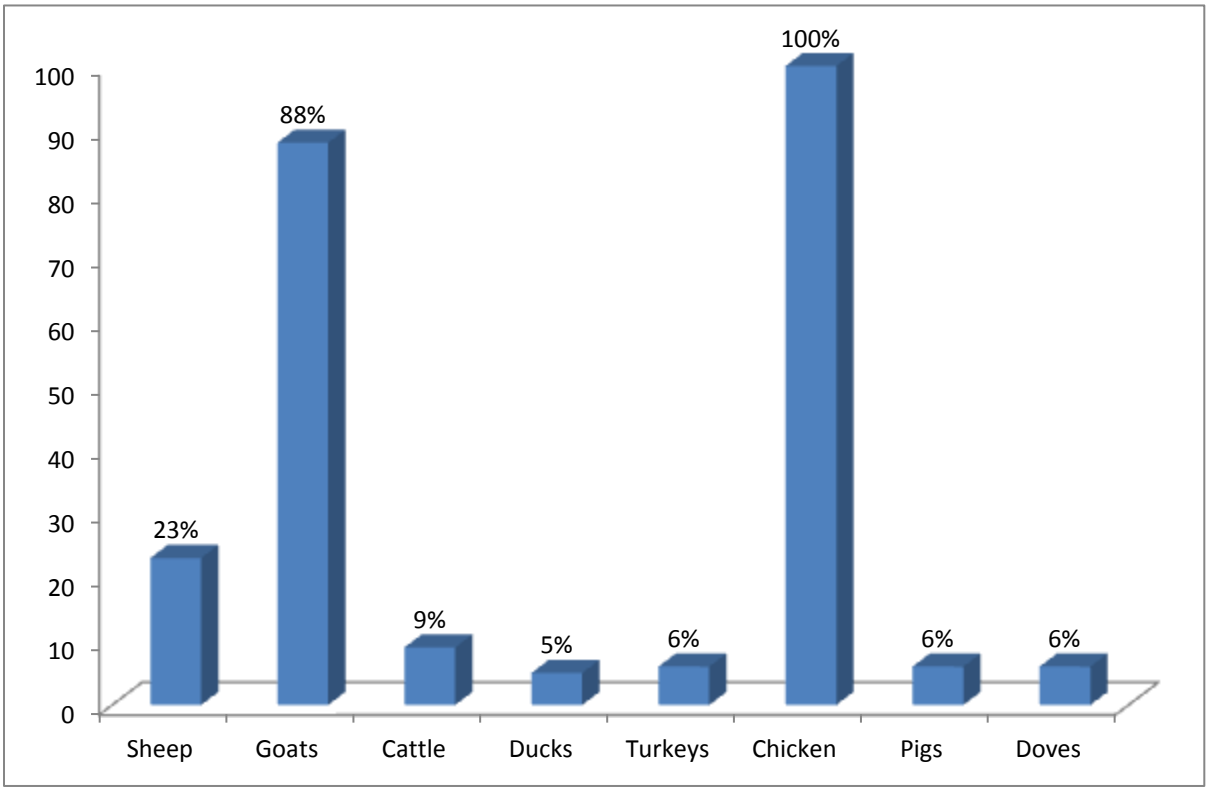


Figure 1: Types of livestock kept

Reasons for keeping livestock

Figure 3 further reveals that 76.0% of the respondents reared livestock for income generation, while about 46% of them reared livestock for meat consumption. Those that reared for the purpose of getting manure constituted only 32.0%. About 8% of the respondents keep livestock for the economic security. It could be observed that greater proportion of the respondents that kept livestock reared poultry and small ruminants. This could be because of low initial capital outlay, ease of management and prolific ability of these livestock

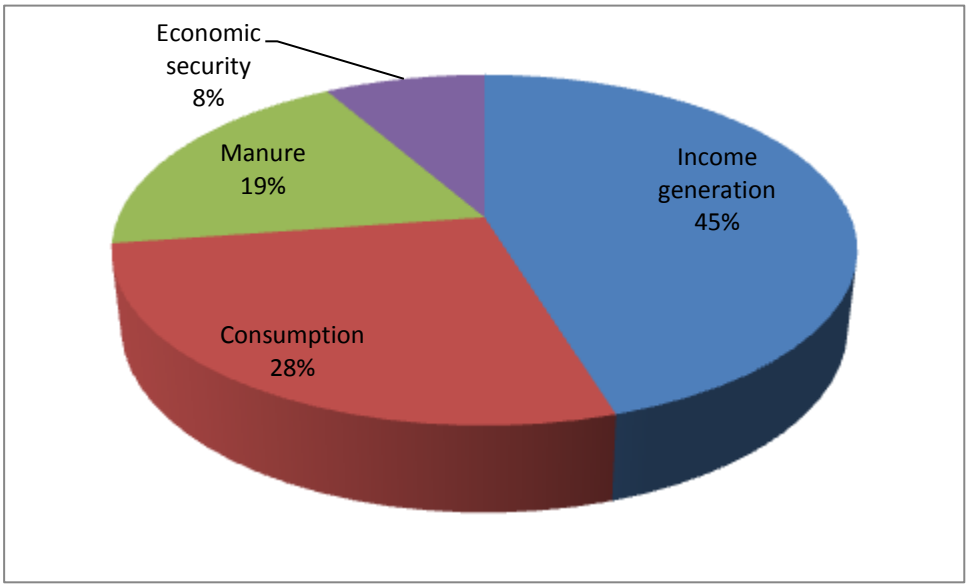


Figure 2: Reasons for rearing livestock

Household Decision Making in Livestock Production

Table 2 shows that all household members had roles to play in livestock production. Husband were more involved in initiation of livestock raising (78.0%), construction of housing (92.0%), decision on herd size to keep (88.0%), planning and organising for breeding (68.0%), and management of building and equipment (77.0%) and fodder collection (55.0%). This implies that a husband as the head of the family has a great role to play in energy requiring activities and creative thinking on decision making of the family.

Wives are more involved in health care and veterinary services (57.0%), and sales of livestock (87.0%) and feed composition for feeding livestock (81.0%). Traditionally, it is the women who are responsible for the buying and selling of agricultural produce in the farm families both crops and animals. Children were more involved in feeding of the livestock (52.0%), provision of water (55.0%), and stable cleaning. This implies that children were more involved in day to day activities that do not require money and more energy.

It is important to note that climate change will create different opportunities and challenges for men and for women. In many countries, the role of women in livestock production systems is significant. In general, women are often responsible for most livestock nurturing activities and play an active role in on-farm livestock duties such as feeding, watering, fodder collecting, stable cleaning, milking and milk processing, caring for small and sick animals, poultry raising, wool work and traditional animal health care. Men are generally responsible for marketing, animal feed purchasing, procuring veterinary services, and herding. While men's tasks are seasonal, most women's tasks are daily (Nassif, 2008).

TABLE 2: Percentage distribution of household decision making role in livestock rearing (n = 100)

Variables	Husband (%)	Wife (%)	Children (%)
Initiation of livestock raising	78.0	18.0	4.0
Feeding of livestock	26.0	22.0	52.0
Construction of housing for livestock	92.0	3.0	5.0
Health care and veterinary services	28.0	57.0	15.0
Water supply	1.0	44.0	55.0
Marketing of livestock	1.0	87.0	12.0
Decision on herd size	88.0	3.0	9.0
Planning and organizing for breeding	68.0	10.0	22.0
Management of building and equipment	77.0	17.0	6.0
Fodder collection	55.0	10.0	35.0
Feed composition for feeding livestock	2.0	81.0	17.0
Stable cleaning	25.0	52.0	23.0

The level of awareness of the available veterinary extension services

Data in Table 3 show that the farmers were aware of the following available veterinary extension services. They included: consultation (M =1.7). This implies that majority of the respondents in the area were involved in consultation of veterinary services when the need arises. This has contributed in no small way to the elimination of many acute diseases of farm animals. This could be as a result of the closeness of University of Nigeria, Nsukka to the study area. This was followed by visitation of veterinary extension services of the University of Nigeria, in the area. Other veterinary extension service that the famers were aware of include giving injection to farm animal (M = 1.6). This practice will help to limit pest and diseases among the animals. The farmers are also aware that there was need for management of pest and diseases (M = 1.1), provision of health care to sick animals (M= 1.1) and provision of drug therapy when and where necessary (M = 1.1) which also could limit high incidence of pest and diseases in the livestock production.

The level of awareness of the following veterinary extension services was very low. These include radio and television jiggles and programmes on veterinary extension services (M = 0.7); dipping and spraying (Acaricide / Insecticides) (M = 0.2); and awareness of disease free strains of livestock (M = 0.2). The fact that the awareness is very low as regards radio and television jiggles and programmes of veterinary service could be as a result of timing of the programme and or unavailable of television set. Radio and Television programme directed towards farmers could be done in the evening after the farmers' field activities.

TABLE 3: Mean score of the level of awareness of the available veterinary extension services (n = 100)

Variables	Mean score(M)	Std. Deviation
Provision of health care	1.1*	0.4
Provision of drug therapy	1.1*	0.4
Management of pest and diseases	1.1*	0.6
Awareness of disease free strains of livestock.	0.2	0.4
Consultation / Visitation of veterinary extension (staff / doctor)	1.7*	0.5
Dipping and spraying (Acaricide / Insecticides)	0.2	0.4
Giving injection to sick animals	1.6*	0.5
Radio and television jiggles and programme on available veterinary extension services	0.7	0.5

**aware*

Constraints Associated with Livestock Production

Data in Table 4 show respondents opinion on the constraint associated with livestock production. Inadequate finance (M=2.9) and instability in government policies on livestock production (M= 2.8) were the most serious constraint to livestock production. The importance of adequate financial resources cannot be over emphasized in any meaningful agricultural production. When this is lacking, it will surely affect the productivity and may also discourage those that wish to invest in livestock business. Majority of the livestock farmers' sourced money for livestock production from person purse. This finding is in support of Laseinda (2002). He reported that poor financing is major constraints militating against increase livestock production and that most farmers finance their livestock business with their personal saving. Also inconsistency in government policy could affect the livestock enterprises in different ways. .

Other constraints associated with livestock production were lack of education on the modern farming method (M=2.7) which can limit rate of productivity in the livestock production; pest, diseases and predators (M=2.7) which can cause the reduction in the production of animals. According to Laseinda (2002), livestock disease remains one of the major threats to boosting livestock production in Nigeria. There has been considerable loss of animals through diseases and pest. Diseases and pest experienced by most farmers in Nigeria include new castle disease, fowl pox, fowl, typhoid coccidiosis, ticks among others.

Lack of collateral required to secure loan (M=2.7) and high interest rate on loan (M=2.7) were also considered as a major constraint to livestock production. The

inaccessibility of livestock farmers to bank loans was mainly because of their lack of collateral. Majority of the respondents, who are often small scale farmers do not have access to bank loans and thus rely on local money leader whose interest rate are almost equal to the principal. This of course could affect livestock productivity. Other constraints were high cost of improved stock (M = 2.1), high incident of pest and diseases infestation (M = 2.1) which would increase the high mortality rate in the livestock production, poor sales (M = 2.0) which could discourage the farmers from continuing in the livestock productions and unavailability of labour to carryout essential production activities (M = 1.8) and theft (M = 1.8).

Unfavourable weather condition (climate change) (M = 1.9) was also considered as a constraint to livestock production. The livestock production systems would be vulnerable to climate change in respect of anticipated decrease in rainfall and consequent reduction in the available pastureland; declining availability of surface water resources for animals; possible increase in salinity at water resources for animals; and possible increase in salinity at watering points due to increase in temperature and evaporation in the face of reduced rainfall. Climate change leads to decrease in livestock production, resulting in an impaired availability of animal protein, including meat, egg, milk and animal products such as hides and skins. These have implications for food security.

Factors that were not considered as serious constraints by the respondent in the livestock production include, high cost of feed intake (M = 1.4); poor access road for transportation of livestock to the market (M = 1.0); and scarcity of farm land for rearing of livestock production (M = 0.8).

TABLE 4: Mean score of constraint associated with livestock production in the area (n = 100)

Constraints	Mean score (M)	Std deviation
Inadequate finance	2.9*	0.3
Scarcity of farm land for livestock production.	0.8	1.1
High cost of improved livestock stock	2.7*	0.6
High interest rate on loan	2.7*	0.6
Lack of collateral required to secure loan	2.7*	0.6
High incidence of pest and disease infestations	2.0*	0.7
Unavailability of labour to carryout essential livestock production	1.8*	0.6
Poor extension agent farmers ration	2.1*	0.6
Poor access road for transportation of livestock to the market	1.0	1.2
Lack of adequate information on modern livestock management	2.7*	0.7
Instability in government policies / economic instability.	2.8*	0.6
Poor turn over on sales	2.0*	0.6
Unfavourable weather condition (climate change)	1.9*	0.7
High rate of theft	1.8*	0.8
High cost of feed intake	1.4	0.8
Pest, diseases and predators	2.7*	0.7

* *Constraint*

Conclusion and recommendations

The African continent is subject to drought and food insecurity. Even before climate change issues became evident, serious concerns had been raised about agriculture in Africa, which has the slowest rate of productivity increase in the world. Nevertheless, agriculture remains the backbone of most African economies. In addition to the changing climate, there are many other factors simultaneously affecting livestock production systems, such as rapid population and economic growth, and increased demand for food (including livestock products).

Apart from diseases / pests, other factors that could affect livestock production include the following financial constraints, low quality of livestock feeds, high cost of feeds, inadequate supply of replacement stock, marketing problems, high cost and availability of veterinary services and drugs, hygiene problem, breeding problems and climate condition. Despite this constraint, there exists high level of awareness of the available veterinary extension services in the study area. This could of course, help in cushioning the effect of climate change in the area. The study

recommended that, to reduce hostility rate of birds and other animals, farmers should inoculate their animals with appropriate drugs.

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Upscaling Indigenous Knowledge (IK) of Forest Products in Anambra State, Nigeria

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Abstract

The study analyzed mechanisms for upscaling indigenous knowledge (IK) of forest products in Anambra State. Interview schedule was administered to 80 respondents to collect information for the study. The findings revealed that all (100%) of the respondents know certain forest trees/plants that could be used for medicinal purposes. The respondents also had IK of forest protection measures like policing of the products by organizations such as age grades, youth associations, task forces etc. (92.6%). The present mechanisms for upscaling IK of forest products were perceived by respondents as not effective. Some serious constraints to the mechanisms for upscaling IK of forest products were lack of government policy/ capital (M=2.74) and decline in size of forests (M = 2.66). The state government and non-governmental organizations are required to take proactive action to protect both the IK and forest products.

Key words: Upscaling, mechanisms, indigenous knowledge, forest products

Introduction

One way to ensure sustainability of forest resources is through upscaling of indigenous knowledge (IK) of the products. IK is local knowledge that is unique to a given culture or society and it contrasts with the international knowledge system generated by the universities and research institutes. It is the basis for local level decision making in agriculture, education, natural resource management and a host of other activities in rural communities. Such knowledge is passed down from generation to generation in many societies by word of mouth. In a broader sense, IK refers to the collective knowledge of an indigenous people about relationships between people, habitat and nature (International Union for Conservation of Nature, 1997).

In the 1950's and 1960's, theorists of development saw IK as inefficient, inferior and an obstacle to development. However, in current development discourse, formulations about IK recognize that derogatory characterization of the knowledge of the poor and marginalized populations may be hasty and naïve. In contrast to modernization theorists, advocates of IK underscore the promise it holds for sustainable development (Warren, 1991, Orlove and Brush, 1996).

Involvement of local people in forest resources and sustainable management is very important. This is based on the advantages that can be gained by drawing on IK of the forests and forest products, and by building on the sustainable systems of use that local people have created (Redford and Mansour, 1996).

IK and organizational structures have several important advantages over projects that operate outside them (Bicker, 2004). IK provides the basis for grassroots and local level decision making much of which takes place at the community level through indigenous associations and organizations where problems are identified and solution to them are determined. Locally available skills and materials are thus often more cost effective than introducing exotic technologies from the outside sources (Wollenberg, Nawir, Uluk and Pramond 2001). As well, local people are familiar with them and so do not need any specialized training. However, IK has its limitations and should not be mistaken into believing that whatever indigenous people do is right or sustainable but should be utilized by helping local people record and use their knowledge by being gathered and documented in a systematic and coherent fashion to assist national development.

It is well known today that the world forest resources are facing extinction much faster than they would through natural processes alone (FAO, 2001). As the effects of climate change multiply and deepen in scope and intensity, forest products are adversely affected. Therefore, application of IK in management of forest products can ameliorate the effect of climate change.

Local people are very committed to the management and conservation of the forests by their efforts in establishing traditional laws, forest reserved areas for deities, veneration of trees and other physical features. These laws frown against tree felling, cultivation on specific areas, bush burning, illegal hunting and fishing and restrictions to certain seasons (Enwelu, 2002). These traditional laws, folklores and institutions are used to protect the forests and place sanctions on disturbed lands. The local people have a very strong relationship with the forest lands and try their best to conserve and protect the forest (Forestry Association of Nigeria, 2003). These indigenous practices and rules can protect forest products and improve their productivity.

According to Warren (1992) small scale resource-poor farmers in developing countries (Nigeria) breed local crop varieties for improved production using informal innovation systems based on IK… They often employ their own taxonomy, encourage introgression, select, hybridize, field test, record data and name their varieties (lamola, 1992).

He affirms that IK and biodiversity are complementary phenomena to human development but however stated that very little of this knowledge has been recorded yet it represents an immensely valuable data base that provides humankind with insights on how numerous communities have interacted with their changing environment including its floral and faunal resources. In particular, IK is not accorded the required recognition in some African countries including Nigeria. To ignore people's knowledge is to ensure failure in development because indigenous systems are embedded in social and cultural milieu of their particular community and scientific knowledge seeks to distinguish very clearly between these different dimensions (Agarwal, 1995).

Since IK is essential to development, it is often suggested that it must be gathered and documented in a coherent and systematic fashion, in order to ensure the management of these forest resources. This reiterates the need for upscaling of IK of forest products to ensure the sustainability of these resources. Therefore there is

compelling need to find out through this research existing IK of forest products and mechanisms for upscaling them.

However, the following salient questions still remain: are there IK of forest products in the study area? what are the mechanisms for upscaling IK of forest products? what are the constraints to the mechanisms for upscaling IK of forest products? In trying to unravel answers to questions posed above and others, the study specifically sought to: describe the IK of forest products in Anambra state; examine IK of forest protection measures; ascertain mechanisms for upscaling IK of forest products; determine respondents' perceived effectiveness of mechanisms for up-scaling IK of forest products and determine perceived constraints to the mechanisms for upscaling IK of forest products.

Methodology

The study was carried out in Anambra State. The population of the study comprised all the people engaged in forestry activities. Anambra State is made up of three senatorial zones, namely: Anambra North, Anambra Central and Anambra South with seven local government areas (LGAs) allocated to each zone (www.igbofocus.co.uk). Two out of the three senatorial zones were purposively selected for the study (Anambra North and Anambra South). One Local Government Area (LGA) was purposively selected from each selected zone (Awka South LGA-Anambra North Zone and Orumba South LGA- Anambra South Zone) while two communities each were also purposively selected from each LGA (Awka South LGA- Enuorji and Adabebe communities, Orumba South LGA- Umuchu and Umuomaku communities). The reason for purposive selections was because of the existence of traditional forests in those areas. A list of 40 people engaged in forestry activities was compiled in each community based on their villages and hamlets/kindred from which 20 respondents were randomly selected giving a total of 80 respondents for the study.

Interview schedule based on the objectives of the study was developed and used to collect data for the study. To describe the IK existing in the area, the respondents were asked to identify IK of forest activities in their area from the list of indigenous activities provided e.g. Certain forest trees/ plants used for medicinal purposes, reservation of trees/lands for sacred purposes, Local classification of soils/plants, certain plants used for identification etc. Also, IK of forest protection measures was measured by listing indigenous forest protection measures such as no indiscriminate felling of forest trees for timber, no illegal hunting/poaching, fines and sanctions for illegal exploiters etc and respondents asked to tick ones applicable to them. Mechanisms for up-scaling IK of forestry products in the communities were measured by asking the respondents to identify such upscaling mechanisms from the list provided such as: oral based records, documenting forest products on books/leaflets/articles, processing of medicinal trees/plants/herbs, preservation of fresh forest fruits etc. Again, the respondents' perceived effectiveness of mechanisms for up-scaling IK of forest products was measured on three point Likert-type scale of very effective (2), effective (1) and not effective (0). The values were added up to 3 and divided by 3 to give a mean score of 1. Variables with mean scores of 1 and above were regarded as effective up-scaling mechanisms while variables with mean scores of below 1 were regarded as not effective mechanisms.

To determine respondents' perceived constraints to mechanisms for upscaling IK of forest products, they were asked to tick from the list of perceived constraints provided on a four point Likert-type scale, with options of: very serious (3), serious (2), a little bit serious (1) and not serious (0). The nominal values of 3, 2, 1 and 0 were summed up to 6 and divided by 4 to give a mean score of 1.5. Variables with mean scores of 1.5 and above were regarded as serious constraints while variables with mean scores below 1.5 were regarded as not serious constraints. Data collected were subjected to descriptive statistics such as mean and percentage.

Results and Discussion

Indigenous Knowledge of Forest Products

Table 1 shows that all (100%) of the respondents know certain forest trees/plants that could be used for medicinal purposes for example *"uziza*" (P. guineense) and "*utazi"(G. latifolium)* leaves which can be used to cure cough and the "*Akwu Ojukwu*" (*Elaesis spp)* palm nut which cures all types of poison. Also, majority (96.3%) knew certain trees/plants could be used for identification purposes. For example "*Omu"* (i.e. young palm frond from the palm trees) could be used to protect land/property from land speculators/ thieves, indicate danger or show mark of ownership.

Majority (92.6%) of the respondents had local knowledge of certain plants/trees that are beneficial to the environment. Example, raffia palm and kola (*Elaesis spp and Kola spp*) trees help to purify air and also provide the local people with the traditional raphia palmwine known as "*ngwo*" and *kola nut,* which are used for traditional ceremonies in the study area. Again, majority (91.4%) of the respondents agreed to the reservation of trees for sacred purposes for example "*Ogilisi*" and "*Ogbu*" (*Newbouldia levis* and *Ficus spp L*.) trees are dual purpose trees for worship and boundary purposes. Seventy four percent of the respondents had IK of preservation of fruits e.g. banana, plantain, palm nuts etc. This implies that certain perishable products can be preserved for longer period of time which can help to attract better prices for them.

About 98% of the respondents reported that they had IK in local classification of soils, crops and animals e.g. use of colour to name soil (red, black etc.), use of location to name crops like "*Akpu Abagana*" (i.e cassava from Abagana community). Also, the respondents had IK in the naming of plants, animals and birds based on certain characteristics for example "*Oshigbu*" (*Ocimium gratissimum L*.) for the smell, *"Enyi*" (Big sized animal e.g. Elephant) *"Nza"* (Small sized bird e.g. sparrow) etc.

TABLE 1: Percentage distribution of respondents based on their IK of forest products

Indigenous knowledge	Frequency (f)	(%)
Reservation of trees/lands for sacred purposes	74	91.4
Certain plants used for identification	78	96.3
Certain forest trees/plants used for medicinal purposes	80	100.0
Certain plants and trees beneficial to soil/environment	75	92.6
Local classification of soils/plants etc	79	97.5
Preservation of fruits	60	74.0
Processing of forest products	13	14.6

IK of Forest Protection Measures

Entries in Table 2 show that the respondents had IK of forest protection measures such as: policing of the products by organizations like age grades, youth associations, task forces etc. (92.6%); no indiscriminate felling of forest products (81.5%); fines/sanctions on illegal exploiters (81.5%); no illegal hunting/poaching (77.8%); punishment by spirits (55.6%); no grazing of animals (55.6%); and regulation of exploitation of certain forest products (42.0%).

The local people through their IK safe-guard their forest products against illegal exploiters. This action inadvertently protects the forest from heat stress, loss of vegetative cover and agricultural land. The beliefs of indigenous people on the power of spirits to punish those who desecrate the forest helped in protecting the sacred forests. This is in line with (Miller 1999) which confirms that this has been a major reason for the survival of shrines and sacred forests. Based on their IK, forest products in the communities were protected through local laws against indiscriminate felling of forest trees for timber/farming as well as regulation of exploitation of certain forest products like palm nuts, fuel-wood, etc. This shows the commitment of local people in ensuring that the forest resources are not destroyed. They also impose sanctions on illegal exploiters (illegal hunters or poachers) to protect the forest products. Again, grazing animals were prohibited around the forest area. However, through FGD it was discovered that some of the forest protection measures are fast eroding probably because of harsh economic situation in the country coupled with high poverty levels which compel people to resort to excessive exploitation of these resources.

TABLE 2: IK of forest protection measures

Indigenous forest protection measures:	Freq. (f)	(%)
No indiscriminate felling of forest products	66	81.5
No illegal hunting/poaching	63	77.8
Policing of forests by groups/organizations	75	92.6
Fines/sanctions on illegal exploiters	66	81.5
Punishment by spirits	45	55.6
Regulation of exploitation of forest products	34	42.0
No grazing of animals within and around the forest	45	55.6

Mechanisms for upscaling IK of forest products

Entries in Table 3 show that respondents upscaled their IK of forest products through: oral based records (98.8%); improved keeping of animals/birds (93.8%); preservation of fresh forest fruits (74.0%); processing of medicinal trees, plants, herbs into liquid, syrup, tablets etc. (67%); documenting plants on books/leaflets/articles (21%); raising of forest seeds/seedlings (11.3%); creation of forest reserves/ zoological gardens (3.8%); and posting information on plants/animals to the internet (1.3%).

The implication of the people upscaling their IK of forest resources through oral based records in form of stories and legends confirms the need to incorporate peoples' IK in development plans. The effect of climate change on forest resources for instance can only be effectively tackled when it is understood from indigenous point of view. This is in line with Indigenous Peoples' Earth Charter (1992 in IUCN, 1997) which states that some IK systems produce sacred text, mostly oral based often revealed through stories and legends.

Again, over time people improved their IK on keeping of animal/birds. In most rural communities in Anambra State, local birds/animals are raised through combination of modern technology and IK. According to Ezekwe (2009) intensification of livestock production particularly those species that are highly prolific and for which appropriate and adaptable technologies already exist for their production has been embraced by livestock producers in Nigeria. Perhaps the most successful farm animal species that has enjoyed very wide acceptance and commercialization is the domestic chicken (*Gallus domesticus*).

The study further revealed that local people upscaled their IK of forest fruits through preservation of fresh forest fruits like apple, banana, mango etc against effect of high temperature. This implies that the effect of climate change like excess heat can be minimized through enhanced local preservation methods. Similarly they upscaled their IK of medicinal trees, plants and herbs by improving their utilization through processing into liquid, syrup, tablets etc. For example some herbalists have acquired machines for processing of their herbs into tablets and syrups. This implies

that some of the medicinal herbs like *uziza* being lost as a result of effect of climate change are put into better uses for bettering the life or health of the local people.

On the contrary only 21% of the respondents reported that they upgraded their IK of forest products through documenting plants on books/leaflets/articles. Also, only 1.3% of the respondents had upscaled their IK by posting information on plants/animals to the internet. This has great implication in development of communities because much of this knowledge is at as much risk of being lost as is the case with biodiversity (Linden, 1991). Therefore, upscaling IK of forest products in various areas will help in preservation of these products.

The few number of people that were involved in upscaling their IK through raising of seeds/seedlings (11.3%) can adversely affect the prospects of forest products in the communities. The slow rate of regeneration of forest resources which when combined with the present rate of forest degradation will result to total clearance of forest reserves. Since only about 4% of the respondents up-scaled their IK by creating forest reserves and zoological gardens the future of forest products is highly undermined. Presently forest reserves are gradually phasing out to the detriment of forest products which are already threatened at their natural forest habitats.

TABLE 3: Mechanisms for upscaling IK of forest products

Mechanisms	**Frequency (f)**	**(%)**
Oral based records	79	98.8
Documenting forest products on books/leaflets/articles	17	21.0
Posting of forest products to internet	1	1.3
Processing of medicinal trees/plants/herbs	54	67.5
Preservation of fresh forest fruits	60	74.1
Raising of forest seeds/seedlings	9	11.3
Creation of forest reserves/zoological gardens	3	3.8
Improved keeping of animals/birds	75	93.8

Perceived effectiveness of mechanisms for upscaling IK of forest products

Entries in Table 4 reveal that mechanisms for upscaling IK of forest products were perceived by the respondents as not effective. These mechanisms include: oral based records (M=0.99), improved keeping of animals/birds (M=0.94), preservation of fresh fruits (M=0.75), processing of medicinal trees/plants/herbs (M=0.68), documenting forest products on books/leaflets/Articles (M=0.21), raising of forest seeds/seedlings (M=0.11), Creation of forest reserves/zoological gardens (M=0.04) and posting of forest products to internet (M=0.01). Although some mechanisms like oral based records (M=0.99) and improved keeping of animals/birds (M=0.94) were

fairly effective but in absolute terms were not effective upscaling mechanisms with mean scores less than one. This implies that all mechanisms for upscaling IK of forest products in the communities are generally weak and ineffective. This portends danger for survival of forest products especially in the face of worsening climate change scenarios. For instance, upscaling IK through oral based records is necessary because most indigenous people have traditional songs, stories, legends, dreams, methods and practices as means of transmitting specific human elements of IK (www.nativescience.org/html/traditional-knowledge.html)

TABLE 4: Perceived effectiveness of mechanisms for upscaling IK of forest products

Mechanisms	Mean (M)	STD. Deviation
Oral based records	0.99	0.57
Books/leaflets/Articles	0.21	0.43
Internet records	0.01	0.40
Processing of medicinal trees/plants/herbs	0.68	0.67
Preservation of fresh forest fruits	0.75	0.41
Raising of forest seeds/seedlings	0.11	0.39
Creation of forest reserves/zoological gardens	0.04	0.43
Improved keeping of animals/birds	0.94	0.67

Constraints to upscaling IK of forest products

Table 5 reveals some serious constraints to the mechanisms for upscaling IK of forest products. They include: lack of government policy/ capital (M=2.74), decline in size of forests (M = 2.66), lack of education (M = 2.59), high level of poverty (M =2.56) etc. The finding shows that all the serious constraints cut across all the mechanisms for upscaling IK of forestry products except one i.e. ineffectiveness of forest officers (M=1.15). The implication of this finding is that if governments and non-governmental organizations fail to take proactive actions (such as government policy on IK, provision of capital for documentation of IK etc) to harness IK, it will gradually phase out as custodians of the knowledge are allowed to die with their knowledge. For many indigenous people today, they are bombarded by technology that teaches them non-indigenous ways and limits the capacity of elders to pass on traditional knowledge to the young. As the elders die, the full richness of IK is diminished, because some of it has not been passed on and so is lost (www.nativescience.org/html/traditional-knowledge.html)

Again, the standard deviations of the constraints that were less than 1, such as ineffectiveness of forest officers (0.92), lack of research on IK (0.86), ignorance of upscaling mechanism (0.83) etc. implied that the responses of the respondents based on the constraints to the mechanism for upscaling IK of forest products did not differ much from their mean scores and therefore a true reflection of the situation.. The constraints that were greater than 1.0 such as lack of processing/storage facilities (1.15) non involvement of NGO's on forestry matters (1.08), corruption of leaders (1.03) etc. showed that there were differences in the responses of the respondents from the mean score and as such may not be the real situation on the ground. This situation calls for involvement of extension workers in management of forest products.

TABLE 6: Constraints to upscaling IK of forest products

Constraints	Mean (M)	STD. Deviation
Lack of research on IK	2.55*	0.86
Lack of education	2.59*	0.69
Decline in size of forests	2.66*	0.73
High poverty level	2.56*	0.79
Lack of government policy/capital	2.74*	0.76
Non involvement of NGO's	2.18*	1.08
Ineffectiveness of forest officers	1.15	0.92
Corruption of leaders	2.22*	1.03
Lack of processing/storage facilities	1.67*	1.15
Little or no conservation effort	1.71*	1.01
Ignorance of upscaling mechanism	2.56*	0 .82

*= serious constraints

Conclusion/recommendation

The study concluded that local people had IK of certain forest trees/plants which can be used for medicinal and other purposes like identification, sacred/worship, local classification etc. There also exist IK of measures for protection of forest products. However, mechanisms for upscaling these IK are still weak and ineffective. Therefore, for preservation of IK in Anambra State, both the government and non-governmental organizations should take proactive actions in harnessing it (IK) before it is lost forever.

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Upscaling Indigenous Knowledge (IK) of Forestry Resources in Anambra State: Implications for Climate Change Policies

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Abstract

The work was on upscaling indigenous knowledge of forest resources in Anambra State and its implications for climate change policies. Data for the study was collected from the respondents through the use of interview schedule and analyzed, using descriptive statistics. The result revealed that all (100%) of the respondents know certain forest trees/plants that could be used for medicinal purposes for example "uziza" and "utazi" leaves and the "Akwu Ojukwu" a species of palm nut. About 98% of the respondents reported that they had IK of local classification of soils, crops and animals while 92.6% had indigenous knowledge of certain plants/trees that are beneficial to the environment. On the other hand, 92.6% of the respondents had IK of methods of protecting forest resources through policing of the resources by organizations like age grades, youth associations, task force etc. Also, the respondents had IK of method of protecting forest resources through local laws against illegal hunting or poaching (77.8%) and through social sanctions (56.0%). About 99.0% of the respondents upscaled their IK of forest resources through oral based records in form of stories and legends, production of animals/birds (93.8%), preservation of fresh forest fruits (74.1%) etc. The study found out that the IK upscaling mechanisms of forest resources such as oral based records (0.99) production of animals/birds (0.94), preservation of fresh fruits (0.75) and medicinal trees/plants/herbs (0.68) were in absolute terms not effective upscaling mechanisms with mean scores less than one. Some constraints to a great extent that militated against the mechanisms for upscaling of IK of forest resources include: lack of government policy/ capital (M=2.74), decline in size of forests (M = 2.66), lack of education (M = 2.59), High level of poverty (M =2.56) etc. The study further draws implications for climate change policies in areas like methods for protection of forests and upscaling Ik of forest resources. The study recommends climate change policies that will accelerate and strengthen IK of forest resources to help in minimizing the effect of climate change.

Key words: Upscaling, indigenous knowledge, climate change, policies, forest resources

Introduction

One way to ameliorate the effect of climate change is through upscaling of indigenous knowledge (IK) of forestry resources. IK is local knowledge that is unique to a given culture or society and it contrasts with the international knowledge system generated by the universities and research institutes. It is the basis for local level decision making in agriculture, education, natural resource management and a host of other activities in rural communities. Such knowledge is passed down from generation to generation in many societies by word of mouth. In a broader sense, IK

also refers to the collective knowledge of an indigenous people about relationships between people, habitat and nature (International Union for Conservation of Nature, 1997).

In the 1950's and 1960's, theorists of development saw IK as inefficient, inferior and an obstacle to development. However, in current development discourse, formulations about IK recognize that derogatory characterization of the knowledge of the poor and marginalized populations may be hasty and naïve. In contrast to modernization theorists, advocates of IK underscore the promise it holds for sustainable development (Warren, 1991, Orlove and Brush, 1996).

Involvement of local people in forest resources and sustainable management is very important. This is based on the advantages that can be gained by drawing on IK of the forests and forest products, and by building on the sustainable systems of use that local people have created (Redford and Mansour, 1996).

IK and organizational structures have several important advantages over projects that operate outside them (Bicker, 2004). IK provides the basis for grassroots and local level decision making much of which takes place at the community level through indigenous associations and organizations where problems are identified and solution to them are determined. Locally available skills and materials are thus often more cost effective than introducing exotic technologies from the outside sources (Wollenberg E.A.A. Nawir, A. Uluk and H. Pramond (2001). As well, local people are familiar with them and so do not need any specialized training. However, IK has its limitations and should not be mistaken into believing that whatever indigenous people do is right or sustainable but should be utilized by helping local people record and use their knowledge by being gathered and documented in a systematic and coherent fashion to assist national development.

It is well known today that the world forest resources are facing extinction much faster than they would through natural processes alone (FAO, 2001). As the effects of climate change multiply and deepen in scope and intensity, the need for multi-dimensional solutions becomes imperative. Therefore, application of IK of forestry resources to ameliorate the effect of climate change becomes urgent and necessary. According to Warren (1992), IK and biodiversity are complementary phenomena to human development. He however stated that very little of this knowledge has been recorded yet it represents an immensely valuable data base that provides humankind with insights on how numerous communities have interacted with their changing environment including its floral and faunal resources. In particular, IK is not accorded the required recognition in some African countries including Nigeria. To ignore people's knowledge is to ensure failure in development because indigenous systems are embedded in social and cultural milieu of their particular community and scientific knowledge seeks to distinguish very clearly between these different dimensions (Agarwal, 1995).

Local people are very committed to the management and conservation of the forests by their efforts in establishing traditional laws, forest reserved areas for deities, veneration of trees and other physical features. These laws frown against tree felling, cultivation on specific areas, bush burning, illegal hunting and fishing and restrictions to certain seasons (Enwelu, 2002). So these traditional laws, folklores and institutions are used to protect the forests and place sanctions on disturbed lands. The local people have a very strong relationship with the forest

lands and try their best to conserve and protect the forest (Forestry Association of Nigeria, 2003). Since IK is essential to development, it is often suggested that it must be gathered and documented in a coherent and systematic fashion, in order to ensure the management of these forest resources.

However some questions still remain: Are there IK for forest protection in the study area? What are the methods for upscaling the IK of forest resources? What are the constraints to the mechanisms for upscaling the IK of forest resources? In trying to unravel answers to questions posed above, the study specifically sought to: describe the IK of forest resources in Anambra state; examine IK methods of protection of forest resources; examine mechanisms for upscaling IK of forest resources; determine the constraints to mechanisms for upscaling IK of forest resources; and draw implications for climate change policies.

Methodology

The study area was carried out in Anambra State. The target population comprised all the people engaged in forestry activities. Anambra State is made up of three senatorial zones, namely: Anambra North, Anambra South and Anambra Central with seven local government areas (LGAs) allocated to each zone (www.igbofocus.co.uk). Two out of the three senatorial zones were purposively selected for the study (Anambra North and Anambra South). One Local Government Area (LGA) was purposively selected from each selected zone (Awka south and Orumba south) while two communities each were also purposively selected from each LGA (Enuorji and Adabebe, Umuchu and Umuomaku). The reason for purposive selections was because of the existence of traditional forests in those areas. A list of 40 people engaged in forestry activities was compiled in each community based on their villages and hamlets/kindred from which 20 respondents were randomly selected giving a total of 80 respondents for the study.

Interview schedule based on the objectives of the study was developed and used to collect primary data while secondary data were collected through literature search.

To describe the IK existing in the area, the respondents were asked to identify the IK from the list provided e.g. reservation of trees/lands for sacred purposes, certain plants used for identification etc. Also, IK based on forest protection methods against climate change was measured by listing the IK forest protection methods such as no indiscriminate felling of forest trees for timber, no illegal hunting/poaching, fines and sanctions for illegal exploiters etc. The mechanisms for up-scaling of the IK of forestry resources in the communities were measured by asking the respondents to identify the mechanisms for up-scaling the local knowledge of forest resources in their communities such as documentation, classification, utilization etc. Again, the effectiveness of up-scaling mechanisms was measured on three point Likert-type scale of very effective (2), effective (1) and not effective (0). The values were added up to 3 and divided by 3 to give a mean score of 1. Variables with mean scores of 1 and above were regarded as effective up-scaling mechanisms while variables with mean scores of below 1 were regarded as non effective mechanisms. The extent of the constraints to the mechanisms for upscaling of indigenous knowledge of forest resources were measured on a four point Likert-type scale i.e. to great extent (3), to moderate extent (2), to a little extent (1) and to no extent (0). The nominal values of 3, 2, 1 and 0 were summed up to 6 and divided by 4 to give a mean score of 1.5. Variables with mean scores of 1.5 and

above were regarded as constraints militating to great extent while variables with mean scores below 1.5 were regarded as constraints to no extent. Data collected were subjected to descriptive statistics such as mean and percentage.

Results and Discussion

Indigenous Knowledge of Forest Resources

Table 1 shows that all (100%) of the respondents know certain forest trees/plants that could be used for medicinal purposes for example *"uziza*" and "*utazi"* leaves which can be used to cure cough and the "*Akwu Ojukwu*" a species of palm nut which cures all types of poison. Also, majority (96.3%) knew certain trees/plants could be used for identification purposes. For example the young palm frond ("*Omu)* from the palm trees could be used to protect land/property from land speculators/ thieves, indicate danger or show mark of ownership.

Majority (92.6%) of the respondents had local knowledge of certain plants/trees that are beneficial to the environment. Example, raffia palm and kola trees help to purify air and also provide the local people with the traditional wine known as "*ngwo*" and *kolanuts,* which are used for traditional ceremonies in the study area. Again, majority (91.4%) of the respondents agreed to the reservation of trees for sacred purposes for example "*Ogilisi*", "*Ogbu*" trees are dual purpose trees for worship and boundary purposes. Seventy four percent of the respondents had IK of preservation of fruits e.g. banana, plantain, palm fronds. This implies that certain perishable products can be preserved for longer period of time which can help to attract better prices for them.

About 98% of the respondents reported that they had IK in local classification of soils, crops and animals e.g. use of colour to name soil (red, black etc.), use of location to name crops like cassava ("*Akpu Abagana*"). Also, the respondents had IK in the naming of plants, animals and birds based on certain characteristics for example "*Oshigbu*" (Plant smelling) *"Enyi*" (Big sized animal) *"Nza"* (Small sized bird) etc.

TABLE 1: Percentage distribution of respondents based on their IK of forest resources

Indigenous knowledge	Frequency (f)	Percentage (%)
Reservation of trees/ lands for sacred purposes	74	91.4
Certain plants used for identification	78	96.3
Certain forest trees/ plant used for medicinal purposes	80	100.0
Certain plants and trees known to be beneficial to the soil/environment	75	92.6
Local classification of soils/plants etc	79	97.5
Preservation of fruits	60	74.0
Processing of forest products	13	14.6

Source: Field data, May 2011.

IK of Methods for Protection of Forest Resources

Entries in Table 2 show that majority (92.6%) of the respondents had IK of methods for protection of forest resources such as policing of the resources by organizations like age grades, youth associations, task force etc. Also, 90.1% of the respondents believed that sacred forests could be protected through punishment by spirits which may be immediate or delayed while 81.5% of the respondents had the IK of method for protection of forest resources through local laws against indiscriminate felling of forest trees for timber/farming. About 78% reported that Forest resources were protected through local laws against illegal hunting or poaching while 55.6% the respondents were engaged in prohibition of grazing animals within and around the forest area. The regulation of exploitation of certain forest products was observed by 42% of the respondents. On the other hand, only 21% of the respondents know coal as the alternative source of energy for domestic purposes e.g. use of coal for cooking instead of fuel-wood.

The local people through IK safe-guard their forest lands using those local organizations to ensure against illegal exploiters of the forest resources. This action inadvertently protect the forest against climate change effects such as increase in heat stress, increase in loss of agricultural land, reduction in vegetation cover etc. (Tologbonse, *et al*. 2010)

The beliefs of indigenous people on the power of spirits to punish those who desecrate the forest helped in protecting the sacred forests. This is in line with (Miller 1999) which confirms that this has been a major reason for the survival of shrines and sacred forests. The IK of method of protecting forest resources through local laws against indiscriminate felling of forest trees for timber/farming was observed in most of the communities. This shows the commitment of local people in ensuring that the forestry- resources are not destroyed thereby ameliorating the effect of climate change. They also, believed that sanctions were imposed on illegal exploiters (illegal hunters or poachers) to protect forest resources. The people based on their IK undertook prohibition of grazing animals within and around the forest area as well as regulation of exploitation of certain forest products like palm nuts, fuel-wood, etc. to avoid excessive exploitation. However, through FGD it was discovered that some of these indigenous methods of protecting forest resources are fast eroding probably because of harsh economic situation in the country coupled with high poverty levels which compel people to resort to excessive exploitation of these resources.

Only few people (21%) knew coal as the alternative source of energy for domestic purposes e.g. use of coal for cooking instead of fuel-wood. Nevertheless, in either case, both methods contribute to aggravation of effects of climate change by increasing green house gas (GHG) emissions. This calls for climate change policies on how to moderate the use these methods.

TABLE 2: IK Methods of Protection Of Forest Resources

IK methods of forest protection:	Freq. (f)	(%)
No indiscriminate felling of forest trees for timber/farming	66	81.5
No illegal hunting/poaching	63	77.8
No killing of animals/fishes with chemicals	29	35.8
Policing of forests by groups or organizations	75	92.6
Fines/sanctions on illegal exploiters	66	81.5
Punishment by spirits	45	55.6
Regulation of exploitation of certain forest products.	34	42.0
No grazing of animals	45	55.6
Encouraging alternative sources of energy	17	21.0

Source: Field data, May 2011

Mechanisms for upscaling IK of forest resources

Entries in Table 3 show that 98.8% of the respondents upscaled their IK through oral based records. In terms of production: 93.8% of the respondents upscaled IK through animal/bird production, raising of forest seeds/seedlings (11.3%) and creation of forest reserves/ zoological gardens (3.8%). About 74.0% of the respondents had upscaled their IK of forest fruits' utilization through preservation of fresh forest fruits while 67% of the respondents upscaled their IK of medicinal trees, plants, herbs by improving their utilization through processing into liquid, syrup, tablets etc. On the contrary 21% of the respondents upgraded their IK of forest through documenting plants on books/leaflets/articles while only 1.3% of the respondents upscaled their IK by posting information on plants/animals to the internet.

The implication of the people upscaling their IK of forest resources through oral based records in form of stories and legends confirms the need to incorporate peoples' IK in development plans. The effect of climate change on forest resources can only be effectively tackled when it is understood from indigenous point of view. This is in line with Indigenous Peoples' Earth Charter (1992 in IUCN, 1997) which states that some IK systems produce sacred text, mostly oral based often revealed through stories and legends.

Again, over time people improved their IK on animal production. In most rural communities in Anambra State, local birds/animals are raised through combination of modern technology and IK. According to Ezekwe (2009) intensification of livestock production particularly those species that are highly prolific and for which appropriate and adaptable technologies already exist for their production has been embraced by livestock producers in Nigeria. Perhaps the most successful farm animal species that has enjoyed very wide acceptance and commercialization is the domestic chicken (*Gallus domesticus*). However, increase in production of animals/poultry can lead to aggravation of effects of climate change through GHG emissions that cause climate change. *Livestock's Long Shadow,* the widely-cited

2006 report by the United Nations Food and Agriculture Organization (FAO), estimates that 7,516 million metric tons per year of CO2 equivalents (CO2e), or 18 percent of annual worldwide GHG emissions, are attributable to cattle, buffalo, sheep, goats, camels, horses, pigs, and poultry. That amount would easily qualify livestock for a hard look indeed in the search for ways to address climate change. But analysis shows that livestock and their by products actually account for *at least* 32,564 million tons of CO2e per year, or 51 percent of annual worldwide GHG emissions (Goodland and Anhang, 2009). Since livestock are already well-known to contribute to GHG emissions there is need for climate change policy to ameliorate the effect.

The study further revealed that local people upscaled their IK of forest fruits' utilization through preservation of fresh forest fruits like apple, banana, mango etc against effect of climate change like increased temperature. This implies that the effect of climate change like excess heat can be minimized through enhanced local preservation methods. They also upscaled their IK of medicinal trees, plants and herbs by improving their utilization through processing into liquid, syrup, tablets etc. For example some herbalists have acquired machines for processing of their herbs into tablets, syrups. This implies that some of the medicinal herbs like *uziza* being lost as a result of climate change are put into better uses for bettering the life or health of the local people.

On the contrary only 21% of the respondents had upgraded their IK of forest resources against climate change through documenting plants on books/leaflets/articles. Similarly, only 1.3% of the respondents had upscaled their IK by posting information on plants/animals to the internet. This has great implication on our efforts to mitigate the effects of climate change because the people are not yet linked to the international knowledge system provided by internet. Tologbonse et al. (2010) confirm that climate change has resulted in environmental refugees, biodiversity loss, disappearance some species of flora and fauna as well as drying up lakes and ponds. Therefore, its effects can only be tackled by involvement of all the stakeholders.

Also, the effect of climate change can be reduced by upscaling IK in raising of forest seeds/seedlings for afforestation programme. However, the few number of people involved in raising of seeds/seedlings (11.3%) can adversely affect the prospects of forest resources in the area. The slow rate of regeneration of forest resources which when combined with the present rate of forest degradation will result to total clearance of forest reserves. Also, only about 4% of the respondents up-scaled their IK by creating forest reserves and zoological gardens. This implies that forest reserves are gradually phasing out to the detriment of forest resources which are already threatened at their natural forest habitats.

TABLE 3: Percentage distribution of Respondents on Mechanisms for upscaling of IK of forest resources

Mechanisms (%)	Frequency (f)	Percentage
Documentation:		
Oral based records	79	98.8
Books/leaflets/Articles	17	21.0
Internet records	1	1.3
Utilization:		
Medicinal trees/plants/herbs	54	67.5
Preservation of fresh forest fruits	60	74.1
Production:		
Raising of forest seeds/seedlings	9	11.3
Creation of forest reserves/zoological gardens.	3	3.8
Production of animals/birds	75	93.8

Source: Field data, May 2011

Effectiveness of mechanisms for upscaling IK of forest resources

Entries in Table 4 show that the mean values of oral based records (0.99) (documentation), production of animals/birds (0.94), preservation of fresh fruits (0.75) and medicinal trees/plants/herbs (0.68) were in absolute terms not effective upscaling mechanisms with mean scores less than one. The rest of the mechanisms much lower than one were not at all effective upscaling mechanisms. This implies that mechanisms for upscaling IK of forest resources in the communities are generally weak. And this portends danger for worsening climate change scenarios.

TABLE 4: Effective mechanisms for upscaling of IK of forest resources against climate change

Mechanisms	Mean (M)	STD. Deviation
Documentation:		
Oral based records	0.99	0.57
Books/leaflets/Articles	0.21	0.43
Internet records	0.01	0.40
Utilization		
Medicinal trees/plants/herbs	0.68	0.67
Preservation of fresh forest fruits	0.75	0.41
Production		
Raising of forest seeds/seedlings	0.11	0.39
Creation of forest reserves/zoological gardens.	0.04	0.43
Raising of animals/birds	0.94	0.67

Source: Field data, May 2011

Constraints to mechanisms for upscaling of IK of forest resources

Table 5 reveals some constraints militating to a great extent against the mechanisms for upscaling of IK of forest resources. They include: lack of government policy/ capital (M=2.74), decline in size of forests (M = 2.66), lack of education (M = 2.59), high level of poverty (M =2.56) etc. These findings of the study amply show that almost all the constraints listed, affected the mechanisms for upscaling the IK of forestry resources. Also, the standard deviations of the constraints that were less than 1, such as ineffectiveness of forest officers (0.92), lack of research on IK (0.86), ignorance of upscaling mechanism (0.83) etc. implies that the responses of the respondents based on the constraints to the mechanism for upscaling IK of forest resources did not differ much from their mean scores and therefore a true reflection of the situation.. The constraints that were greater than 1.0 such as lack of processing/storage facilities (1.15) non involvement of NGO's on forestry matters (1.08), corruption of leaders (1.03) etc. showed that there were differences in the responses of the respondents from the mean score and as such may not be the real situation on the ground.

TABLE 6: Constraints to Mechanisms for Upscaling of IK of Forest Resources

Constraints	Mean (M)	STD. Deviation
Lack of research on IK	2.55*	0.86
Lack of education	2.59*	0.69
Decline in size of forests	2.66*	0.73
High poverty level	2.56*	0.79
Lack of government policy/capital	2.74*	0.76
Non involvement of NGO's	2.18*	1.08
Ineffectiveness of forest officers	1.15	0.92
Corruption of leaders	2.22*	1.03
Lack of processing/storage facilities	1.67*	1.15
Little or no conservation effort	1.71*	1.01
Ignorance of upscaling mechanism	2.56*	0 .82

Source: Field data, May 2011

** = effective mechanisms*

Implications for climate change policies

The issue of climate change in our contemporary society is undoubtedly a major challenge that remains unresolved. However, Igbokwe and Mkpado (2011) believe that the level of awareness and understanding of the climate change phenomenon and their impacts on our planet earth and its inhabitants have significantly improved over the past few decades. They further stated that modelling and observational research have provided ample evidence that the long term shifts in climate parameters have impacted substantially on many aspects of life on earth.

A preliminary study conducted by the Intergovernmental Panel on Climate Change (IPCC) on the vulnerability of various sectors of the Nigerian economy to climate change, identified seven natural and human systems which were condensed into five systems thus:

- Human settlements and health;
- Water resources, wetlands and freshwater ecosystems;
- Energy, industry, commerce and financial services;
- Agriculture, food security, land, forestry and biodiversity; and
- Costal zone and marine ecosystems.

According to the study, virtually all the sectors analyzed especially forest resources manifested some evidence of vulnerability to climate change. None was unaffected, nor will remain unaffected in future by changes to climate conditions (IPCC, 2007). This notion is confirmed by Ozor *et al.* (2010) when they stated that the vulnerability of the developing countries like Nigeria is worsened by heavy reliance on renewable natural resources for livelihoods, employment and incomes. For instance, most Pan-African consultations show that the most affected groups are farmers, pastoralists, foresters, fisher folks and hunters.

Therefore the need to address these problems through appropriate climate change policy instrument is overwhelming and urgent especially when such policy is yet to be in place. According to Igbokwe (2012), the history of documented policies at all levels of governance in Nigeria is a recent development, often lacking in implementation and subject to jettisoning as government change hands. Even at that various agricultural policies never made reference to climate change/adaptation and efforts to adopt proactive steps that will place the subject on the front burner have met with little success. Nigerian Daily Independent newspaper, lamented that Nigeria, one of the participating countries to the United Nations framework convention for climate change of the conference of parties (COP17) is yet to establish a climate change commission that would negotiate and coordinate the countries' activities at the conference. The proposed climate commission is supposed to be an independent body under the presidency charged with the coordination of existing institutions, policy priority setting and development of action plans and expansion of international cooperation….(Daily Independent, Wednesday, 20 July, 2011)

Therefore, there is need to put in place policies that bear on all sectors affected by climate change. This view was canvassed by Building Nigerian Response to Climate Change [(BNRCC), 2011] when it recommended review of national agricultural and related policies in the following areas:

- Nigerian Agricultural Policy
- National Irrigation and Water Policies
- Other policies relating to agricultural research, livestock, seeds, crops,
- Other policies relating to water harvesting, erosion and flood control, soil conservation practices, drought and desertification and related matters

The review of these policies should ensure the effective participation of all stakeholders, including women and other vulnerable groups. Where significant policy gaps are identified, or where policies are inconsistent with the need to adapt to climate change, the Federal Government should update the policies through a broad consultative process with stakeholders that ensures gender inclusion.

Climate change policy should cover areas that encourage use of IK in conservation of forest resources including use of new seeds, good cultivation practices, and incentives for observing good conservation practices. Regulatory policies that control unregulated sand

and lateritic soil mining on farm lands and deforestation and desertification and incentives for adoption of agro-forestry systems and other mixtures and afforestation should be put in place (Igbokwe, 2012).

The government policy on research and extension should be modified to cater the new challenges posed by climate change. The research emphasis should focus on developing new crop and animal varieties, new cultural practices, modified ecosystem etc that can ameliorate the effect of climate change. According to Igbokwe, 2006, one of the quick fixes in this regard is the adoption of genetically modified organisms' research. Also, government policy should be tailored towards training extension workers in the areas of IK and forestry to help in empowering the vulnerable groups to contribute to climate change adaptation and mitigation strategies. It is advocated that climate change policies should also cover areas like methods for protection of forests and upscaling Ik of forest resources.

Conclusion/recommendation

The study concluded that local people had IK of certain forest trees/plants which can be used for medicinal and other purposes like identification, sacred/worship, local classification etc. Also, the people had IK of methods for protection of forest resources e.g. policing of forest resources by age grades, youth and task forces. They upscaled their IK through oral based records, animal production, preservation of forest fruits etc. However, most of the upscaling mechanisms were not effective. Mechanisms for upscaling were constrained by lack of research work, lack of government policy/capital and high poverty level.

The study recommends climate change policies that will accelerate and strengthen IK of forest resources to help in minimizing the effect of climate change. Also, there is need for urgent policy reforms and technical innovations that will insure adaptation and mitigation strategies to douse the effects of climate change in Anambra State.

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Rice Farmers' Knowledge of and Attitude to Climate Change in Abia State, Nigeria

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Abstract

The study was carried out to examine rice farmers' knowledge of and attitude to climate change in Abia State. The specific objectives of the study were to assess the farmers' knowledge of climate change, investigate the farmers coping strategies at the time of climate change and determine the constraints to adapting to climate change. A well structured questionnaire was used to solicit information from respondents in Ohafia Agricultural Zone. Description statistics and likert rating scale technique were adopted as analytical tools. Results showed that the farmers had good knowledge of climate change Planting at different time and different varieties were their major coping strategies. Insufficient credit and savings, and lack of improved agricultural technologies were identified as being the major constraints to adapting to climate chang. It was recommended that adequate credit and savings and improved agricultural technologies should be made available to the farmers. Besides, extension programmes on how to adapt effectively to climate change should be embarked on by the relevant authorities.

Introduction

Rice is the second most important cereal in the world after wheat. More than half of the human race needs rice as source of calories (Rice Today, 2007). FAO (2004) identified rice as a very important primary food source and this is drawn from the understanding that rice-based systems are essential for food security, poverty alleviation and improved livelihood by enhancing the socio-economic profile of the farmers. It is the leading cereal crop of South Asia region of the world (Agba, 2000). He further stressed that in Asia alone more than 2 billion people obtain 60-70 percent of their energy intake from rice and its derivatives. It is the most rapidly growing food source in Africa and is of significant importance to food security in an increasing number of low income food deficient countries.

Over 65% of the world's output of rice comes from China, India, Bangladesh, Japan, Pakistan, and the adjoining Islands in the Pacific (Catling, 1999). Ayoade (2004) noted that Nigerian is the word's second importer of rice, spending over 300 million US dollar annually in rice import alone. Nguyem (2004) observed that Nigeria

accounts for only about 2% of rice production in the world, rice is produced in the middle belt and in some far northern states of Nigeria

The importance of rice has risen dramatically since the oil boom and the rising urbanization as a result of migration of people to towns and cities. Rice is in very high demand because of several factors. Milled rice is boiled and eaten. It is easier to cook for table use than other cereals. It has the highest digestible energy because of its low crude fibre and tannin contents (Agba, 2000). Rice straws are used for roofing, mulching and feeding of livestocks. The brans and the offals contain high amount of protein and so are used in compounding livestock feeds (Aduku, 2004). Any effort to increase rice production is in the right direction to curb hunger and food insecurity in Nigeria.

While there is need to feed the world, there is also a growing concern about global climate change issues. Steps are being taken to arrest, mitigate or slow down climate change. It is well known that anthropogenic activities during the cultivation of crops cause green house gas (GHG) emission (Yew, et al, 2009). The two factors affecting crop yield are weather conditions of an area (observed as the climate), because climate parameters such as temperature, rainfall, humidity as well as sunshine hours affect the agricultural output of any region. Daily, seasonal or annual variations in the values of the climate element are of great importance in determining the efficiency of crop growth (Ayoade, 2004).

The issue of climate change has become more threatening, not only to the sustainable development of socio-economic and agricultural activities of any nation, but to the totality of human existence (Adejuwon, 2004). Human beings have been adapting to the variable climate around them for centuries worldwide. Local climate variability can influence peoples' decision with consequences for their social, economic, political and personal conditions and can affect their lives and livelihoods (UNFCCC, 2007). As further explained by United Nation frame convention on climate change (UNFCCC) the effect of climate change implies that the local climate variability that people have previously experienced and adapted to is changing and this changing is observed in a relatively greater speed.

The wide fluctuations in annual yields of rice in Nigeria impacts negatively on planning and predictability of availability of rice produce. Given that the yields of the crop are influenced by weather, it is necessary to investigate the degree of variability in the climate elements in rice production in Nigeria. This will give an actual picture of all rice production and impact of irregularity in climate conditions on the production.

The study dwells on examining the knowledge of and attitude of rice farmers to climate change in Abia State. It is expected that the findings will catalyze actions aimed at raising awareness of the activities of rice farmers in climate change issues in Abia State building capacities of surveyed communities in the study area to adopt (cope) with climate change effects.

Problem statement

The demand for rice is increasing at a much faster rate than domestic production in Nigeria more than any other in African continent since the mid 1970s (Rice today, 2007). Rice which used to be an occasional food during festive periods has now assumed a daily meal status.

Various reasons have been attributed to the wide demand-supply gap of rice in Nigeria which include: aging farming population, improper production techniques, scarcity and high cost of inputs, rudimentary post-harvest and processing methods, poor/low mechanization on rice farms and low competitiveness with imported rice (Daramola, 2005). In recent times, rice farming is being bedeviled with increasing temperatures, irregularity in rainfall pattern (shorter periods of rainfall and lower amount of precipitation). This has been attributed to climate change. Climate change also referred to as global warming is any long term change in the statistics of weather over periods of time that range from decades to million of years. Global warming is the average temperature of Earth's near-surface air and oceans since the mid-20th century and its projected continuation. The Inter Governmental Panel on Climate Change concluded that increasing green house gas concentration, results from human activities such as fossil fuel burning and deforestation caused most of the observed temperature increase (Peng *et al*, 2004). The most critical aspects of Climate Change to rice production is increase in temperatures. This has the most damaging effects on rice quality. Temperature changes greatly influences the growth pattern, duration and productivity of rice crops (Nguyem, 2004). A change in the pattern of precipitation is another important limiting factor to the yield of rain-fed rice (Maclean *et al*, 2002). In freely drained upland rice, moisture stress causes severe damages or even death of rice plants in an area that receives as much as 200mm of precipitation in 1 day and then the rain stops for the next 20 days. This may lead to complete crop failure especially if the severe stress takes place during the reproduction stages (Nguyem, 2004). Over the years farmers have been responding to climate change through adaptation which is the process by which ecological, social or economic systems adjust in response to actual or expected climatic stimuli and their effects or impacts (Smit *et al*, 2001). Farmers often select crop combinations that will survive harsh conditions such as maize-beans, cowpea-sorghum and millet-groundnut. There will be a serious implications for rice food security in Nigeria, if there are no quick and effective measures to adapt rice production to climate change.

Purpose of study

The paper focuses on the following objectives to:

(i) Assess the farmers' knowledge of climate change.

(ii) Investigate the farmers' coping strategies at the time of climate change.

(iii) Determine the farmers' constraints to adapting to climate change.

Methodology

The study was carried out in Abia State of Nigeria. Abia is divided into three agricultural zones namely: Ohafia, Umuahia, and Aba agricultural zones. A combination of purposive and multi-stage random sampling technique adopted for this study. Ohafia Agricultural Zone was purposively selected being the major area of rice production in the State. Two LGAs in the zone, based on performance in rice production were purposively selected for the study. From each of the chosen LGA, 3 communities were randomly chosen given a total of 6 communities. Two villages were randomly chosen from each of the 6 communities giving a total of 12 villages. The list of rice farmers in each village formed the sampling frames from which samples of rice farmers were selected using random sampling procedure. In all 120

rice farmers were chosen. Data were collected using a structured questionnaire. The instrument was structured into four sections. Section A elicited responses on personal data while section B, C, and D contained items which were placed on 4 point scale of Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD). The items elicited information on farmers' knowledge, strategies for coping and constraints adapting to climate change. Data were analysed with mean, percentahes, frequencies and likert rating scale. A mean criterion of 2.5 and above indicated a positive response to the items being assessed.

Result and Discussions

Table 1 represents the socio-economic characteristics of the rice farmers

TABLE I: Socio-economic characteristics of rice farmers

Characteristics	Frequency	Percentage
Gender		
Male	94	78
Female	26	22
Total	120	100
Age		
< 30	14	12
31 – 50	82	68
50 and above	24	20
Total	120	100
Marital Status		
Married	88	74
Single	12	10
Widowed	16	13
Divorced/Separated	4	3
Total	120	100
Educational Status		
No formal education	40	33
Primary	52	43
Secondary	25	23
Tertiary	3	2
Total	120	100
Farming Experience		
1 – 5	5	4
6 – 10	22	18
11 – 15	27	23
16 – 20	56	47
21 and above	10	8
Total	120	100
Farm size (hectares)		
1 – 2	38	32
3 – 4	75	62
5 – 6	7	6
Total	120	100
Income level per annum (₦)		
6 – 300,000	84	70
300,001 – 500,000	20	17
500,001 – 700,000	10	8
> 700,000	6	5
Total	120	100
Access to Extension services		
Access	108	90
No Access	12	10
Total	120	100

Source: Field Survey, 2010

Table 1 also reveals that majority (90%) of the respondents have access to extension services, so they are informed on changes in production practices and the latest innovation including information on weather and climate change. This is in agreement with (Feddema et al, 2001) that farmers' access to extension services will enhance their knowledge capacity, linkages with other colleques and at the long run reduce their fears about production uncertainty.

Table 2 shows the farmers knowledge on climate change

TABLE 2: Rice farmers' knowledge on climate change

Items	Frequency	Mean
Climate change can result to:		
Production in climate change	120	4
Flooding	80	2.6
Yellowing of leaves	88	2.9
Poor growth and development	80	2.6
Diseased plant grain	90	2
Crop failure	100	3.3
Premature grain	98	3.2
Increase weeds	90	3
Reduction in grain size	100	3.3
Late planting	120	4
Erosion	80	2.6

Source: Field survey, 2000

Note: Multiple responses recorded

Data analysis result represented in table 2 reveals items 1-11 mean score knowledge of rice farmers to be above the criterion mean of 2.50. This indicates that the farmers agree to have good knowledge of climate change. The finding is in line with ealier studies that there is need for knowledge on climate change by farmers because rainfall, humidity sunshine (day light) are important climate elements that influence crop production. The overall predictability of these elements is imperative for the day to day medium term planning of farm operations (Sowunmi and Akintola, 2010). The findings also agree with Smit B. et al (2002) who noted that knowledge of climate change by farmers will help them to adopt to weather challenges.

Table 3 reveals the attitude or coping strategies of rice farmers to climate change in Abia State

Table 3: Farmers attitude to climate change in Abia State

Attitudes	Frequency	Mean
Planting different varieties	93	3.1
Planting at different dates	93	3.1
Planting at different sites	87	2.9
Increasing farm size	84	2.8
Engaging in other occupations	75	2.5
Increase chemical herbicides use	78	2.6
Increase fertilizer use	84	2.8

Increase water conservation	87	2.9
Prayers/rituals	66	2.2
Don't do anything	36	1.2
Insure farms	54	1.8

Source: Field survey, 2010

Multiple responses was recorded

The research finding presented in table 3 reveals items 1-8 mean score of farmers attitude to climate change to be above the set criterion mean value of 2.5. This indicates that the items are the farmers coping strategies. Ngaira (2007) observed that climate change can increase the incidence of pest and diseases that attack crops and increase weeds in the farm. So it may be the reason for the farmers' use of chemical and herbicides.

Voices (2009) also revealed that farming seasons have become unpredictable. Sometimes the rain starts late and ends early. When the rain comes, they can be so heavy that soil is washed away and crops are destroyed. So, farming attitudes of planting at different dates and different varieties is a good coping strategy to climate change.

Table 4 shows the constraints to adapting to climate change in the study area.

TABLE 4: Constraints adapting to climate change in the study area

Constraints	**Frequency**	**Mean**
Climate and weather information	90	3.0
No access to water	40	1.3
Drought resistant	50	1.6
Land tenure	98	3.2
No sufficient credit/saving	110	3.6
Lack of improved agricultural technologies	102	3.4
Unsustainable agricultural practices	95	3.1
Don't know how to adapt	30	1.0
No market access	70	2.3
Rationing of resources	80	2.6

Source: Field survey, 2010

Multiple responses was recorded

The result in table 4 reveals that no sufficient credit/saving lack of improved agricultural technologies and unstainable agricultural practices are the major constraints to adapting to climate change. The result is in agreement with (Enete et al 2011) who observed that poverty constraint, land and efficient input, information and training, land tenure and labour were the factors constraining farmers in south eastern Nigeria from climate change adaptation.

The findings are also in line with the contributions of (Ozor and Cynthia, 2010) which showed that the major constraints to adaptation in Enugu State were lack of improved agricultural technologies, low adaptive capacities and unsustainable agricultural practices in the area.

Conclusion and Recommendation

The study shows that rice farmers in Abia State have a good knowledge of climate change and are doing everything possible within their means to alleviate its effect on their production. It is therefore recommended that adequate credit and savings and improved agricultural technologies should be regularly made available to the farmers to help them cope with the adverse effect of climate change. Extension programme on how to adapt effectively to climate change should be embarked on by the relevant authorities.

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Impact of Climate Change on Food Availability in Smallholder Agriculture in rural Nigeria

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Abstract

The study assessed the impact of climate change on food availability in small holder agriculture in rural Nigeria. This paper aimed at (i) assessing the status of food availability in the country, (ii) assessing effects of climate change extremes on food availability and (iii) describing the factors militating against food availability. Methodology is by intensive literature search. Food availability is the most important component of food security because if food is not produced we cannot speak of distribution, exchange, access and utilization. Rural household engaged as subsistence and smallholder farmers are mostly vulnerable to the impact of climate change on food availability as there may be increased likelihood of crop failure, pest and disease outbreak, livestock mortality and flooding of farm lands. Some of the climate change impact that aggravated the problems of food availability include; post harvest loses due to prolonged rainfall, flooding, reduced yield due to erratic rainfall in some areas, damaged transport routes constraining efficient distribution. These problems have been compounded by inefficient technology for processing and storage thus making food availability very difficult during the off season period. Identifying these problems will help to proffer quicker solutions. The study showed that Nigeria at present does not enjoy food security, so is very vulnerable to the effects of climate change. Food security was unstable, availability was inadequate, processing time was inefficient and inflation eroded people's purchasing power. This implies that erratic food supplies will predictably respond through price rises. This might lead to increased risk of climate change-induced urban food riots occurring in the future. This, therefore, demands a sustained and huge investment of capital, time and effort in developing adaptative strategy that will promote food availability without affecting the sustainability of the natural environment.

Keyword: Climate change, agriculture, food security, food availability, smallholder farmers, Nigeria.

Introduction

Climate change has seriously affected agricultural production and therefore, food security (availability of food) (Busayo, 2011). It will act as a multiplier of existing threats to food security. By 2050, the risk of hunger is projected to increase by 10 – 20 %, and child malnutrition is anticipated to be 20 % higher compared to a no-climate change scenario (FAO, 2006). Climate change affects agriculture in a number of ways. Extreme weather events such as thunderstorms, heavy winds, and

floods devastate farmlands and can lead to crop failure. Pests and crop diseases migrate in response to climate variations and will potentially pose a threat to livestock in the drier northern areas (Enete & Taofeeq, 2010). Some of the most important impacts of global climate change will be felt among the populations predominantly in developing countries, referred to as "subsistence" or "smallholder" farmers (IPCC, 2007). Crop production in developing countries would suffer more and earlier, than in developed countries due to a combination of adverse agro-climatic, socio-economic and technological conditions (Darwin, 2005). Climate change will cause substantial reduction in the production of food crops *(availability and stability),* and will worsen the negative food balance**.** The likelihood of increase in diseases will limit the capability of the vulnerable segments of the society to work and earn a living *(Sayne, 2011)*. Their vulnerability to climate change comes both from being predominantly located in the tropics, and from various socioeconomic, demographic, and policy trends limiting their capacity to adapt to change (BNRCC*,* 2008).

Over the coming decades, climate change will affect food and water security in significant but highly uncertain ways (Wall & Smit, 2005). There are strong indications that developing countries will bear the brunt of adverse consequences. By 2080, agricultural output in developing countries may decline by 20 percent due to climate change, compared to 6 percent in industrialized nations. Also due to climate change, yields in developing countries could further decrease by 15 percent on average by 2080 (Braun, 2008). This is largely because of high poverty rates, high vulnerability levels, and low adaptation capacities in the developing world (Actionaid, 2009). Furthermore, the rural populations of developing countries for whom agricultural production is the primary source of direct and indirect employment and income will be most affected because of agriculture's direct exposure to climate change (FAO, 2007). Among developing regions of the world, Sub-Saharan Africa is expected to fare worst, given that temperatures are generally already high, and most of the region's inhabitants depend for their livelihoods on rain fed agriculture (IPCC, 2007). Only 5 percent of cultivated area in the region is irrigated, compared with 37 percent in Asia and 14 percent in Latin America. An increase in extreme weather such as drought in regions like Sub-Saharan Africa would have even greater consequences in terms of malnutrition. Even without an increase of extreme weather events, a simple increase in temperature reduces the productiveness of many crop species, also decreasing food security in these regions.

Over 900 million people experience the hardship that hunger imposes, a figure which continues to rise even amidst the riches of the 21st century (One World, 2011). Estimates suggest that in 2010, approximately 925 million individuals were undernourished (CARE, 2011). Lack of food security, referred to as food insecurity, hunger, and poverty are closely linked. Food security as defined by the World Food Summit (WFS,1996 in FAO, 2007), is when all people at all times have physical or economic access to sufficient safe and nutritious food to meet their dietary needs as well as food preferences for active and healthy life. Furthermore, FAO's vision of a world without hunger is one in which most people are able by themselves to obtain the food they need for an active and healthy life (FAO, 2007,). Food security is a constituent of three important variables namely; food availability, food access (affordability) and food utilization. The most important component of food security is food availability (Ekpenyong, 2009).

Food availability refers to sufficient quantities of appropriate, necessary types of food from domestic production, commercial imports, and other sources, that are consistently available to individuals or are in reasonable proximity to them. In this context, availability refers to the physical existence of food, from own production or in the markets. National level of food availability is a combination of domestic food production, commercial food imports, food aid, and domestic food stocks, as well as the underlying determinants of all of these factors (Busayo, 2011). Food availability is the food that is physically present because it has been produced /grown or manufactured or transported to the local areas from nearby markets (Ekpenyong, 2009). It is the food that is visible in the area. The ability of most households in rural and urban Nigeria to generate a sufficient income, which together with own production, can be used to meet food needs is however undermined as a result of high levels of poverty compounded by impacts of climate change (Sayne, 2011). Food availability comprises of production, distribution and exchange. However, among the elements associated with food availability, production is the most important (Ekpenyong, 2009). This is so because, if food is not produced, we cannot speak of distribution, exchange and all the elements associated with food access and food utilization. For farm households in rural areas, food availability means ensuring that sufficient food is available for them through their own production or purchase from markets. Stability of food implies that the food availability is not affected by any shocks or risks affecting food production at all times. According to FAO, (2010), food availability is determined by the net amount of food remaining after production stocks and imports have been summed and exports deducted. Adequacy is then accessed through comparison of availability with the estimated consumption requirement for each food item. High market prices for foods are usually a reflection of inadequate availability. This is also reflected on the daily increase of prices of common food materials in the local markets.

The impact of climate related extreme events (prolonged drought or flood) has led to gradual decline in per capita food production. Desertification and flooding have reduced the quantity of land available for food production. Furthermore, as a result of the declining crop yields and unpredictable weather patterns, some farmers may abandon farming for non-farming activities thus reducing food availability. Flood has further deteriorated rural roads leading to disruption in food distribution network. Finally heavy and prolonged rainfall towards harvest period has aggravated the problem of poor technology in processing and storage of agricultural produce thus reducing food availability during the offseason.

This paper therefore, aims at assessing the status of food availability in the country, assessing effects of climate change extremes on food availability and to describe the factors militating against food availability.

Methodology

The study scope is Nigeria. Information were sourced from intensive literature search.

Result

The status of food availability in Nigeria

Nigeria at present does not enjoy food security, so is very vulnerable to the effects of climate change (Sayne, 2011). Domestic food supply though is on the increase

but not enough to meet the national food demand (FAO, 2007). The per capita growth of production of major food items has not been sufficient to satisfy the demand of an increasing population. Nigeria is still characterized by high reliance on food imports (Mimiko, 2011). Malnutrition is widespread in the entire country and the smallholder farmers in rural areas are especially vulnerable to chronic food shortages, unbalanced nutrition, erratic food supply, poor quality foods, high food costs, and even total lack of food (Sayne, 2011). In Nigeria, the percentage of food insecure households was reported to be 18% in 1996 and over 40% in 2005 (Busayo, 2011). Despite over 74 million of arable land in Nigeria, the nation spends an average of N24.5 trillion annually on food importation. The food import bill of Nigeria in 2007-2010 was N98 trillion ($628 billion) .In 2010 alone, Nigeria spent N632 billion on importation of wheat, N356 billion on rice, N217 billion on sugar and N97 billion on fish importation .Nigeria produces 500,000 tons of rice and consumes 2.5 million tons (Mimiko, 2011).This implies that Nigeria may not be able to feed her citizens. An assessment on Nigeria food situation shows that food security was unstable, availability was inadequate, processing time was inefficient and inflation eroded people's purchasing power (Ekpenyong, 2009).

The impact of climate change on agriculture puts the Millennium Development Goal (MDG) target at an additional risk (Sayne, 2011).The majority of poor people in Nigeria depend heavily on climate sensitive natural resources for rural income, employment and livelihood, yet they have the least capacity and resources to cope with climate change impact and adapt effectively and sustainably.

Effect of Climate Change on Food Availability on Smallholder Agriculture

Smallholder farmers cultivate about 470 million farms, measuring less than two hectares and producing 80% of the world's food, hence any negative impact on their productivity will greatly affect world food availability and may result to food crisis (Actionaid, 2009). Their vulnerability is exacerbated by inadequate complementary services, such as health, education, insurance services, and lacking agricultural extension.

With the threat of climate change, food insecurity in the country is expected to worsen in the future (FAO, 2010).Wild foods are particularly important to households that struggle to produce food or secure income. However, changes in the geographical distribution of these wild foods resulting from changing rainfall and temperature have affected the availability of foods in the rural areas (FAO, 2010). As a result, negative climate change effects on agricultural productivity implies reduced food availability with direct and indirect impacts on national and household food security. Climate change will directly affect future food availability and compound the difficulties of feeding the world's rapidly growing population, (FAO, 2006). Rising temperatures will compound the situation as they alter runoff patterns, increase evaporation rates severely affecting productivity.

The majority of poor people in Nigeria depend heavily on climate sensitive natural resources for rural income, employment and livelihood, yet they have the least capacity and resources to cope with climate change impact and adapt effectively and sustainably. In the rural areas, reduced food production especially of staple food crops means reduced (or unstable) food supplies and food unavailability at the urban centers. Erratic food supplies will predictably respond through prices rises. Increased prices will make food unaffordable, especially by most urban poor. This

might lead to increased risk of climate change-induced urban food riots occurring in the future (Sayn, 2011; Moyo, 2011). Inevitably, food price increases will also lead to an alteration of food consumption patterns, either through changing dietary habits (eating fewer meals per day) or eating unbalanced diets of less nutritious foods. Such dietary adaptation strategies will have direct negative effects on human nutrition and health (Moyo, 2011). For those who can afford expenditure on food will increase in proportion to price increases with accompanying erosion of disposable income for other household necessities.

Climate change factors militating against food availability

Apart from the traditional risk and uncertainty associated with agricultural production, it is imperative to note that some climate change induced factors have further predisposed agricultural production and food availability to greater danger. Such factors include;

- **Water and wind induced Soil fertility problems** –heavy rain and wind erode the surface of the soil leaving it bare and infertile.
- **Inadequacy of rain-fed agriculture** – due to climate change, rain does no longer fall at the appropriate period. It rains very erratic and heavy rains that extend towards the harvest period increasing post harvest losses.
- **Post-production storage and processing**- Changes in rainfall pattern and intensity greatly influence grain quality, Deterioration in grain quality in storage and transport includes loss of viability and processing quality, fungal growth and mycotoxin production. If moisture content is greater than an acceptable level (12%), harvesting can be delayed and with delayed harvesting both grains quality and yield are lost with every passing day. Due to lack of adequate storage facilities and pressing needs, farmers mostly end up selling excess produce during the harvesting period, and sometimes rely on market purchases during the hungry season, thereby creating a situation of food insecurity for most rural farm producers and households.

Impact of Climate Change on Road Transport – Excessive heat and cold of the Earth's surface will make most of the poorly tarred roads to fail as a result of too much pressure by ever increasing vehicular movements on such roads. Increasing poor weather conditions e.g. heavy downpour of rainfall, strong wind system, and heavy harmattan haze may inhibit visibility for Motorists who are always on the roads, day and night. Too frequent and heavy rainfall may cause flooding and could wash away road structures and bridges. The already water-logged road will result into series of potholes of variaous sizes that may disrupt smooth vehicular movement. In areas of heavy flooding gully erosion may result. Where infrastructure is affected by climate change through either heat stress on roads or increased frequency of flood events that destroy infrastructure, it impacts on food distribution, influencing people's access to market to sell or to purchase food.

Way Forward

Faced with the potential negative impacts of climate change, agricultural planners are compelled to develop more resource efficient and more resilient food system that will help to alleviate the problem of food instability in the country. Hence the following measures are suggested;

- **Develop technology friendly approach**

If food production has to increase by 50% in the next 40 years from a shrinking land resource, this will require a sustained and huge investment of capital, time and effort. This will involve improved technology. This technology will need to produce, process, distribute and market food that is sufficient, safe and nutritious to meet the dietary needs and preferences of the populace, without affecting the sustainability of the natural environment. There should be Farmer / investor support for production, processing, storage and marketing of produce.

- **Research and Extension**

The long-neglected global research and development investment in agriculture and food must at least be doubled to accelerate development. If the goal of retaining an increasing amount of the attainable yield and quality is to be achieved, communication of research must extend beyond the farm gate to promote increased awareness among policy makers and the society at large. In the first instance, research outputs can be made more policy friendly with a 'clear take home message' through extension service.

- **Erosion control and Soil fertility management**

Soil fertility improvement can be achieved using organic matter. The problem of erosion can be addressed by developing covers for the soil, and improving soil structure through promotion of organic matter, planting of economic trees in marginal and eroded soils as well as adapting good agronomic practices.

- **Home gardening**

Small scale production can increase local food availability to reduce risk of sudden shortages.

- **Water scarcity**

Inadequacy of rainfall can be addressed by providing infrastructure and organizational support for fadama development and management.

Conclusion

Food productivity, availability, and distribution are among the major underlying determinants of the success of the food system. Climate change threatens crop productivity and the livelihood of the smallholder farmers. With high population and increased demand for food, the current food availability status seems a threat to the millennium development goal. The place of home gardening and technological advancement in processing and storing agricultural products are highly invaluable if food availability must meet up with food demand.

Achieving food security under a changing climate requires substantial increases in food production on one hand, as well as improved access to adequate and nutritious food and capacities to cope with the risks posed by climate change on the other hand. Greater collaboration among government, agricultural, food, and health research institutions to understand the effect of regional and local food availability on public health, and to foresee and develop adaptive capacities that can help reduce climate change effects on food availability at both community and national levels.

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Policy Issues in Climate Change Mitigation and Adaptation: A Review of China Experience

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Abstract

Climate change is a major global issue of common concern to the international community. It is an issue involving both environment and development. China is not environmentally friendly; leads in green investment. To address climate change and promote sustainable development, China has carried out various policies and measures, such as economic restructuring, energy efficiency improvement, development and utilization of hydropower and other renewable energy, ecological restoration and protection, as well family planning among others. Also, efforts are being made by Chinese government to build a resource conservative and environmentally friendly society, enhance national capacity to mitigate and adapt to climate change, reduce carbon dioxide intensity by 40-45% by 2020, and make further contribution to the protection of the global climate system. The paper relies heavily on literature and participant observation. It highlights the various policies and programmes initiated in China to combat the effect/ impact of climate change.

Keywords: Policy issues, climate change, mitigation, adaptation, China experience

Introduction

The impacts of climate change are already being experienced across the globe. The Intergovernmental Panel on Climate Change (IPCC), (2001) concludes that human activity (primarily related to fossil fuel consumption) is largely responsible. While climate change will affect everyone, it is expected to have a disproportionate effect on those living in poverty in developing countries. Climate change poses a serious threat to development and poverty reduction in the poorest and most vulnerable regions of the world. According to Parliamentary Office of Science and Technology (POST, 2006) the scale of action needed to tackle climate change is unprecedented and involves two concurrent approaches: Mitigation and Adaptation. While mitigation is action that tackles the causes of climate change, such as reducing greenhouse gas emissions, adaptation is action that minimizes the consequences of actual and expected changes in the climate. These processes are inherently linked. The degree to which society needs to adapt depends on the extent of climate change, which depends on greenhouse gas emissions. The Kyoto Protocol (1997) to the United Nations Framework Commission on Climate Change (UNFCCC) requires ratifying industrialized countries to limit their greenhouse gas emissions by agreed amounts below their 1990 levels over the period 2008-2012. The UK government has agreed on a 12.5% reduction by 2012.

Climate change according to Agne (2008) is one of the biggest challenges of our times and therefore, high on the policy agenda in Europe, China and many other countries. Earlier this year, the European Union (EU) decided to unilaterally decrease greenhouse gas emissions by 20% as compared to 1990. The challenge for both China and the EU is to speed up the transition of their economies into “low carbon economies”. At the same time we must increase the capacity of our societies to adapt to climate change impacts that cannot be avoided. These substantial efforts support the policies and initiatives taken by the Chinese Government such as the target to decrease energy use per unit of GDP by 20% between 2006 and 2010.

Climate change however, is an issue involving both environment and development, but it is ultimately an issue of development. As a developing country of responsibility, China attaches great importance to the issue of climate change. The National Coordination Committee on Climate Change was established, and series of policies and measures to address climate change have been taken in the overall context of national sustainable development strategy, making positive contributions to the mitigation of and adaptation to climate change. Many observations in recent 100 years according to China.org.cn (2007), show that the earth's climate is now experiencing significant change characterized by global warming. And the trend of climate change in China is generally consistent with that of global climate change. To address climate change and promote sustainable development, China has carried out various policies and measures which have contributed significantly to the mitigation of climate change. The specific objectives of the paper were to: i) describe the observational trend of climate change in china; ii) examine China's basic national circumstances of climate change; iii) highlight the various policies and programmes initiated in China to combat the effect/ impact of climate change; and iv) identify China's efforts and achievements in mitigating climate change. The paper relies heavily on literature and participant observation.

Observations and Trend of Climate Change in China

The Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2001) has clearly indicated that most of the global warming observed over the past 50 years was likely induced by the increase in concentrations of greenhouse gases (GHGs), such as carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), due to human activities. In the context of global warming, climate in China has experienced noticeable changes over the past 100 years as well.

The major observed evidence of climate change in China according to China.org.cn (2007) includes the following: i) Temperature. Annual average air temperature has increased by 0.5~0.8^{O}C during the past 100 years, which was slightly larger than the average global temperature rise. The seasonal distribution of the temperature changes shows that the most significant temperature increase occurred in winter, and 20 consecutive warm winters were observed nationwide from 1986 to 2005; ii) Precipitation. In the past 100 years, there was no obvious trend of change in annual precipitation in China, but there exists considerable variation among regions. The annual precipitation decreased gradually since 1950s with an average rate of 2.9 mm/10a, although it increased slightly during the period of 1991 ~ 2000; iii) Extreme climate/weather events. The frequency and intensity of extreme climate/weather events throughout China have experienced obvious changes during the last 50 years. Drought in northern and northeastern China, and flood in the middle and lower reaches of the Yangtze River and southeastern China have become more severe. The annual precipitation in most years since 1990 has been larger than normal, with the precipitation pattern being a dipole, corresponding to frequent disasters in the

North and flood in the South; iv) Sea level. The rate of sea level rise along China's coasts during the past 50 years was 2.5 mm/a, slightly higher than the global average; v) Glaciers. The mountain glaciers in China have retreated, and the trend is accelerating.

China's Basic National Circumstances of Climate Change

1. *Inferior climatic conditions and severe natural disasters*. China has relatively harsh climatic conditions. Most of China has a continental monsoon climate with more drastic seasonal temperature variations compared with other areas at the same latitude such as North America and West Europe. In most part of China, it is cold in winter and hot in summer with extremely high temperature. Therefore, more energy is necessary to maintain a relatively comfortable room temperature. Precipitation in China is unevenly distributed both seasonally and spatially. China frequently suffers from meteorological disasters, which are unusual worldwide in terms of the scope of affected areas, the number of different disasters, the gravity of disaster and the mass of affected population.

2. *Vulnerable ecosystem.* China is a country with a vulnerable ecosystem. The national forest area for 2005 is 175 million hectares and the coverage rate is just 18.21 percent. China's grassland area for the same year is 400 million hectares, most of which are high-cold prairie and desert steppe while the temperate grasslands in Northern China are on the verge of degradation and desertification because of drought and environmental deterioration. China's total area of desertification for 2005 is 2.63 million square kilometers, accounting for 27.4 percent of the country's territory. China has a continental coastline extending over 18,000 kilometers and an adjacent sea area of 4.73 million square kilometers, as well as more than 6,500 islands over 500 square meters. As such, China is vulnerable to the impacts of sea level rise.

3. *Coal-dominated energy mix.* China's primary energy mix is dominated by coal. In 2005, the primary energy production in China was 2,061 Mtce, of which raw coal accounted for as high as 76.4 percent. For the same year, China's total primary energy consumption was 2,233 Mtce, among which, the share of coal was 68.9 percent, oil 21.0 percent, and natural gas, hydropower, nuclear power, wind power and solar energy 10.1 percent; while the shares of coal, oil, and natural gas, hydropower and nuclear power in the world primary energy consumption were 27.8 percent, 36.4 percent and 35.8 percent, respectively. Because of the coal-dominated energy mix, CO_2 emission intensity of China's energy consumption is relatively high.

4. *Huge population.* China has the largest population in the world. In 2005, the population of China's mainland was 1.31 billion (not including Hong Kong, Macao and Taiwan), accounting for 20.4 percent of the world total. By the end of 2008, China’s population totals 1.328 billion, accounting for one fifth of the world population. It is also a country with the highest population density, averagely 137 persons per square kilometer (Ministry of Commerce of the People Republic of China, 2011). China is still at a low level of urbanization, with a huge rural population of about 750 million, and in 2005, urban population accounted for only 43 percent of the national total population, lower than the world average. Due to the huge population, China's per capita energy consumption is still at a low level. In 2005, China's per capita commercial energy consumption was about 1.7 tce, only 2/3 of the world average, let alone the average level of the developed countries.

5. *Relatively low level of economic development.* China is currently at a relatively low level of economic development. In 2005, the per capita Gross Domestic Product (GDP) of China was about US$1,714 (based on exchange rate of the same year, the same below), only about 1/4 of the world average level. Poverty eradication is still a huge challenge for China. By the end of 2005, the poverty-stricken people in China's rural areas numbered 23.65 million, with the per capita annual pure income less than 683 Yuan (about N17, 075 equivalents).

China's Policies and Measures to Address Climate Change

In accordance with the requirement of carrying out the Scientific Approach of Development according to china.org.cn June 2007, China will combine its efforts to address climate change with the implementation of sustainable development strategy, the acceleration of building-up a resource-conserving and environmentally-friendly society, and an innovative country, which will be integrated into the overall national economic and social development plan and regional plan; and it will mitigate greenhouse gas emissions and in the meantime improve its capacity to adapt to climate change.

Key Areas for Green House Gas (GHG) Mitigation involve the following:

1. Energy production and transformation - These include (i) Formulate and implement relevant laws and regulations such as vigorously strengthen energy legislation to establish and improve energy legal system, promote the implementation of China's national energy development strategy, establish the legal status of medium and long term energy program, promote the optimization of energy mix, mitigate GHG emissions from energy production and transformation. (ii) Strengthen institutional innovation and mechanism construction. -- Accelerate China's institutional reform in energy sector. -- Further promote mechanism construction for renewable energy development. (iii) Intensify relevant policies and measures in energy industry. -- Properly develop hydropower on the precondition of protecting the ecosystem. Hydropower development should be regarded as an important countermeasure to promote a cleaner and less carbon intensive energy mix in China. It is expected that the GHG emissions can be reduced by about 500 Mt CO_2 by 2010 and (iv) Strengthen the development and dissemination of advanced and suitable technologies.

2. Industrial processes -- To develop circular economy vigorously and follow the pattern of new industrialization. According to the principle of “reduction, reuse and recycle of waste” and the requirement of new industrialization, China will take various effective actions and measures to further promote the development of clean production and circular economy in industrial sector, to accelerate the building-up of a resource-conserving and environmentally-friendly society. In order to reduce greenhouse gas emissions from the production and use of industrial products, China will work hard to save the use of cement, lime, iron and steel, calcium carbide and other raw materials to the uttermost while satisfying the necessary demand of these industrial products for the legitimate social and economic development.

3. Agriculture. -- Gradually establishing and improving the system of laws and regulations based on Laws of Agriculture, Grassland and Land Management of the People's Republic of China, together with administrative rules and regulations, that can lead to improved agricultural production and increased agricultural ecosystem carbon storage; developing farmland and pasture protection construction plans, strictly controlling land reclamation in areas with fragile ecosystems, and forbidding any destruction of pasture or waste of land. -- Intensify the construction of ecological agriculture in highly-intensive production areas. Implementing projects on prevention and control of agriculture non-point source pollution, extending technologies concerning reasonable use of chemical fertilizers and pesticides to improve the farmland quality; implementing a new round of fertile soil programme, scientifically applying chemical fertilizers and guiding the increased use of organic fertilizer to promote soil fertility and reduce emission of nitrous oxide from the croplands.-- Further enhance technology development and transfer. Selecting and breeding rice varieties with high yields and low GHG emission rates, promoting semi-dry rice cultivation technology, scientific irrigation, research and development of microorganism technology, reducing methane emission from rice paddies; research and development of technologies to breed fine ruminant varieties, improving management practices for intensive livestock operations, and reducing methane emission from livestock; further promoting straw treatment technology, and enhancing/refining the technologies for household-type biogas digesters; developing and transfer of key technologies to produce environmentally sound fertilizers and to reduce nitrous oxide emissions from croplands; vigorously promote

the return of straws to croplands and non-tillage technologies to increase carbon sink in croplands (Wang, Huang, and Scott, 2010).

4. Forestry. -- Improve formulation and implementation of laws and regulations: to accelerate the formulation, amendment, and streamline of forestry related laws and regulations, including development of regulations on conservation of natural forests, regulations on transfer rights of forests, forest products, and forest land use, etc.; and to enhance the implementation of laws and regulations, by means of improving the system, strengthening inspection, and expanding social supervision of law enforcement. -- Reform and optimize current industrial policies: to optimize target-oriented management responsibility system for afforestation by governments at all levels and forestry sectors, to probe ways of national voluntary tree-planting under market economy, and to establish related policies to promote voluntary planting and governmental afforestation, so as to increase forest resources and carbon sequestration.

China's Efforts and Achievements in Mitigating Climate Change

As a developing country of responsibility, China according to China.org.cn (2007) is among the first to formulate a national Agenda 21 entitled “China's Agenda 21” - White Paper on China's Population, Environment and Development in the 21st Century. And soon after the United Nations Conference on Environment and Development in 1992, China adopted a series of policies and measures taking into account its specific national circumstances, making positive contribution to the mitigation of climate change as discussed below.

1. ***Restructuring the economy, promoting technology advancement and improving energy efficiency***

Beginning from the late 1980s, the Government of China paid more and more attention to the change of the economic growth pattern and the restructuring of economy, and integrated the reduction of energy and other resources consumption, the promotion of clean production, and the prevention and control of industrial pollution into its national industrial policies. The industrial structure has been significantly improved through the implementation of a series of industrial policies to accelerate the development of the tertiary industry and restructure the secondary industry. During the period of 1991 ~ 2005, China has achieved an annual GDP growth rate of 10.2 percent with an annual growth rate of 5.6 percent in energy consumption, i.e. about 0.55 of the elasticity of energy consumption. As calculated on the year by year comparison, during the period of 1991 ~ 2005, an accumulated 800 million tons of coal equivalent (tce) of energy were saved by economy restructuring and energy efficiency improvement, which is equivalent to a reduction of 1.8 billion tons of CO_2 emissions, using China's 1994 emission factor of 2.277 tCO_2/tce.

2. ***Optimizing energy mix by developing low-carbon and renewable energy***

Under national policy guidance and with financial support, the share of high grade and clean energy was improved by strengthening the development and utilization of hydropower, nuclear energy, oil, gas and coal-bed methane, and supporting the development and utilization of new and renewable energy including biomass, solar, geothermal and wind power in rural areas, remote areas and other suitable areas. In 2005, the utilization of renewable energy in China equaled to 166 million tce (including large hydropower), accounting for 7.5 percent of China's total energy consumption in that year, equivalent to a saving of 380 million ton CO_2 emissions.

3. ***Launching national wide tree-planting and afforestation campaign and enhancing ecology restoration and protection***

Since the reform and opening up to the outside world, tremendous achievement has been made in tree-planting and afforestation along with the implementation of key forest ecological projects. According to the Sixth National Forest Survey, the acreage of conserved artificial forests in China was 54 million hectares, ranking the top one in the

world, and the amount of growing stock was 1505 million cubic meters. Total area of forest cover in China was 174.91 million hectares, and the percentage of forest coverage increased from 13.92 percent to 18.21 percent during the period from early 1990s to 2005. In addition, China initiated many other policies for ecology restoration and protection, including natural forest protection, reclaiming cultivated land to forest or grassland, pasture restoration and protection, further enhancing the capacity of forest as the sinks of greenhouse gas. Meanwhile, urban green area grew rapidly in China as well. The green area helps absorbing CO_2 in the atmosphere. Estimated by relevant experts, from 1980 to 2005, a total of 3.06 billion ton CO_2 absorption was achieved by afforestation, a total of 1.62 million ton CO_2 absorption by forest management, and 430 million tons of CO_2 from deforestation were saved.

4. ***Effectively controlling the growth rate of population through family planning***

The Government of China has made it a basic national policy to carry out family planning all along and the excessive population growth trend has been brought under effective control. According to the statistics of the United Nations, China's fertility rate was lower than that of other developing countries and the world average as well. In 2005, birth rate in China was 1.240 percent, and the natural growth rate was 0.589 percent, dropped by 8.66 and 8.50 per millage points respectively compared to the level of 1990, making China one of the countries with a low fertility rate in the world. Since the implementation of the family planning program, over 300 million births have been averted nationally by 2005. According to the average per capita emissions from the IEA statistics, the averted births have resulted in an annual reduction of CO_2 emissions by about 1.3 billion tons in 2005. It is a significant contribution that China achieved in the fields of controlling world population and mitigating GHG emissions.

5. ***Strengthening laws and regulations, and policies and measures relevant to addressing climate change***

To address newly-emerging issues in recent years, the Government of China has advocated for the Scientific Approach of Development and Strategic Thoughts of Building a Harmonious Society, and accelerated the building of a resource-conserving and environmentally friendly society, thus further reinforcing the policies and measures relevant to addressing climate change. In December 2005, the State Council issued the Decision to Publish and Implement the Interim Provisions on Promoting Industrial Restructuring and the Decision to Strengthen Environmental Protection by Applying the Scientific Approach of Development. In August 2006, the State Council issued the Decision to Strengthen Energy Conservation. All those documents serve as the policy and legal guarantee to further enhance China's capability in addressing climate change.

6. ***Further improving institutions and mechanisms***

China established the National Coordination Committee on Climate Change (NCCCC), which presently comprises 17 ministries and agencies The NCCCC has done lots of work in the formulation and coordination of China's important climate change-related policies and measures, providing guidance for central and local governments' response to climate change. In recent years, the Government of China has strengthened its comprehensive management of energy that is closely related to addressing climate change by establishing a National Energy Leading Group and its office, which has further strengthened its work on energy management. In October 2005, the amended Measures for Operation and Management of Clean Development Mechanism Projects were promulgated by the relevant departments of the Government.

7. ***Attaching great importance to climate change research and capacity building***

The Government of China highly values its capability and capacity to support scientific studies and researches on climate change, and constantly enhances them. It has implemented a number of key research projects, such as Study on Forecasting, Impact and Countermeasures of Global Climate Change, Study on Global Climate Change and Environmental Policies, etc. Under the National Climbing Program and the National Key Fundamental Research Program, projects such as Study on Formation and Prediction Theory of Key Climate and Weather Disasters in China, and Study on Carbon Cycle in China's Terrestrial Ecosystems and Its Driving Mechanism were conducted. Under the Innovative Research Program, Carbon Balance Study in China's Land and Offshore Area has been accomplished. Other key projects related to climate change were also conducted.

8. ***Strengthening education, training and public awareness on climate change***

The Government of China always attaches importance to education, training and public awareness on climate change. The Program of Action for Sustainable Development in China in the Early 21st Century states that China will vigorously develop all forms of education at all levels, to enhance the public awareness on sustainable development and enhance their scientific and cultural capacity for their participation in the sustainable development by reinforcing personnel training. In recent years, China has intensified its efforts to promote education, training and public awareness on climate change by organizing various kinds of lectures on climate change basic knowledge, conducting climate change training courses for policy makers at central and provincial levels, and organizing conferences such as Climate Change and Ecological Environment, as well as setting up an official bilingual website on climate change (China Climate Change Info-Net http://www.ccchina.gov.cn) in Chinese and English to provide comprehensive information on climate change and commendable results have been achieved accordingly.

Conclusion and Recommendations

Studying climate change adaptation and mitigation in developing countries involves a number of complex methodological aspects since the climate issues are deeply rooted in core economic development issues. Developing countries experience a number of limitations in managing investments, technological change, natural resources, institutional issues, equity and other human well being dimensions. Inefficiencies or constraints in any of these areas will enhance the vulnerability to climate change impacts, and at the same time will tend to generate energy systems and consumption patterns that are costly and GHG emission intensive.

As a developing country of responsibility, China adopted a series of policies and measures taking into account its specific national circumstances, making positive contribution to the mitigation of climate change. It also made efforts to realize the objectives and tasks presented in adopting a series of institutional, legal, economic and technological instruments in order to strengthen energy conservation, optimize energy mix, improve ecological environment, enhance adaptation capacity, intensify research and development and improve research capacity, raise public awareness and improve mechanisms for climate change administration. It is recommended that Nigeria as a developing country should imitate the policies, principles and strategies adopted by China in adaptation and mitigation of climate change. There should be full commitment in the implementation of already initiated climate change policies and programmes in Nigeria. There is therefore scope for exploring linkages

between development and climate change policies. Given the current inefficiencies in technology and resource utilisation in developing countries and the inherit institutional weaknesses, one of the major conditions for climate change adaptation and mitigation policies will be to understand how policy implementation can be integrated with local development efforts and partnerships.

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Climate Change and Food Security: Implications for Effective Agricultural Extension Services in Nigeria

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Abstract

The paper examines the causes of climate change and its attendant negative effects on food security in Nigeria. It posits that the evolvement and application of effective agricultural extension service that is properly organized, well funded, focused on the right target audience, that is, the real farmers and based on appropriate technology, can serve as a veritable tool for redressing some of the inherent problems of food security in Nigeria. The paper makes recommendations on how to improve agricultural extension services in Nigeria and how to use agricultural extension to mitigate the attendant effects of climate change on food security.

Introduction

In recent time, the twin issues of climate change and food security have assumed a centre stage in global discourse. Climate change is affecting many facets of development all over the world ranging from agriculture to industries.

Today, more countries of the world, including Nigeria, are witnessing increasing frequency and intensity of unusual weather fluctuations. The world is witnessing unprecedented disasters caused by heavy rainfall, wind storms, excessive flooding, desertification and land slides etc.

The world conference in Rio de Janeiro in 1992 marked a historical landmark and global awareness on the threat posed by environmental degradation. Since then, several sessions of the United Nations Conference of Parties to the Convention on Climate Change have been held in Berlin, Kyoto, Buenos Aires and The Hague and recently in Bonn, Germany to deliberate on what to do to reverse the environmental situation of the world. (Osuntokun, 2002:2).

Of great concern, perhaps, are the attendant consequences of climate change on agricultural production and food security in particular, especially in developing countries like Nigeria. Admittedly, the changing weather patterns or extreme weather events such as floods or droughts can have negative consequences on agricultural production. For instance, since 80% of Nigerians are engaged in agriculture and agriculture is rain-fed, the tendency is that Nigeria's food production system would be adversely affected by the variability in timing and amount of rainfall. Similarly, more than two-thirds of Nigeria is prone to desertification, especially in the north. The fear is that climate change would worsen the menace of drought and desertification with grave consequences for agricultural production and food security.

Referring to the effect of climate change on Ghana's food security, Kunateh (2011) explains that food security is under the threat from unpredictable changes in rainfall and more frequent extreme weather. He explains that an increased body of evidence shows that climatic variability is adversely affecting Ghana's natural resources (such as land, water, forests and vegetation as well as human capital) and is expected to have significant impact on the key resource-dependent sectors, such as agriculture and food production.

The threat posed by climate change on the sustenance of life generally and food security in particular poses a great challenge to agricultural extension service in Nigeria. It calls for extension's renewed efforts towards creating awareness and educating people especially the farmers on climate change and its effect on society generally and food security in particular. It also calls for effective dissemination of information by extension on the control measures put in place on climate change as well as the strategies and methods designed to promote food security. Of course the need to double food production in the face of adverse effects of climate change cannot be over emphasized.

Objectives

Specifically, the study sets to explore the attendant effects of climate change on agricultural production and food security especially in Nigeria, to identify the factors contributing to climate change, to examine the critical role of agricultural extension services in mitigating the effects of climate change on agricultural production and food security, to identify the problems of agricultural extension and to proffer solutions to the problems.

Methodology

The study is based on information sought from both primary and secondary sources. Empirical and observational evidence is mainly derived from various literature and personal interaction with agricultural extension workers in Abia State, Nigeria.

The Concept of Climate Change

Climate change is the permanent departure of climate patterns from mean value of observed climate indices (Obioh, in Aju, 2008: 129). Nwachukwu and Nnadozie (2008:35) refer to climate change as a change in the statistical distribution of weather over periods of time that range from decades to millions of years, a change in the average weather or change in the distribution of weather events around an average. The main elements of weather include wind, temperature, rainfall, dew, humidity, storm, sunshine, haze etc. Climate change manifests itself when there are rising temperatures, irregular humidity and rainfall patterns, flooding, erosion of coastal plains, rising sea levels, drought, desertification, threat to natural water resources and increase in inland erosion (Aluko, Oyeleye, Sulaimon and Ukpe 2008:36).

Generally, climate change refers to a deviation from the normal climatic conditions of an area over time, whether due to natural variability or as a result of man that results in degradation of the environment.

Factors Contributing to Climate Change

Climate change in different parts of the globe is caused by a host of interacting natural and man-made factors including the emission of carbon dioxide ($C0_2$) and other green house gases to the atmosphere, deforestation, desertification, land clearing, industrialization, pollution, agriculture and other human activities. It is believed that these factors/forces have the potential to warm the planet at a rate that has never been experienced in human history. According to the Washington-based Environmental Protection Agency, humans spend six billion tonnes of carbon dioxide and other green house gases into the atmosphere each year (Awake Magazine, 1998: 4-5).

The Concept of Food Security

The term, food security, has been defined in different ways by various authors and discussants. Food security may be referred to as the ability of a country, region or household to ensure that her population or members have a timely access to reliable and nutritionally adequate supply of food. The 1996 World Food Summit, perhaps, adopted a more comprehensive approach to the definition of food security when it explained that food security at the individual, household, national, regional and global levels is achieved when all people at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. Essentially, food security implies that all people at all times should have both physical and economic access to the basic food they need. It implies the right to nutritionally balanced food for healthy and active life. Abbey (2011:17) had explained that the concept of sustainable food security arose from a need to tackle the horrifying problem in the world where each day our world witnesses 800 million people going hungry and 170 million children under 5 years of age suffer from malnourishment.

Between November 16 and 18, 2009, a World Summit on Food Security was convened by Food and Agricultural Organization (F.A.O) in Rome and attended by heads of states and governments at the F.A.O headquarters. The Rome declaration called on all members of the United Nations to half the number of chronically undernourished people on earth by the year 2015. Recently in April 2010, the World Bank launched the Global Food Security Programme which has among other initiatives, Global Food Crisis Response Programme developed to give grants to 40 nations for seeds etc for improving agricultural productivity and increasing its yearly spending for agriculture to $6-$8 billion from earlier $4 billion (Abbey, 2011: 22).

Some of the causes of global food crisis can be identified as follows:

- General increased demand for food across the globe;
- Unprecedented increases in demand for animal proteins.
- Increase of grain and oilseed crops diverted for biofuel production.
- Downward trend of global food reserves.
- Export bans and government controls.
- Many years of under - investment in agricultural productivity, particularly in developing countries.
- Unusual climate change (Ekwe and Ezulike (2011:56-58).

Added to the above stated factors is the serious gap between the rate of growth of population and the rate of growth of food production especially in the developing world and sub-Saharan Africa in particular. Iwe (2008:6) had stated that Nigeria's population is expected to increase from 88.517 million in 1991 to about 219.165million by the year 2025, representing an increase of 248% over 32 years. The implication is that Nigeria's current state of food security would worsen, if no serious and urgent measures are taken to boost sustainable food production in the country. It must also be stated that Nigeria's oil boom of the mid 70^{s} which led to the neglect of the agricultural sector also contributed to low agricultural production and food insecurity in the country.

Effects of Climate Change on Agricultural Production and Food Security

As noted earlier, climate change has become a new global reality that brings with it variations in weather patterns which have far-reaching consequences on the social, economic and environmental life of the people. It is reported that the dangers posed by climate change are nearly as dire as those posed by nuclear weapons (Bulletin of the Atomic Scientists in Awake Magazine, 2008:3). This horrifying situation is supported by earlier observations by Munslow et al (1988:190) that 3.7 million hectres of woodland disappear annually in Africa and more than a quarter of the continent was already undergoing desertification ranging from moderate to severe.

Generally, food security is vulnerable to extreme weather and dependent on rainfall patterns (Aluko *et al,* 2008:37). Climate change affects agriculture and food supply in various ways. Such extreme weather conditions as flood, thunder storm, heavy wind and drought can lead to crop failure, poor harvest and consequently food insecurity. Climate change tends to worsen the persistent low agricultural production in developing countries where most of the farmers are poorly educated, resistant to change and produce at subsistence level.

Over the years, the relatively stable weather patterns in Nigeria have become most erratic and unpredictable due to climate change. Ordinarily, rainy season starts in March and ends in September, while dry season starts in October and ends in February. Today, however, the northern parts of Nigeria are witnessing water stress, drought and desertification, while the southern parts of Nigeria are witnessing increasing rise in sea level and increased flooding. The consequences of these unpredictable patterns in climate include irregular planting of crops and smothering of crops that were planted following false signals of early rain. Others include the destruction of crops and livestock like cattle, sheep and goats, due to long drought and inadequate pasture. The fishes and other aquatic animals are also not speared of the negative effects of climate change. Cury and Shanon (2004) have explained that in coastal regions that have major lagoons or lake systems, changes in fresh water flows and greater intrusion of salt water into lagoons as a result of climate change, affects inland fisheries and aquatic culture. Similarly, Kesit and Ndeayo (2010:160) have also explained that global warming affects aquatic ecosystems, and aquaculture are also threatened by the secondary effects of warming.

The implications of the negative effects of climate change on aquaculture is that fishes and other sea foods may be threatened, leading to the short supply of these sea foods and food insecurity. Children are most vulnerable to the effects of climate

change on aquaculture as they may suffer from malnutrition due to inadequate consumption of fishers and other sea foods.

Agricultural Extension Services and the Challenges of Climate Change and Food Security

Admittedly, agricultural extension has a critical role to play in mitigating the effects of climate change on agricultural production and food security in particular. The much desired food security in Nigeria cannot be achieved without the transformation of the agricultural sector. In this regard, much can also not be achieved by the agricultural sector in terms of increased food supply without effective transfer of new technologies to the resource poor rural farmers who control most of the cultivated land. Nwachukwu and Nwosu (2005:270) have explained that if food production is to keep pace with rising population, more effective farming techniques or practices must be introduced by persuading resource-poor farmers to become more innovative.

Creating awareness among the farmers on climate change and its effects on food security will put the farmers in a better position to understand and appreciate the relationship between environmental changes in their communities and food production, and to be partners in finding solutions to the problems. Essentially, the role of extension will be to provide assistance to rural poor farmers in form of long-run information on adaptive technology. Such assistance would include information about suitable crops and livestock alternatives to help farmers increase production. Okezie and Simonyan (2011:169) further identified other forms of assistance to include:

- The provision of technical information, advice or guide.
- The provision of weather and seasonal forecasts and warnings; information on the best practices and innovations currently being developed globally by numerous research efforts on how to boost the adaptive capacity and resilience of their clientele.

Agricultural Extension: A Conceptual Overview

Generally, agricultural extension has played the traditional role of linking farmers to the researchers and other actors in the innovation system. Agricultural extension can be referred to as an educational system that provides farmers with technical advice required to increase their agricultural production and incomes including advice on credit, other inputs and markets (Ogunbameru, 2005:197).

The objective of agricultural extension is to improve the farming methods and techniques of the rural clients as well as their income, social status and overall standard of living, helping them to make their own decisions from a range of options of innovations. In this regard, agricultural extension must take into cognizance that farmers have a store house of indigenous knowledge which has helped them to cope with challenges of production over the years (Agbarevo and Obinne, 2010:50) and seek ways of improving such indigenous practices.

Problems of Agricultural Extension

For agricultural extension to effectively play a role and contribute meaningfully to the challenges of climate change and food security in Nigeria, it must address certain fundamental problems that serve as serious constraints to the function. Nwosu (2008:212) identified some of the problems to include the following:

- Inadequacy of funding
- Ineffective motivation of agricultural research and extension personnel.
- Lack of professionalism among practitioners in agricultural extension.
- The poverty status of rural farmers and their inability to effectively utilize new agricultural technologies.
- Unfavourable marketing and pricing policies for various agricultural products, which in turn discourage farmers from embarking on large-scale farming.
- Ineffective implementation of the Research-Extension-Farmer-Input-Linkage System (R.E.F.I.L.S)
- Irregular provision of farm inputs; resources that are meant to compliment the agricultural extension services.
- The conservative attitude of rural farmers arising from their traditions and customs, which makes them resistant to technological innovations.
- Ineffective response to global changing trends in agricultural extension.

Other problems which had tended to render agricultural extension services in Nigeria ineffective include the following:

- Marginalization of women in agricultural extension services.
- Poor programme implementation in terms of ineffective monitoring and evaluation.
- Neglect of the marketing component of agricultural extension.
- Poor logistics support for extension field staff.
- Poor quality of agricultural extension workers in terms of education, knowledge and technical competence.
- Inability of the government in developing nations to recognize agricultural extension as a priority area in their development agenda.

Improving Agricultural Extension Services in Nigeria

Since agricultural extension is the hub of agricultural programme, it follows that any improvement in agricultural extension will go a long way towards assisting extension practitioners in providing effective and efficient technical services and advice to farmers. In this regard, the following suggestions are made towards improving agricultural extension services in Nigeria:

- To provide adequate funds for agricultural extension programmes and operations.

- To engage more women in agricultural extension services, to enable them serve the technological requirements of the farm women

- To encourage participation of private firms in the provision of agricultural extension services in Nigeria, promote competition and professionalism in agricultural extension.

- To ensure effective linkage/collaboration among the various components that are involved in the generation and transfer of technologies.

- To emphasize the recruitment of qualified personnel with appropriate education, requisite knowledge and skills for effective service delivery in extension.

- To properly motivate extension workers with appropriate incentives and logistics support.

Agricultural Extension Services and the Challenges of Climate Change and Food Security

It must be stated that agricultural extension has a critical role to play in assisting the farmers to effectively respond and adapt to the challenges of climate change and food security. It is the duty of extension to ascertain what the farmers know about climate change, their needs and problems, in order to offer assistance on adaptation practices that meet these needs. In other words, extension should engage in massive campaign on the reality of climate change and its consequences on food security. Extension should assist farmers to adapt to the impact of climate change by the efficient use of climate data forecasts through early warning systems. Information on how to encourage farmers to adapt to climate change can be shared among the extension agents during their Fort Nightly Meetings (FNT^S) and Block Meetings (BM^S).

Extension should teach farmers to engage in paradigm shift of activities as a way of responding to the negative effects of climate change. According to the National Root Crops Research Institute (NRCRI, 2008), these activities include shifting of interests and resources towards the short duration crops, commencement of cropping activities much earlier than before, increased use of Fadama areas and exploring possibilities of growing crops during all seasons. Another challenge to extension in response to climate change would be that of introducing to farmers heat and drought resistant crop varieties that may be better adapted to climatic and atmospheric conditions.

Extension should also teach farmers on how to use simple technology or locally available technology to process and store products as a means of minimizing post-harvest losses, improving farmers' productivity and boosting food security. Similarly, extension should teach farmers on the processing of their farm products into value-added products, as a means of enhancing the life-span of these products and maximizing profits from them. For example, cassava, soya bean and plantain can be processed into high quality cassava flour, soya bean flour and plantain flour, respectively.

The extension agents should assist resource poor farmers to procure necessary farm inputs such as fertilizer, herbiades, insecticides, tractors and loan at the right time and at subsidized rate. Agricultural extension also faces the challenge of organizing the large number of small- scale farmers into cooperatives, to enable them enjoy the benefits of economy of scale for increased agricultural production and food security.

Furthermore, for sustainable food security, extension service training should target young crop of entrepreneurs in agri-business to replace the current aging farming population. Importantly, too, agricultural extension should liaise with government at various levels to ensure that a more sizable portion of Nigeria's land area of 98.3million hectares is cultivated, with more farmers introduced to modern farming systems. This will increase agricultural production and reduce poverty as well as boost food security in the country. The current situations in which less than half of

Nigeria's cultivable land area of 74 million hectares is being explored and 100 million Nigerians are poor out of 140 million Nigerians are not the best.

Another area of challenge for extension is that of teaching farmers to desist from those habits and practices that may contribute to climate change such as indiscriminate felling of trees for agricultural purposes, over-grazing of pastures, over cultivation of land, pollution, bush burning etc. Importantly, too, extension should collaborate with other stakeholders in the agricultural sector including agro-climatologists, rural sociologists, research institutes, and inputs providers towards mitigating the effects of climate change on food security.

Conclusion

The foregoing discourse has examined the twin issues of climate change and food security which are currently on the front burner of global discourse. The grave consequences of climate change on agricultural production and food security in particular have been examined. The paper has further discussed the critical role of agricultural extension in the dissemination of new adaptive technologies to farmers for enhanced agricultural production and effective adaptation to the effects of climate change. It is the view of this paper therefore that, granted the appropriate incentives and support to assume a more professional status, agricultural extension can serve as an effective tool for mitigating the adverse effects of climate change on agricultural production and guaranteeing food security in Nigeria.

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Impact of Climate Change on Food Security in Nigeria

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Abstract

Global warming or climate change is a consequence of emission of immense greenhouse gases. Since the mid-20th century, the earth's surface has witnessed an increase in average temperature which is blamed on the emission of greenhouse gases such as carbon particles which deplete the ozone layer, the earth's protective cover. The carbon emissions are worsened by the unchecked depletion of forests and felling of trees, which should have absorbed the carbon particles in the atmosphere. Apart from trees dying from plant disease toxin, the forests have been victims of all sorts of abuse, and the consequence of arable land degradation. This affects seriously agricultural production and food security. This review paper therefore looks into the issue of climate change and its impact on food security in Nigeria. Means of averting threats of disaster, food insecurity and health problems, deforestation and desertification as they affect food production and in turn food security were highlighted. It also presents the expectations from the extension delivery system and finally recommends the need to move from words to action to stall increasing threat to humanity.

Key words: Climate change, impact, food security, deforestation Desertification, extension

Introduction

Nigeria has about 65% of its population in the rural areas, where agriculture and agro-based occupations dominate the people's livelihood. Conscious attempts at developing the rural areas, and improve the livelihood of its inhabitants will have to be agriculture-oriented (Nwachukwu and Nnadozie, 2011). Reports have shown that agricultural production and productivity remain below thresholds in the country, leading to food and fibre insufficiency and nutrition-related negativities. This scenario is despite intensified efforts both on the part of government at all levels and the private sector, at strengthening the development process at the rural level. However, an emerging constraint which further darkens this scenario is the negative effects of climate change in agricultural production and by extension, affecting food security.

Food security is vulnerable to extreme weather events such as drought and floods. A variety of food crops produced in Nigeria are all dependent on rainfall, so that where rain is in abundance (such as middle belt) crops dependent on rain are

planted and in drier part of the country, crops that do not require much rain are cultivated. Food production on the whole, however, has not kept pace with Nigerian's population increase. Climate change can seriously affect agricultural production and therefore food security.

Nigeria at present does not enjoy food security, so is vulnerable to the effect of climate change (Ozor and Nnadi, 2011). Bio-diversity is terribly vulnerable to climate change. Many species of plant and animal are rapidly becoming extinct. Also the fruiting intensity of some trees is diminishing, aberrations in animal mating habits and changes in birds and animal migratory patterns are evident.

Climate is defined as the statistical distribution of weather over a period of time that range from decades to millions of years. It can also be seen to be a change in the average weather condition or change in the distribution of weather events around an area, and may be limited to region, or occur across the whole earth (IPCC, 1990). Climate change and agriculture are interrelated processes both of which take place on a global scale. In recent years, global climate change is projected to have significant impacts on conditions affecting agriculture, including temperature, carbon dioxide, glacial run-off, precipitation and the interaction of these elements (Nkeme and Ndaeyo, 2011).

Climate change is a change of climate which is attributed directly or indirectly to human activity that alters the composition of global atmosphere, and it is synonymous with global warming (United Nation Framework Convention on Climate Change, 2009). The impacts of change are already being experienced across the globe. The intergovernmental Panel on Climate change (IPCC, 2001) concludes that human activity primarily related to fossil fuel consumption is largely responsible. While climate change will affect everyone, it is expected to have a disproportionate effect on those living in poverty in developing countries. Economic studies show that climate change will affect not only agricultural productivity but also agricultural prices, trade and food self-sufficiency (Nwalieji, 2012).

Climate change has become a global issue in recent times manifesting in variation of different parameters including cloud cover, precipitations, temperature ranges, sea levels and vapour pressure (Ministry of Environment of the Federal Republic of Nigeria, MOE,FRN, 2002). The variations in climate affects different sectors of the economy such as agriculture, health, water resources, energy, etc. Agriculture directly contributed to around 14% of global greenhouse gas emissions in 2005 and drives additional emissions through its role in deforestation. As climate change impacts exacerbate food production, stresses on ecosystems. It is conceivable that such collapses become commonplace, with enormous implications for food security, especially in developing world where two billion rural poor depend on ecosystems for sustenance and livelihoods (Ozor and Nnadi, 2011). In view of this the study therefore set out to investigate and present review attempts on the impact of climate change on food security in Nigeria.

Objectives of the Study

The present review attempts to collate impacts of climate change on food security in Nigeria. Specifically, the review is tailored to:

(i) highlight the concept of food security in Nigeria;

(ii) assess the impact of climate change on food security in Nigeria;

(iii) describe the means of averting climate change on food security

(iv) describe extension expectations on climate change and food security.

Methodology

This positional paper was embarked upon making use of relevant articles gotten from books of abstracts, conference proceedings, journals and credible books of knowledge. The researcher also consulted the Ministry of Agriculture for materials on food security and the Ministry of Environment on materials for climate change.

Concept of Food Security in Nigeria

Adetunji *et al.* (2005), stressed that agricultural production is still dependent on weather and climate despite the impressive advances recorded in agricultural technology which makes food available to all. A household is food secured when it has access to the food needed for a healthy life for all its members. Iheanacho and Abdullahi (2006) note that food is a basic substance needed for sustenance of life which has to be provided to maintain good health and optimal performance. In view of these, it must be in adequate quality and quantity. Thus food security is not only the availability but accessibility, procurement and intake of adequate quality and quantity of food by individual, household, community or region. According to FAO (2003), food security exists when people in a geographical location can meet their dietary needs within sufficient, safe and nutritious food at all times. The definition stands on two planks: the ready availability of nutritionally adequate and safe foods and the availability of dignified means of acquiring these foods. Unfortunately, these two planks are not implemented owing to high unemployment, the incidence of global warming and lack of dignified means of acquiring safe and nutritious food.

Although it is believed that worldwide, there is enough food to feed everybody adequately, nonetheless, food insecurity exists at the global, national, community, household and individual levels. At a global level, food security deals with food availability. Food security at the national level is dependent on the balance between food imports and local food production. Food security at the national level is not a good indicator of food security (Uwaegbute, 2011). To achieve this food security experts need to work alongside agriculturists and biologists to maximize food production while minimizing further ecosystem and biodiversity loss (Ozor and Nnadi, 2011).

Types of Food security

(i) **National food security:** Production and ability to import food from global market to meet a national's consumption needs.

(ii) **Households food security**: Yearly round access to an adequate supply of nutrition and safe food to meet nutritional needs of all households member.

(iii) **National security**: Requires that household member have access not only to food but also to health care, hygiene environment and knowledge of personal hygiene.

Impact of Climate Change on Food Security

Food security is vulnerable to extreme weather and dependent on rainfall pattern. This affects the age-long practices of farmers to predict when to plant their crops

(Aluko, 2008) According to him, the unpredictable changes in the onset of rain in the past years had led to situations where crops planted with the arrival of early rain get smothered in the soil to the unexpected dry spell that can follow early planting. The late arrival of rain due to climate variability relies on rain fed agriculture. Food is the most basic of human needs for survival, health and productivity. Since climate change affects food production and food production increases greenhouse gases that translate to climate change. How can we combine food production and climate change so as to have sustainable food production to ensure foods security? Climate change is having a significant impact on fragile soil and the traditional farming systems. Small rural farmers and communities can no longer produce efficient quantities of the food needed to sustain their populations. Food security is being adversely affected world wide according to (FAO, 2008) statistics, food prices rose from 24% in 2007 to 53% in 2008. The increase in the prices of food is threatening food security of developing countries; Nigeria inclusive, where people spend about 70^ to 80% of their budget on food. The main factor underlying the increase is the decline in food stocks due to low food stock, drought and floods emanated from climate change. According to Adetunji *et al.* (2005) the impacts on food production can be seen in the area of distortion of crop and livestock as well as crop yields within a given climate zone, affects all stages of agricultural production chain, intensifies prevalence of disease in a given area, affect food production in all population and will result in household food insecurity for all.

A new ICTSP-IPC study by Jodie Keane, suggests that climate change could cause farm output in sub-saharan Africa to decrease by 12 percent by 2080, although in some African countries like Nigeria this fiture could be as much as 60 percent with agricultural exports declining by up to one fifth in others (Ozor and Nnadi, 2011). Adapting to climate change could cost the agriculture sector $14 bn globally a year, the study finds.

Easterling *et al.* (2007), looked at studies that made quantitative projections of climate change impacts on food security. It was noted that these projections were highly uncertain and had limitations. However, the assess studies suggested a number of fairly robust findings. The first was that climate change would likely increase the number of people at risk of hunger compared with reference scenarios with no climate change. Projected climate change impacts depended strongly on future social and economic development. According to Easterling *et al* (2007) sub-Saharan Africa would likely surpass Asia as the most food insecure region. The study also pointed to the large potential benefits of climate change mitigation (i.e. reducing greenhouse gas emissions) on the agriculture sector. These benefits, might only become apparent in the second half of the 21st century, the study suggests. To satisfy the food demand and ensure the food security of an area, Pendleton and Lawson (1989) suggested that agricultural production needs to be increased by 2.3% annually over the next decades in order to even maintain the currently substandard nutritional level. This means that there is a great need for larger agricultural expansion and intensification of agricultural production.

TABLE 1: Factors Contributing to Climate Change

S/No.	Natural factor	Human induced factors
1.	Change in solar activities	Enhanced greenhouse effect
2.	Change in earth's orbit	Land use change
3.	Natural greenhouse effect	Enhanced atmosphere aerosols
4.	Natural atmospheric aerosol, volcanic emission	

Source: Climate change: the basic natural Resources, 2008

Aju (2008) observes that there were increasing evidences that human activities are artificially increasing the amount of greenhouse gases in the atmosphere and thereby disturbing their natural geo-chemical cycles and affecting the global temperature. The atmosphere is made up of 99% of two gases; nitrogen 78% and carbon dioxide 21%. The remaining 1% is made up of HG. These heat trapping gases are as a result of nitrous oxide emitted by deforestation biomass burning, nitrogenous fertilizers and fossil fuel combustion, ozone accounts for 14% of greenhouse effect. Methane firm biomass burning from the stomach of cattle and other ruminants, coal mines landfills as well as natural swamps, are responsible for 16% effect. Chlorofluoro carbon used in a variety of industrial applications accounts for 10%, carbon dioxide contributes about 60%, carbon dioxide greenhouse effect.

Climate change and the consequent to global warming are fast attracting global concern. It manifests itself when there are rising temperature, irregular humidity and rainfall patterns, flooding, erosion of plains rising sea levels, drought, desertification threat to natural water resources and increase in inland erosion (Aluko *et al.,* 2008). Climte and climate change over any particular place on the globe are caused by a host of interacting natural and man-made factors such as the solar output, earth-sun geometry and the interstellar dust all of which are extraterrestrial in nature.

Factors which are open to the influence of man include land systems (comprising the latitude, elevation, topography and vegetation) the atmosphere (comprising its composition and prevailing winds) and, the oceans along with their associated currents. The influence of man which creates man-made climate change and which poses danger to existence of life is in the emission of large quantities of heat absorbing greenhouse gases such as carbon dioxide, methane, nitrous oxide, hydrocarbons and sulphurhexa fluoride into the atmosphere. In Nigeria as in any other parts of the world, the emission comes in form of burning of all forms of fuel such as gas flaring, automobile exhausts, bush burning and several others. Increase in the composition of the greenhouse gases results in increased global warming. Other human activities contribute to climate change and global warming includes deforestation, farming, desertification, urbanization, logging and population explosion.

i. Food Insecurity

Human society is also vulnerable to climate as a result of increased incidence of drought and threats to food security (Akinyem *et al.,* 2008). When a nation, household or individual fails to meet the food requirements of its members then it is vulnerable to food insecurity (Zaku, 2008).

Types of Food Insecurity

(i) **Chronic food insecurity**: Household persistently unable to meet the food requirement of its members over a long period of time.

(ii) **Transitory food insecurity** is a short-term problem which may affect any household, such as crop failure, scarcities, temporary illness or unemployment of productive member of household may cause this problem.

When a nation, household or individual fails to meet the food requirements of its members then it is vulnerable to food insecurity. Two forms of food insecurity are chronic food insecurity and transitory food insecurity. The former is a long-term problem which a household is unable to meet the food requirement of its members while the latter, is a short-term problem which may affect any household e.g. illness, crop failure or unemployment, etc. Reliable records indicates that 60% of climate-related trends of water flows, air, temperature and sun pack between 1950 and 1999 are human induced which has the potentials to reduce yields from rainfall agriculture by 50% by years 2020, thus creating food security (Umar *et al.,* 2008).

ii. Climate change and human health problem

Climate change poses a serious threat to our environment, our rural communities, ourfarmers, and the millions who rely on them for food and fibre. Climatological factors such as temperature, wind speed, relative humidity have been observed to have serious impact on the physiological sensation of human comfort and discomfort (Aluko *et al.*, 2008). Heat stress in hot regions and seasons, is invariably unfavourable, it adds to discomfort and even contributes to death especially among the aged and areas of constant malnutrition (Jauregui, 1984; Oke, 1992; Okpara and Adekunle, 1997). Increased ultraviolet radiation resulting from depletion of atmosphere ozone layer could raise the incidence of skin cancer (Awosika and Florunsho, 2006). The Ozone layer protects most of the sun's biologically harmful ultra-violet radiation. Increased ultra-violet levels on the earth's surface are damaging to human health, air quality and biological which in turn affects food production and food security.

iii. Climate change and deforestation

The term deforestation is used to refer to activities that use the forest, for example, fuel wood cutting, commercial logging, as well as activities that cause temporary removal of forest cover such as the slash and burn technique, a component of some shifting cultivation agricultural systems or clear cutting (Adekunle and Akinlemibola, 2008) with the advent agriculture fire became the prime tool to clear land for crops. Today, several factors are responsible for deforestation in the tropics. These include clearing of forest for agriculture, fuel wood cutting, and harvesting of wood products (FAO, 2005). The burning of forest plants in order to clear land releases

tones of Co_2 into the atmosphere thus increasing the impact of global warming. Deforestation reduces soil cohesion, so that erosion, flooding and landslides often ensue. It decreases evaportranspiration lessens atmospheric moisture (Macnally and Horrocks, 2002). Deforestation is often cited as one of the major causes of greenhouse effect. Trees and other plants remove carbon (in form of carbon dioxides from the atmosphere during the process of photosynthesis (Sucoff, 2003). Deforestation causes carbon stocks held in soil to be released. Both the decay and burning of wood release much of this stored carbon back to the atmosphere (Macnally *et al.,* 2002). When part of the forest is removed, the region cannot hold as much water and can result in a much drier climate (Whitney, 1996). Deforestation has serious agricultural, environmental, ecological, social and economic impacts on food production thereby causing food insecurity. Once a forest is degraded, it is often very difficult economically and ecologically to rehabilitate it.

iv. Climate change and desertification

Desertification is the decline in the biological or economic productivity of the soil in the arid and semi-arid areas as a result of various factors including human activities and variations in climate. Desertification often results in a decrease in the amount of vegetation covering the land. Soil temperature rise will accelerate the breakdown of organic matter in the soil and the evaporation of water. The absence of vegetation also enhances runoff and erosion by water and wind. Erosion may cause gullies lowering the water table and making, less water available for plants. The net effect is that people will be unable to grow enough food or raise livestock and more resources will diminish creating environmental refugees as people make efforts to escape scorching environment. Other human needs such as fire wood, household and industrial energy, fruits for consumption and herbs for medicinal uses, will become scarce as desertification prevails.

Means of Ameliorating Climate Change on Food Security

According to Aluko *et al.* (2008), forests play critical role in combating climate change both locally and globally through the absorption of solar energy, modification of air movement, partitioning of energy and water and exchange of carbon dioxide during photosynthesis and plant respiration. Application of forest technologies in forest conservation, afforestation, reforestation and sustainable forest management is the most feasible and plausible approach to solving problems of climate change not only in Nigeria, but all over the world.

Human activities through deforestation logging, farming urbanization, road construction and population explosion must be within the ambit of the law. Development and implementation of policies on environment, to include participation. Public, private and community of organizations (Umar *et al.,* 2008). Nigerians need to be educated and informed about climate change, its effects on food security and, protection of environment and life generally (Aluko, 2008). Every organization, Government at Federal, state and local government, non-governmental organizations and individuals should convict the menaces of climate change.

Farmer adaptation, such as switching crop varieties, introducing more suitable crops or shifting from crops to grazing depending on region by individual farmer can enhance production. Government can encourage agronomic research for the development by either traditional breeding or biotechnology of new varieties better

able to withstand the effects of global warming (Darwin, 2001). He posited that Government can provide reliable 6 to 8months weather projections or information about suitable crop and livestock alternatives to help farmers increase production efficiency. Agronomists may be able to increase the ability of crops to use Co_2 more efficiently in photosynthesis.

To cope with climate change that is likely to be both rapid and unpredictable, agricultural systems must be resilient and able to adapt to change. Resilient agriculture systems are those that are more likely to maintain economic ecological and social benefits in the face of dramatic exogenous changes such as climate change and price swings, National Sustainable Agriculture Coalition (NSAC, 2009). NSAC posited that current agricultural activities are a significant source of greenhouse gases that aggravate climate disruption that sustainable and organic agricultural systems can help reduce agricultural GHG emissions through energy conservation, lower levels of carbon-based inputs, lower use of synthetic fertilizer and other features that minimize GHG emissions and sequester carbon in the soil.

Expectations from Extension Service Delivery on Climate Change

According to Unamma (2001), sustainable food security is a situation that exists when all people at all times have physical, social and economic access to sufficient safe and nutritious food that meets their dietary needs requires and fuses with the goals of household food security. Sustainable food security can only be made possible through sustainable agriculture which depends on appropriate technologies generated by research and promoted by extension baring the constitution of the global warming and the impacts on farmers' production profile. Therefore, raising rural productivity would increase the security of all through increased food supply and poverty alleviation.

Though extension service has metamorphosed over the years, one of the lessons learnt is that scientific technology or whatever forms taken is not always the answers, but indigenous agricultural practices drawn from experience of the farmers offers many answers to challenges brought about by global warming (Akanji, 2006). Consequently, the extension service delivery is expected to be innovative in service delivery for sustainable environment management. Umar *et al.* (2008), suggests a use driven advisory Extension, model which fosters interdisciplinary and new partnerships, promotes working together, breaking imaginary real barriers to effective extension delivery and bridging efforts to build a better extension service that will be effective for environmental management, and essentially, such system is expected to be the tool for sustainable National Food security (Umar *et al.,* 2007)).

Conclusion

From the representation above, Climate change is observed to be both natural and man-made. Greenhouse gases emission can have adverse or negative impacts on food production which ultimately affect food security in Nigeria, and other developing countries. The effects of climate change are also seen in the area of food insecurity, human health problem, deforestation, desertification, entire agricultural production (crops and animals), means of curtailing and curbing these effects and extension expectations were also analyzed. Therefore, in respect to this write up, if the above mentioned precautionary measures are practiced, effect of climate change on agricultural production will greatly be mitigated and agricultural productivity will be greatly enhanced thereby leading to food security in Nigeria.

Recommendation

Averting the climate change risk and promoting food security must be a national concern. Still important is to be conscious of the effect of climate change on national food security viz a viz creating deserved attention to the management of our environment. The effects of climate change should be tackled with great concern that exhibit sustainable action plans development and implementation of policies on environment, to include active participation of public, private and community organizations must be ensured. There should be effective communication with policy makers, the poor and disadvantaged about causes and consequences of environmental mismanagement. Knowledge sharing extension to include information tools, which favours interaction at the grassroots level with farmers and ruralite, must be instituted as much as possible.

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Poultry farmers' adaptation to climate change in Enugu North Agricultural Zone of Enugu State, Nigeria

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Abstract

The study surveyed the perceived effect and adaptation of climate change on poultry production in Enugu-North Agricultural Zone of Enugu State. A questionnaire/interview schedule was used to collect information from 60 poultry farmers. Percentage and mean score were used to analyze the data. Reduced body weight (M=3.1); reduced fertility (M=3.3) and reduced feed intake (M=3.1) were perceived by farmers as effects of climate change on poultry. Coping strategies used by farmers included keeping of resistant varieties (56.5%); adapting extensive poultry management (65.8%) and keeping other livestock (53.8%). Respondents perceived climate change as excessive sunshine (90%); excessive rainfall (80%) and increased incidence of drought (66%). The perceived causes of climate change included burning of fossil fuels from industries (M=4.2); burning of firewood (M=4.0) and deforestation (M=3.7). Sources of information available to the farmers were radio (33.3%); farmers' meeting (28.3%), and friends (26.7%). Technical innovations (adaptation measures) should be made available to farmers to enable them cope with the challenges of climate change.

Keywords: Climate change, poultry farmers, adaptation

Introduction

Poultry keeping is makes an important contribution to the livelihoods of the most vulnerable rural households in developing countries. Poultry has become a popular industry for the small holders that have great contribution to the economy of the country (Nigeria). The poultry profession has assumed greater importance in improving employment opportunity and animal food production. (Olagunju and Babatunde, 2011). The poultry industry has also been described as the fastest means of bridging the protein deficiency gap prevailing in the country (Eekeren, Mass, Saatkamp and Verschuur 1995; Apantaku, Omotaya and Oyesola 1998). A report by Okonkwo and Akubuo (2001) shows that about ten (10) percent of the Nigerian population is engaged in poultry production, mostly on subsistence and small or medium-sized farms. People depend on poultry for food and poultry farming serves as part-time work to supplement the income of small and marginal farm families. Poultry production is essential activity because of its vast potential to bring about rapid economic growth, particularly benefiting the weaker or the less privileged in the community. Furthermore, it needs low capital and short period of time to make quick returns within weeks and months in case of broilers and layers, respectively (Ekunwe**,** Soniregun and Oyedeji, 2006)

However, it is obvious that temperature has influence on poultry farming. This influence has amplified as there is climate change across the globe. Climate change is any change in climate over time, whether due to natural variability or as a result of human activity (BNRCC, 2011). Evidence from the Intergovernmental Panel on Climate Change (IPCC, 2007) is now overwhelmingly convincing that climate

change is real, that it will become worse, and that the poorest and most vulnerable people will be the worst affected. The IPCC predicts that by 2100 the increase in global average surface temperature may be between 1.8° C and 4.0° C. With increases of 1.5° C to 2.5° C, approximately 20 to 30 per cent of plant and animal species are expected to be at risk of extinction (FAO, 2007) with severe consequences for food security.

The International Fund for Agricultural Development (IFAD, 2009) acknowledges climate change as one of the factors affecting rural poverty. While climate change is a global phenomenon, its negative impacts are more severely felt by poor people in developing countries such as Nigeria who rely heavily on the natural resource base for their livelihoods, and due to their low level of coping capabilities (Nwafor, 2007; Jagtap, 2007). Changes in climate are severely affecting agricultural production in many African countries (APF/NEPAD, 2007). Studies by Deressa, Hassan, Alemu, Yesuf et al. (2009) reveal that African's agriculture is negatively affected by climate change and its rural poor communities rely greatly for their survival on agriculture and livestock keeping that are also amongst the most climate-sensitive economic sectors. The weather is erratic, vulnerable and unreliable to livestock farmers. Todaro and Smith (2009) conclude that worst impacts of climate change are felt by livestock farmers.

Climate changes in form of drought, temperature variability, too much sunshine and windstorm (Gueye, 2003) have negative effects on poultry production. High or low temperatures lead to diseases infection while wind may serve as agent for spread of air-borne diseases that affects poultry (Guey, 2003). Furthermore, Rajkuma, Reddy, Rama Rao, Radhika et. al. (2011) reported that poultry flocks are particularly vulnerable to climate change because birds can only tolerate narrow temperature ranges**.** Adaptation to climate change refers to adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities (IPCC, 2001). Poultry farmers therefore need to consider making adaptations now to help reduce cost, risk and concern in the future (Farming Features, 2009). Therefore, this study answers the following questions: What are farmers perceive evidence to climate change? What are their perceive effects of Climate change? What are the effects of climate change on poultry? What adaptive measures do the farmers undertake and what are the constraints for carrying out these measures successfully.

Therefore this study was designed to ascertain poultry farmers' adaptation measures to climate change in Enugu North agricultural zone of Enugu State, Nigeria. Specifically the study sought to: ascertain perceived evidence of climate change by the farmers; determine perceived causes of climate change by the respondents; ascertain the perceived of climate change on poultry production; determine adaptation measures undertaken by farmers; and identify constraints to the use adaptive measures.

Methodology

The population for the study comprised all poultry farmers in Enugu North Agricultural Zone of Enugu State. Six blocks were randomly selected out of eight blocks in the zone. Two cells were selected from each of the six blocks using simple random sampling procedure. A list of all poultry farmers was collected with the help of extension agents from each of the cells. Five poultry farmers were then selected

by simple random sampling technique giving a total of 60 poultry farmers. Pre-tested questionnaire/ structured interview schedule was developed based on objectives and used to collect data.

The socioeconomic characteristic of the respondents were measured thus: age (years), sex (male or female) etc. In order to ascertain the perceived evidence of climate change by poultry farmers, a check list was provided for them to tick accordingly. Any respondent that scored 50% and above was regarded as those that perceived evidence of climate change while those that scored less than 50% did not perceive evidence of climate change. The respondents were asked to identify the causes of climate change from the list of possible causes. Therefore, the extent to which the identified causes of climate change were perceived by the respondents were measured on five point Likert-type scale of : to a very great extent (5), to a great extent (4), to an extent (3), to a little extent (2) and to no extent (1). These values were summed up to 15 and divided by 5 to give a mean score of 3.0 The items with mean score ≥ 3.0 were regarded as perceived causes of climate change by the respondents while items with mean score < 3.0 were regarded as not perceived as causes of climate change by the respondents. The level of effects of climate change on poultry production was measured on a four point Likert-type scale of: high (4), moderate (3), low (2) and no effect (1). The values were summed up to 10 and divided by 4 to give a mean score of 2.5 The items with mean scores ≥ 2.5 were regarded as having high effect of climate change on poultry production while those with scores < 2.5 were regarded as having low effects.

In order to obtain a quantitative measure of respondents' agreement on the use of each technique (adaptive measures) in cushioning the effects of climate change, a checklist of various adaptive measures which were obtained from literature and personal interviews, was utilized. Respondents were requested to tick the measures used in adapting to the climate change effects. Any response option (adaptive measure) with score ≥ 50% was regarded as being useful and important while items with scores < 50% was regarded as not being useful and important in cushioning the effects of climate change by farmers. In case of the constraints, a check list of possible constraints was provided and respondents asked to indicate accordingly. Thereafter, items with scores ≥ 50% were regarded as having constraints to the adaptive measures while items with scores < 50% were regarded as having no constraints to the adaptive measures. Descriptive statistics such as percentage, mean score and standard deviation were used to analyse the data. Objective 3 and 4 were analysed by use of mean scores and standard deviation while objective 1, 2, 5 and 6 were analysed using percentage.

Results and Discussion

The result shows that majority (75.0%) of the respondents (Table 1) were within the age range of 30-39 years. The mean age of the respondents was 49 years. This shows that the respondents were in their active age and therefore productive. Majority (66.7%) of the respondents were female. This shows that rural women were more involved in poultry production. Therefore women should be targeted in the event of any climate change programmes on poultry in the study area. About 58% of the respondents were married. This shows that married persons predominated in poultry farming in the study area. Married people are responsible and so may easily find ways of adapting to effects of climate change on poultry as this may increase their productivity and subsequently bring to bear in catering for

their family. Thirty three percent of the respondents had primary education while 30% had post primary education. Only 12% had tertiary education while up to 25.0% of the respondents had no form of formal education. Thus majority (75.0%) of the respondents were educated at least up to primary school level. This implies that they are able to harness information on climate change. Adedoyin, Fapojuwo and Torimiro (1999) pointed out that high level of education is a very good springboard for effective extension service. Good educational qualification may impact positively on the respondents' biochemical, social and economic understanding of climate change issues and ability to adapt to it. Greater proportion (40.0%) of the respondents engaged in farming as their major occupation.

TABLE 1: Distribution of respondents by socioeconomic characteristics

Variable	Frequency	Percentage	Mean (M)
Age	4	6.6	
20-29	10	16.7	
30-39	20	33.3	
40-49	15	25.0	49
50-59	6	10.0	
60 and above	5	8.4	
Sex			
Male	20	33.3	
Female	40	66.7	
Marital status			
Married	35	58.3	
Single	15	25.0	
Widowed	8	13.4	
Separated/divorced	2	3.3	
Educational attainment:			
No formal education	15	25.0	
Primary education	20	33.3	
Post primary education	18	30.0	
Tertiary education	7	11.7	
Household size:			
1-5	22	36.7	
6-10	30	50.0	
11-15	5	8.3	7
16-20	3	5.0	
Major occupation			
Farming	24	40.0	
Trading	12	20.0	
Civil service	18	30.0	
Artisans	5	8.3	
Nursing	1	1.7	

Majority (45.0%) of the respondents had 21-40 birds in their farms (Fig 1). The mean stock size was 36. This implies that poultry production in the study area is on subsistence level. This may be because of constraints (of which climate change effect may be one of them) that may hinder expansion of their farms therefore they

can adapt easily as the cost and time spent for adaptation will be low.

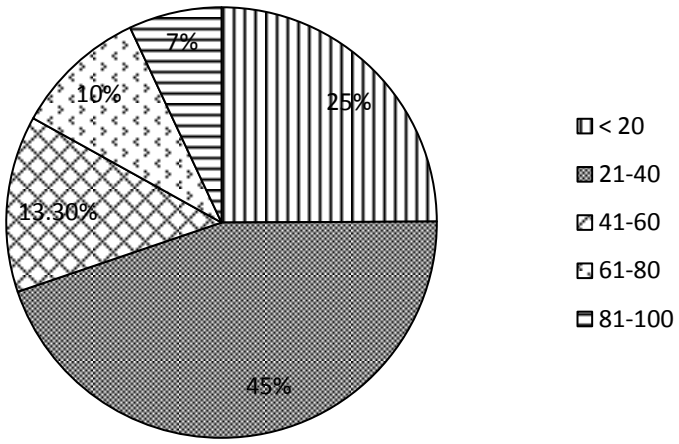


Fig 1: Percentage distribution of stock size

Table 1 indicates that 50.0% of the respondents have a household size within the range of 6-10. The mean household size was 7. This implies that the respondents had fairly large household size which could possibly serve as source of farm/family labour. It could also serve as source of information on climate change issues.

Perceived evidence of climate change

Excessive sunshine was noted by most (90.0%) of the respondents as a sign for climate change (Fig 2). Also majority (80.0%) of the respondents indicated excessive rainfall as a major evidence of climate change. Others included: short period of hamattan (75.5%) and increased incidence of drought (66.7%). This implies that the respondents have perceive evidence that climate has changed and therefore will be willing to adopt new technologies related to climate change adaptation. Yahaya, (2009) stated that the unusual weather change which brings about rain in different parts of Nigeria in January is an indication of serious negative effects of climate change.

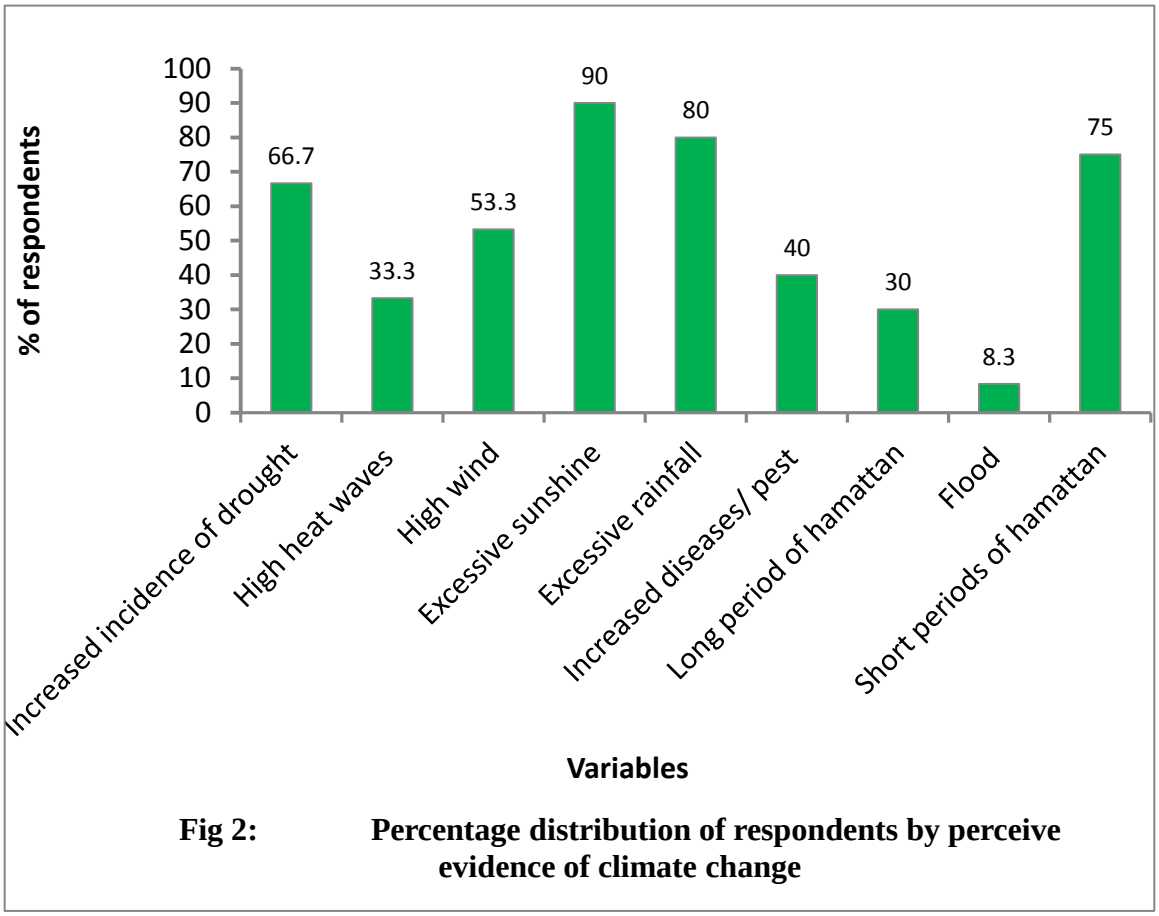


Fig 2: Percentage distribution of respondents by perceive evidence of climate change

Perceived causes of climate change

The results Table 2 indicate that farmers perceived causes of climate change included: burning of fossil fuel (M=4.2), burning of firewood for cooking (M=4.0), use of generator (M=3.9), bush burning (M=3.8), deforestation (M=3.4), overgrazing (M=3.5), use of fertilizer on farmland (M=3.4), use of pesticides (M=3.4) and decomposition of organic waste (M=3.5). This implies that human activities are to a large extent the major causes of climate change as indicated by respondents in the study area. There is strong evidence that the warming of the earth's over the last half century has been caused largely by human activity, such as the burning of fossil fuels and changes in land use including agriculture and deforestation (The Rural Society, 2010). Similarly, IPCC (2007) noted that the main cause of climate change has been attributed to anthropogenic (human) activities while Lohnman (2006) opined that climate change is closely associated with burning of oil, coal or gas. However, the respondents perceived to no extent that swamp rice production (M=2.4), gas flaring from oil companies (M=2.4), oil spillage (M=2.5) etc. were causes of climate change. The reason why they did not perceive oil spillage as one of the causes of climate change may be because oil exploration is not yet common in the zone.

TABLE 2: Perceived causes of climate change

Variable	Mean (M)	SD
Burning of fossil fuel by industries	4.2*	1.22
Burning of firewood for cooking	4.0*	1.21
Use of generator to generate electricity	3.9*	1.24
Bush burning	3.8*	1.20
Deforestation	3.7*	1.25
Over-grazing of farm land by livestock	3.5*	1.22
Use of excess fertilizer on farm land	3.4*	1.23
Use of pesticides	3.4*	1.45
Decomposition of organic waste	3.5*	1.48
Gas flaring from oil companies	2.4	1.5
Gas releases such as CO2 from industries	2.6	1.4
Swamp rice production	2.4	1.5
High rate of irrigation	2.5	1.4
Oil spillage	2.5	1.6

Perceived effects of climate change

Most farmers in the study area have noticed significant changes in the climatic conditions (see Fig 2) and they claim such climatic conditions have been manifested in several forms. Table 3 summarizes the climatic effects farmers have observed. Almost all the variable except reduced sale of poultry birds (M=1.5) and change in taste of poultry meat (M=2.1) were perceived as high effects of climate change on poultry as their mean scores were greater than 2.5. Data in Table 3 also show that the standard deviations for all the issues considered were less than 1.5. This indicates that farmers' individual scores as regards their experience of climate change effects/impacts on agriculture did not differ much from their mean scores. These results are not surprising since it is obvious that high heat waves have a negative effect on poultry production and could have serious impact on poultry industry. This finding corroborates the opinion of Gueye, (2003) who reported that climate changes in form of drought, temperature variability, too much sunshine and windstorm have negative effects on agricultural production especially on poultry production. High or low temperatures lead to diseases infection while wind may serve as agent for spread of air-born disease that affects poultry (Guey, 2003). These extreme climatic events could have dramatic effects on the economy of the country. Heat distress suffered by animals will reduce the rate of animal feed intake and result in poor growth performance (Rowlinson, 2008). For rural communities, losing livestock assets could trigger a collapse into chronic poverty and have a lasting effect on livelihoods.

TABLE 3: Perceived effects of climate change

Variable	Mean (M)	SD
Reduced body weight	3.1*	1.22
Increased disease infection	3.0*	1.21
Reduced egg size	2.8*	1.24
Reduced feed intake	3.1	1.20
Reduced fertility	3.3*	1.25
Decreased activity	3.1*	1.22
Increased mortality	3.2*	1.23
Reduced farmers income	2.7*	1.45
Change in taste of poultry meat	2.1	1.48
Reduced sale of poultry birds	1.5	1.46

Sources of information about climate change

Respondents' sources of information (Fig 3) on climate change included: radio (33.3%),film show (30.0%), farmers meeting (28.3%), friends (26.7%) and extension workers (25.0%) . This result corresponds with the report of Christanell, Burger-Scheidlin and Vogl (2009) who opined that in Australia, farmers' explanations for climate change are dominated by prevailing scientific discourses represented in the media and rarely base on the farmers' conclusions drawn from their own (local) observations. This shows that extension workers did not perform their duties very well as to supply climate change information to the farmers in the study area. In order to sustain the agricultural sector that plays pivotal roles in human existence in terms of the provision of food, fibre, fun, fuel and income, strategies of change need to be urgently initiated to cope with the changing climate. Agricultural extension has key roles to play in initiating this change. This is because adaptations to climate change impacts require changes in knowledge, attitudes, resilience capacities, and skills of the people and agricultural extension can bring this change. It has been observed that agricultural extension is involved in public information and education programmes that could assist farmers in mitigating/adapting to the effects of climate change (MOE FRN,2003) such as awareness creation and knowledge brokerage on the issues of climate change; building resilience capacities among vulnerable individuals, communities and regions; encouragement of wide participation of all stakeholders in addressing climate change issues; and developing appropriate

frameworks for coping/adapting to climate change effects/impacts.

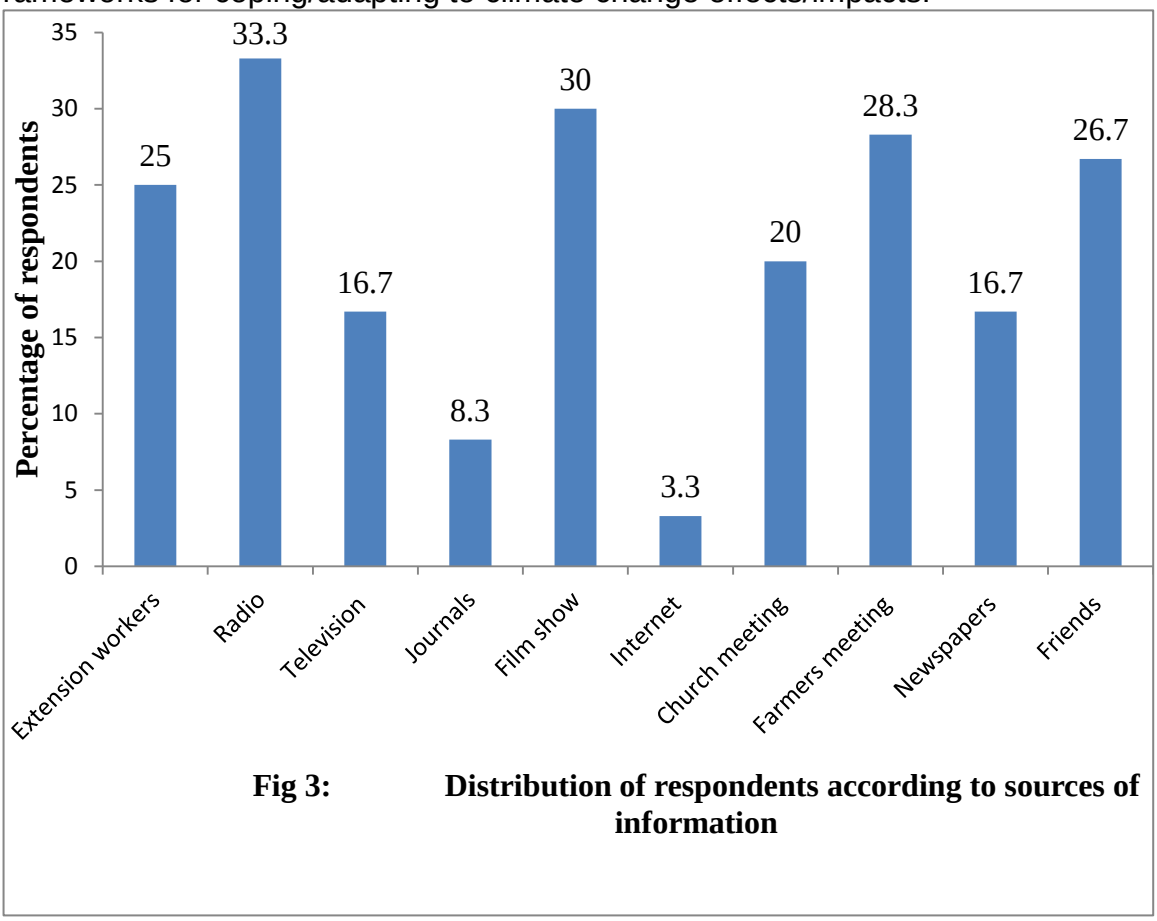


Fig 3: Distribution of respondents according to sources of information

Adaptation strategies of poultry farmers to climate change

The most significant adaptive measures used by farmers in coping with climate change effects in the study area are presented in Fig 4. The respondents undertook keeping of resistant birds (56.5%), keeping of early maturing birds (53.1%), extensive poultry management system (65.8), keeping different bird varieties (51.4%), keeping of birds and other livestock (53.8%), raising brood and sale (52.3%) etc as adaptive strategies to poultry production. This shows that farmers are already making efforts to cushion the effects of climate change. On the contrary, in Australia, even though farmers are aware of the impact climate change has on agricultural land and local ecosystems, farmers rarely react through adaptive actions or changes in the local agricultural production (Christanell, Burger-Scheidlin and Vogl 2009). On the other hand, Nzuma et al. (2010) stated that in Africa local farmers are already using local adaptation strategies to cope with climate change. Furthermore, ILRI (2008) reported investment in multiple livestock species as one of the adaptive measures for farmers to cope with the effect of climate change. In Enugu State, Nigeria, the most popular adaptive measure used by respondents was the use of resistant crop and animal varieties/species (Ozor and Nnaji, 2008**).** The use of resistant poultry species provides useful adaptations and resilience to the effects of climate change. Such birds are known to survive and complete their life cycles normally even when the environment will not allow others to thrive. The increased adoption of resistant species may not be unconnected with the fact that farmers encounter serious disease infections, which have been recognized as one

of the most outstanding effects of climate change in the area (see Table 4). Keeping different types of livestock is adopted by farmers for reasons which may be to ensure food security, increased income, reduced incidence of pests and diseases, among others.

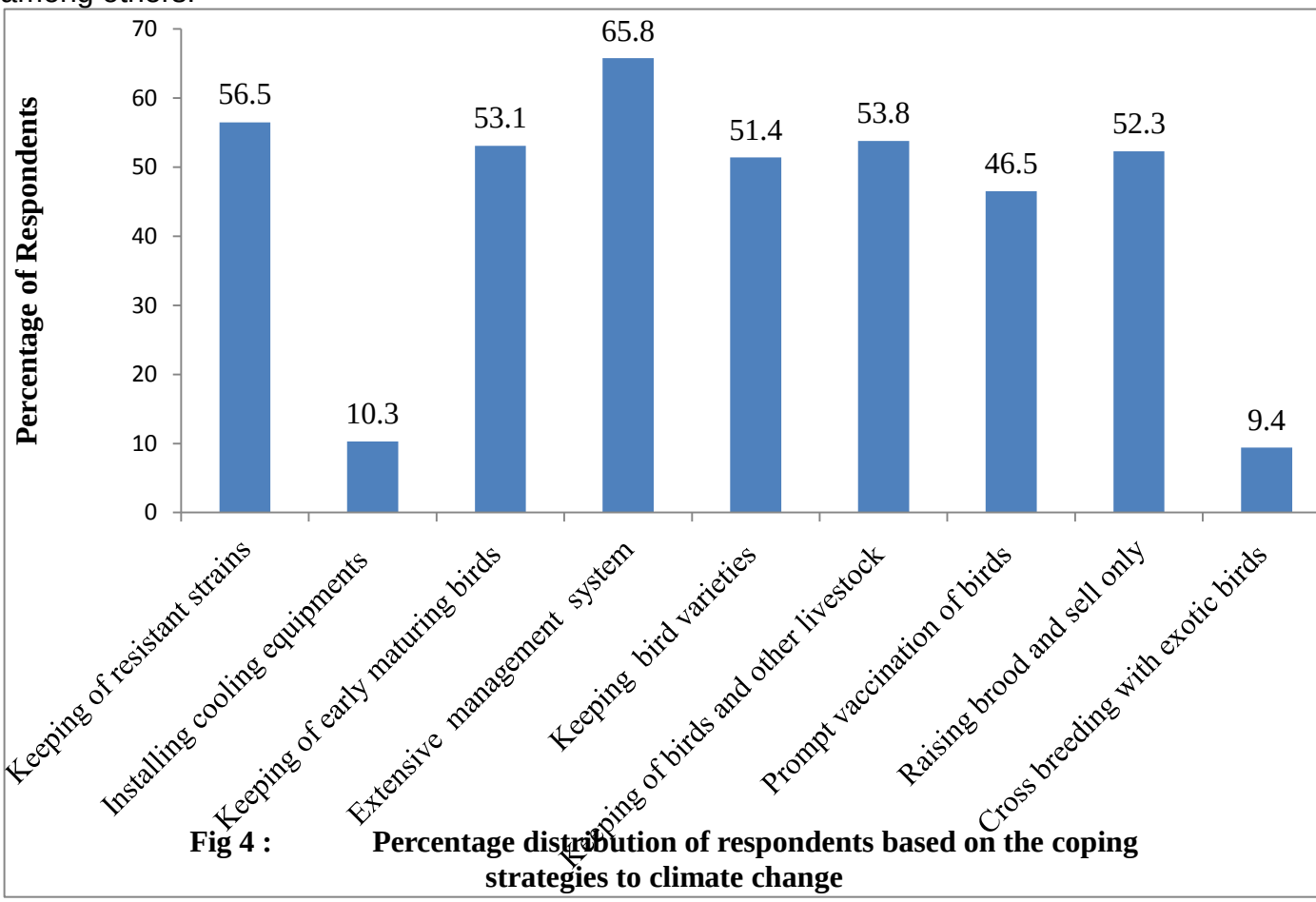


Fig 4 : Percentage distribution of respondents based on the coping strategies to climate change

Constraints to adoption or use of climate change adaptive measures

The analysis of barriers to adaptation to climate change in the study area indicates that there are five constraints to climate change adaptive measures. These are lack of information (92.0%), high cost of adaptation (78.0%), shortage of labour (75.5%), poverty (84.4%) and poor link to input and output markets (61.5%) (Figure 5). Most of these constraints are associated with poverty. Lack of money hinders farmers from getting the necessary resources and technologies. However, lack of information to adaptation options could be attributed to the fact that researches on climate change and adaptation options have not been strengthened in the country hence, information is lacking in this area. The fact that adaptation strategies are costly ((Mendelson and Williams, 2004) makes farmers vulnerable to the negative effects of climate change. This cost could be revealed through the need for intensive labour use. Thus, if farmers do not have sufficient family labour or the financial means to hire labour, they cannot adapt easily to climate change. Apata et al, (2009) reported that the most adverse effects of climate change are felt mainly

by developing countries, especially those in Africa due to their low level of coping capabilities (Nwafor, 2007; Jagtap, 2007). It is noted by IFAD (2009) that the capacity of local communities to adapt to climate change and mitigate its impacts will also depend on their socio-economic and environmental conditions, and on the available resources.

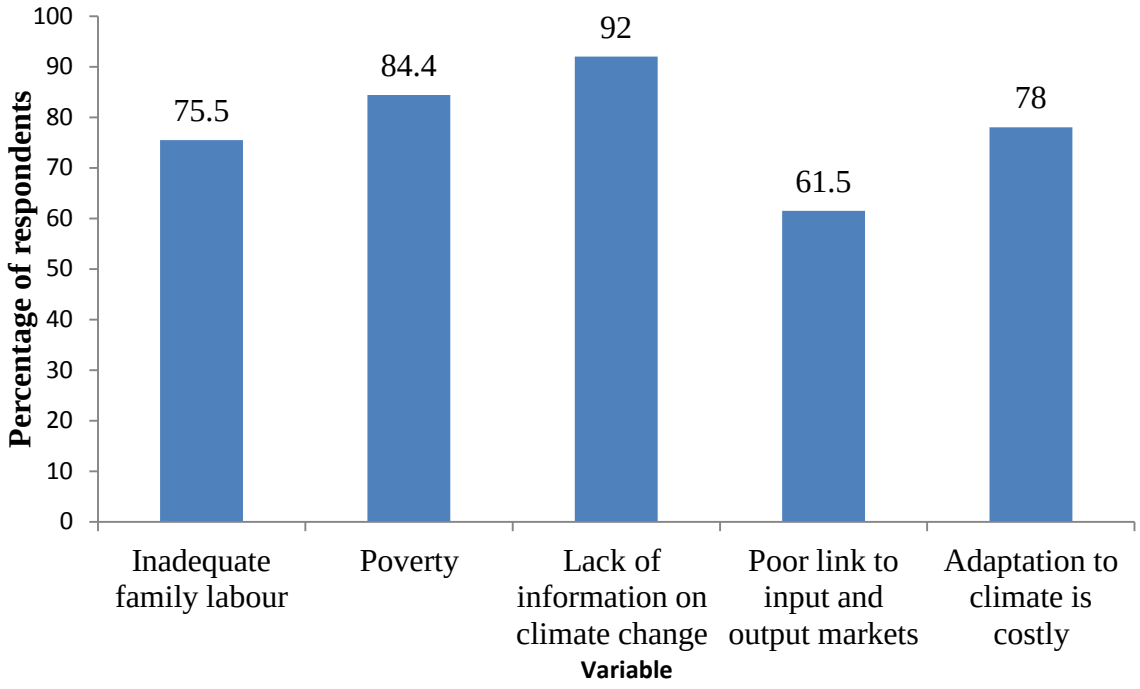


Fig 5: Percentage distribution of respondents according to barriers to adapt to climate change

Farmers need more information and enlightenment on how to curb and mitigate the effect of climate change. The same frontal attack that was and is currently given to HIV/AIDS campaign is needed for climate change issues if we are to ensure food security in the face of unabated urbanization. This circumstance poses great challenge for agricultural extension. Climate change presents new challenges and threats to food security in most countries especially the developing ones. This demands that extension service shall brace up to the development by re-training its staff to acquire the capability (knowledge and skills) in managing the risks that climate change pose especially in rural areas where the greater part of agricultural activities take place.

Conclusion and recommendation

Based on the findings of the study, the following conclusions were drawn: farmers perceived excessive sunshine as evidence of climate change, while anthropogenic causes where the main causes of climate change in the study area; key effect of climate change in the study area was reduced fertility while the key adaptive measure used by farmers was extensive poultry management system; and lack of information on climate change and poverty were the major barriers to climate

change adaptation. The study recommended the following: extension has to play a key role in providing information to farmers in the study are; technical innovations (adaptation measures) should be made available to farmers to enable them cope with the challenges of climate change; government should grant loans to poultry farmers to enable them procure new technologies to meet the protein demands of an ever increasing population; and efficient and affordable adaptation practices need to be developed for the rural poor who are unable to afford expensive adaptation technologies.

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Cognition of Agroclimate Change: An Essentiality for Adaptive Farm Enterprise Production and Responsive Extension Service Delivery in Nigeria

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Abstract
One of the serious challenges confronting agricultural development in today's world is the need to make farm enterprise production amenable to the changing agroclimate. This is more apparent in the developing countries, particularly in the sub-Saharan Africa, where agricultural practice is rain-fed. Although, agroclimatic indices such as rainfall, temperature, humidity, evaporation and transpiration interactively influence sustainable farm enterprise production, erratic nature of these elements, especially the rainfall distribution, heat intensity and evapotranspiration, has made, for example, Nigeria's agriculture less fruitful arising from inability to predict what the weather will turn out to be during the farming season. The attending implications of this include adverse agroclimatic condition, poor farm productivity and stimulation of food insecurity in the country. In order to mitigate the adverse effects of the agroclimatic change on farm enterprise production in Nigeria, this paper proposed a theoretical framework by which the agroclimatic indices can be consciously monitored and have the generated data translated to useful agro-information for onward dissemination to farmers for farm production planning and decision-making; and for utilisation by the extension agents/agencies for the design of seasonal farming calendar for the farmers. Based on this, the rural farmers could thus have their farm enterprise production and other farming activities amenable to the prevailing agroclimatic condition, and as such ensure sustainable development of Nigeria's agriculture.
Key words: agroclimate change, agroclimatic indices, farm enterprise amenability, responsive extension services, Nigeria

Introduction

Development and sustainable farm enterprise production largely depends on the prevailing agroclimate of a given area. In other words, successful production of farm enterprises and methods of production in a given region depends on the existing environmental factors – soil condition, trend of rainfall distribution, temperature and humidity, of the area. These environmental factors, as indicated by Harper (1983) and Jagtap (1995), not only determine the production potentials and supporting capacity of a particular region, but have considerable effects on the growth, development and types of crops and/or farm animals produced in the area. In essence, certain farm enterprise(s) successfully produced and supported or favoured by a particular farming environment may not be successful in another farming environment, even with the use of the same production methods or agronomic practices and variety of seeds or breeds of animals. This situation thus suggests the need for the farmers to have good knowledge of their agroclimate and

farming environment, and as well understand the dynamics of agroclimate indices' variability for successful farm enterprise production and adaptation.

Attainment of this knowledge however depends on conscious monitoring of the trend of occurrences of agroclimate indices on regular basis, coupled with proper management of the climatic information for farm production planning and decision making. With advances in climate-data gathering technologies, there exists a number of agrometeorological tools, ranging between simple hand-held devices and field-implanted sophisticated devices by which the agroclimate of a given area can be readily and steadily monitored. Having good knowledge of what constitutes the concept and dynamics of agroclimate change becomes essential to ascertaining the proper agroclimatic indices to be monitored and managed for farm production planning.

Broad objective: is to guide the extension practitioners for responsive extension service delivery on adaptive agricultural practices to climate change. To achieve this, the flowing specific objectives were addressed:

1. Provision of indepth clarification on climate and weather differentials,
2. Provision of insight into what constitutes agroclimate, based on the relationship between climate and agricultural practices
3. Highlight the dynamics of climate change and its effects on agriculture (with a reflections on case studies),
4. Provision of information on climatic indices to be monitored for generation of agroclimatic information in the Nigerian context,
5. Highlight the adaptive agricultural practises as information base for responsive extension services to mitigating the effect agroclimate change on agriculture.

Methodology

Development of this paper was based on extensive review of literature on agroclimate change, its resultant effects on agriculture and adaptive production practises for mitigating the effects of climate change on agriculture, with focus on the developing countries where the effect of climate change, usually negative, is believed to be strongly manifested Lotze-Campen (2011). In addition, empirical studies on agroclimate change and adaptive measures for its mitigation in the Nigerian context were extensively reviewed to develop a theoretical information base by which responsive extension service guides can be developed farmers adoption.

The concept of Climate: climate and weather differentials

On the ground that the terms 'climate' and 'weather' are both influenced or determined by climatic indices such as temperature, precipitation, air pressure and cloud, the two terms becomes closely related and as such may become mistakenly assumed to mean the same. Rresearchers and authors on climatic issues have however ascertain the existence of technical difference between the two terms, technically based on time frame of the prevalence and dominance of the climatic indices or elements. In the light of this, Rybya (2008) stresses that 'weather' is what condition of the atmosphere is over a short period of time, usually from minutes to hours, hours to days, and days to season. For instance, the trend of daily

occurrence and predominance of temperature, rainfall and humidity in particular day determine the day's weather as either hot, dry, sunny, raining or snowing (Bunnett & Okunrotifa, 1990; University Corporation for Atmospheric Research- UCAR, 2003).

'Climate' on the other hand is what the atmospheric condition is over a relatively long period of time, usually on the average of thirty years and above (Bishop et al, 1989; Weatherwizkids, 2010). In essence, the average weather condition of a given region over a period of nothing less thirty years would give rise to the climatic condition of the region. In view of this, it suggests that the weather elements are inherently variable from minutes to months and such are essentially monitored, recorded and documented by meteorologists for weather forecast and weather-based action decision making. On this ground, it suggests that decades of inconsistent weather variability becomes responsible for the emergence of climate change as it were in today's world.

The concept of agroclimate: a perspective of climate and relationship with agriculture

Among every other endeavours of mankind for social and economic development, agricultural production is known to be directly and largely influenced by the climate. This is based on the fact that successful and sustainable farm enterprise production depends on favourability of climatic elements such as rainfall, temperature, solar radiation, evaporation and transpiration (Anuforo, 2009). The interactive influence of these climatic elements on agricultural production thus gave rise to the term 'agroclimate'. In view of this, successful farm enterprise production would be attained only with conscious and conscientious monitoring of the daily occurrences of the agroclimatic elements, and making applications of the derived information in farm production planning and decision-making.

The predominant climatic element and its duration of variability over a considerable period of time however determine the state of agroclimatic condition of a particular farming environment. For instance, the prevailing temperature range from region to region form the basis for categorisation of the global climate into four main climatic conditions, namely the hot, warm, cool and cold climates (Bunnett & Okunrotifa, 1990). On another note, the rainfall situation of the hot climate, as indicated by Beet (1990), form the basis for categorisation of the tropical climate into four major humidity statuses namely, the predominantly humid, seasonally humid, semi-Arid and dry climates. Within each of these climatic zones, annual rainfall variability, as indicated by Walsh (1981), further form the basis for categorisation of the prevailing seasonality as wet or dry season.

The Nigerian agroclimate and relationship with farm enterprise distributions

Nigeria, with a land area of about 923, 291square kilometre and situated on latitude $4^{o}21'$ to $14^{o}10'$ north of the equator, and longitude $2^{o}15'$ to $14^{o}15'$ east, naturally has a hot climate. The country is however structured into different agricultural zones based on natural factors such as climate, soil type and vegetative cover. In view of the prevailing vegetative cover, Nigeria is divided into two major vegetative zones, namely the forest and the savannah zones; and based on the varying rainfall distribution across the country, the country is categorised into seven major agroecological zones, namely mangrove/swamp forest, rainforest, montane forest/grassland, derived savannah, guinea savannah, sudan savannah and sahel savannah zones (Sowunmi & Akintola, 2010). According to Obioha (2009), the

mean annual rainfall across the ecozones ranged between more than 2000mm in the mangrove/swamp zone to about 200mm in the semi-arid/sahel zone. The maximum mean temperature range varies between 40°C in the semi arid and 31°C in the plateau zone, while the minimum varies between 5°C at the mountain zone and 23°C in the humid climate.

The prevailing rainfall pattern, in terms of intensity and duration of distribution; alongside the soil types characterising each of the agroecological zones, determines the types of crops and farming system that can be or are commonly practised in a particular ecozone of the country. For instance, the southern part of Nigerian, which largely falls within the swamp/mangrove forest and rainforest, and partly within the savannah agroecological zones, and characterised by mean annual rainfall of more than 2000mm per annum, mean monthly temperature range of 26 – 28°C andwell drained soils, is largely dominated by crops such as tubers, maize, rice and tree crops such as cocoa, kola, rubber, oil palm, citrus etc. The northern part of the country which on the other hand largely falls within the savannah ecozones and characterised by mean annual rainfall of less than 500mm and sandy soil is where crops such as cereals and pulses – millet, guinea corn, groundnuts and cowpea are commonly cultivated. Similarly, while the West African Dwarf sheep and goats constitute common small farm animals in the southern part of Nigeria, the likes of balami, yankasa, sokoto red dominated the northern region of the country.

Although, particular crops or farm animals may be commonly produced in a particular ecozone of the country, it does not necessarily imply that such crops or animals are peculiarly confined to such ecozones (Nwafor, 1982), but in natural practice, some of the cultivated crops or animals raised in one agroecological zone may as well be cultivated or raised in other ecozones. This may however be produced on lesser intensity in relation to the ecozone where the crop(s) are intensively and extensively cultivated or the animals raised.

Dynamics of climate change and implications for agriculture

Climate is an important atmospheric factor with great influence on agriculture globally. Such influence is interactively brought about by climatic elements such as rainfall, temperature, humidity, evaporation, transpiration and soil condition (Mubiru, Nanyeenya, & Ssali, 2008). Stability and predictability of these climatic elements are crucial to successful and sustainable farm enterprise production, assured food security and poverty alleviation. It is however chagrin that the climatic elements that were once predictable were no longer so with the resultant damaging effects on social, economic, health, environment and livelihood statuses of man.

Dynamics of climate change takes different dimensions and this could be reflected in form of flooding, dryness and droughts, carbon dioxide concentration, higher temperature, changing precipitation and water availability, sea level rise and soil degradation/erosion (Lotze-Campen, 2011). This situation, as pointed out by the Technical Centre for Agriculture and Rural Cooperation – CTA (2008), is believed to have been brought about man's activities ranging from burning of fossil fuel, deforestation and agricultural practices. While the burning of fossil and deforestation are believed to have respectively produced about 6 and 1.6 billion tons of greenhouse gases (GHG) in form of carbon dioxide; related agricultural activities produced between 15 and 100million GHG in form of methane and dinitrogen/nitrous oxide. Concentration of the GHG in the atmosphere thus alters or

hinders the smooth systems of carbon and water cycle – the natural climate stability maintenance and sustenance mechanisms, thereby creating extreme weather and climatic conditions with negative effects on agricultural production and productivity. The varying dimensions of the climate change however impinge on agriculture and other livelihood endeavours of mankind either interactively or in isolation as expatiated below.

Resultant effects of climate change on agriculture

Effects on crop production: successful crop production certainly depends on good rainfall distribution, soil water availability, adequate temperature and soil structure. Extreme variation of these climatic factors from what is required by cultivated crops certainly results in crop failure. According to Anuoforo (2009), the vagaries of the climate results in crop failures and its attendant food scarcity malnutrition, unchecked disease, untimely famine, with a staggering loss of human and animal life. In addition to this are the spread of pests and disease of crops, biodiversity losses, abrupt vegetation change and poor yield of cultivated crops.

Effects on livestock production: the known effects of climate change on livestock production include reduced fodder quantity and poor nutritional quality, and poor animal performance in terms of poor meat, milk and egg quality and yield quantity. According to Mubiru et al. (2008), changes in temperature affect livestock feed intake and milk production. On another note, Ndikumana, Stuth, Kamidi, Ossiya, Marambii & Hamlett (2008) observed that the southern Ethiopia and northern Kenya respectively experienced about 37% mortality of cattle and 52% small ruminant mortality due to a resultant flooding from high sea level. And during the droughts, the southern Ethiopia experienced about 49% cattle and 52% small ruminant mortality while the northern part of Kenya had about 35% cattle and 43% small ruminant mortality.

Effects on aquatic production: Aquatic lives are not spared as a rise in sea levels caused by the melting polar ice caps result in flooding, storm surge; and higher tides leads to drops in fish production. In the same vein, the Intergovernmental Panel on Climate Change (IPCC) in CTA (2008), indicated that about 75% of the key fishing grounds are greatly threatened by increased acidity level of bodies of waters (seas and oceans) arising from high greenhouse gases (GHG) emissions in the form of carbon dioxide and intrusion of salt water in the water table of the coastal areas.

Effects on seasonal farming calendar: empirical assessment of the effects climate change on agriculture, particular in the developing countries, showed that extreme variability in rainfall pattern, for instance in Nigeria, has greatly characterised the farming season by false or late onset of the rains, pronounced breaks during the rainy season, and early cessation of the rains (Ekpoh, 2010). Other daunting effects of varied rainfall pattern on agriculture, as indicated by Dai, Lamb, Trenberth, Hulme, Jones, & Xie (2004); Anyanwole (2007), include shortened lengths of growing season, disruption of the usual pattern of soil water availability, incorrect timing of commencement of farm operations, crop failures and declining yields. This in turn, brought about falling farm incomes and associated problems of food shortage, malnutrition and general impoverishment of local inhabitants (Ekpoh, 1999; Mortimore and Adams, 2001).

In view of the negative impact of climate change on agriculture and mankind's livelihood in general, it becomes not only important, but urgent to take adaptive measures locally, regionally and globally in order to limit the hampering effects. Adaptive measures to be taken would however depend on good knowledge of the agroclimatic situations; and this can only be attained by appropriate monitoring of the climatic indices and analysis of the collected climatic data for generation of valuable information for pragmatic extension service design and farm enterprise production-decision by farmers.

Essential agroclimatic indices for generation of extension information for farmers

Given that rainfed agriculture is the common practice in the Nigeria's agricultural system, it becomes essential to ensure that daily occurrence of weather elements, especially rainfall, humidity, temperature, solar radiation and potential/ evapotranspiration, are conscientiously monitored by meteorologists and have it translated to useful agro-information for onward dissemination to farmers for farm production planning and decision-making (Akintola, 2002; Anuforo, 2009). In the light of this, functional meteorological stations must be put up for daily collection of data on the agroclimatic elements. However, salient climatic intricacies that are inherently crucial to attaining sustainable farm enterprise production, especially under a rainfed agriculture, include the rainfall pattern, raindays and growing period, dry day spells, rainfall variability, actual water availability and evaopotranspiration rate (Persuad, Ouattara & Alfari, 1987; Perrier, 1987; Lawal-Adebowale, Omotayo & Okuneye, 2006; Bello, 1997; 2008). Collection and analysis of these weather elements could thus provide useful agro-information-base in the following ways:

Rainfall distribution: Collection and analysis of daily rainfall data should reflect what the rainfall situation of a particular farming environment is, thereby making it possible for determination of the onset, duration, intensity and cessation of the rainfall. For instance, analysis of three decades of rainfall distribution in Nigerian by Bello (2008) ascertains the mean dates of the onset and cessation of rainfall in the Nigeria's rainforest zone to be between March 29th and November 12th; between April 17th and October 18th in the Southern Guinea Savanna region; between May 15th and September 30th in the Northern Guinea Savanna region and between June 15th and September 22nd in the Sudan Savanna region. This understanding, as posited by Lawal-Adebowale & Oyegbami (2004), provides the extension agencies the information-base for realistic design of seasonal farming calendar by which the rural farmers could be guided on farm-action planning and implementation. Appropriate articulation of such farm-action planning with the rainfall pattern makes it possible for the farmers to take full advantage of the rainfall distribution for timely take off of land preparation and seed sowing.

Raindays and duration of growing season: Raindays refers to the days with the occurrence of rainfall of at least 0.25mm. For instance, analysis of daily rainfall distribution in the Nigerian rainforest zone by Lawal-Adebowale, Omotayo & Okuneye (2006) showed that the ecological zone has about 88 rain days. The growing season on the other hand ranged between the first and last months with the average rainfall of 51mm. In the light of this, Bello (2008) indicated the length of growing season average 225days in the rainforest zone and 91days in the sahel zones. The value of this information for responsive extension guide is that, only crops that will complete their production cycle within the established growing

periods would be recommended for cultivated. According to Bello (1987), arable crops such as sweet potatoes, cassava, cocoyams, yam, sugar cane, groundnut, rice millet maize and sorghum with gestation period of 90 to 365days, can be conveniently cultivated in the rainforest ecozone of Nigeria.

Dry day spells: This is an important rainfall-related element of importance to crop cultivation. Arising from the fact that rainfall takes place only in a number of days of the weeks and months of a year, it is apparent that there are days or weeks of little or no rain. Thus, the length of days between the occurrence of one rain and another refers to the dry day spells. A two-decade (1981 – 2000) analysis of rainfall distribution in Ogun State by Lawal-Adebowale (2002) for instance, showed on the average, that the raining season in the state is largely characterised by 2 to 4 dry day spells, and this implies that there will always be 2 to 4 consecutive days of little or no rain within the months of the rainy year. Muleba (1987) identifies 10 to 25 dry day spells in Kamboinse, Fada N'gourma and Saria regions of Burkina Faso – a region similar to that of Sudan Savanna in Nigeria. The value of this information to extension agencies is that they can readily guide the farmers on when seed sowing should take place and thus prevents soil-water shortage to the cultivated crop, especially at the critical stage of germination. A longer dry day spells would however portends danger of soil-water stress for the cultivated crops.

Rainfall variability: Notwithstanding the establishment of the rainy periods, it is pertinent to be cognisance of the fact that the same amount of rainfall will not persistently occur throughout the rainy season. Aside the occurrences of dry day spells, the amount of rainfall on rainy days varies over the days. For instance, rainfall distribution in Nigeria, as indicated by Bello (2008), varies between 90 and 225days (from the north downward south). The variability, determined by coefficient variability (CV), is essential in determine the extent to which rainfall distribution is concentrated within a short period or spread through a longer period. As indicated by Jagtap (1995), CV of less than 50% implies well distributed rainfall throughout the rainy season and a higher CV of more than 50% suggests a poorly distributed rainfall. Based on this, crop farmers could be guided on what soil water conservation or draining measures to put in place in case of too little or too much soil-water, and by this, adequate soil-water availability for crop growth and productivity can be ensured.

Actual water availability: Although, the highlighted weather elements are crucial to crop enterprise production, other related climatic factors of importance to crop production include transpiration, evaporation and actual water availability. The evapotranspiration (combination of evaporation and transpiration) process, which constitutes the means of water loss from the surface of the earth, determines the actual soil-water availability for use of cultivated crops. According to Bello (2008), relation of actual water availability to crop-water requirement is crucial to attaining successful crop cultivation in any farming season. In other words, dependence of crop cycle on actual soil-water availability for increased production is more crucial than dependence on the length of the rainy season. In addition, good knowledge of water use efficiency or water requirements of cultivated crops is crucial to effectively guiding the farmers on what specific crop to be cultivated in a particular farming environment and in a particular time-period of the farming season.

Adaptive farm enterprise production for mitigation of agroclimate change: The theoretical framework for responsive extension services in Nigeria

Agricultural extension service has the main goal of empowering the farmers such that they are able to improve their productivity and level of living through the applications of provided knowledge or technologies by the extension agencies. Extension practitioners however depend on the research system for proven and applicable technologies or technical information with which they can adequately and effectively educate and guide the farmers on farm enterprise production measures to be taken for sustainable agricultural production. In view of the heavy reliance of the Nigerian rural farmers on the rainfall distribution for crop cultivation, it becomes essential for the Nigerian agricultural extension agencies to become fully armed with in-depth and up-to-date agroclimatic information for technical guidance of the rural farmers. To attain this, the extension agencies must rely on the agro/meteorologists and agronomists for the technical agroclimatic information.

Agro-meteorological information base: To really arm and empower the extension agencies to become responsive to the rural farmers' agroclimatic information needs, it becomes essential for the meteorologist to monitor the agroclimatic elements dutifully and ensure sound analysis of the collected data for agro-information generation. The generated agroclimatic information, which should reflect the rainfall situation of a given farming environment, including its characteristics distribution, raindays, rainfall variability, length of growing season, dry day spells; should be readily made available to the extension agencies for application in designing pragmatic seasonal farming calendar for appropriate guide of the farmers on what adaptive measures to be taken for attainment of sustainable and increased farm enterprise production.

Adaptive crop production measures: In addition to the agroclimate information, the extension agencies must be well equipped with production and conservative measures based on which the farmers could be guided on adaptive production measures to be adopted for sustainable production. Proven adaptive production practices that could be taken into consideration for guidance of the rural farmers on farm enterprise production include defined specific cropping seasons, good soil-water management systems, and irrigation system in its simplest form (Simpson & St Luce, 2008). Other farm practices of necessity for adaptive cultivation include mulch-farming, multiple cropping to decrease economic risk, planting of contrasting crop species, protective agricultural systems, and changing of crop varieties In line with this, Etene & Boko (2008) stress the need for shifting away from the traditional agricultural practices to adoption of new practices that include utilisation of new crop varieties and principles of fertiliser application, cultivation of larger fields and repeated sowing. In the same vein, Wokou, Boko & Sant'Anna (2008) opined adoption of less-water demanding crop varieties, as observed among the rice farmers in Agonlin Plateu, Benin, where less-water demanding rice varieties (rice nérica) were adopted to mitigate the effect of rainfall deficit and as such have their production enterprise improved. Another crop cultivation strategy to allay the effect of poor rainfall distribution is lowland crop cultivation, whereby cultivated crops could have access to, and efficiently utilize available soil-water. This strategy, as indicated by Youssouf, Léopold, Moussa & Ahmed (2008), is an important way of ensuring food security and territorial construction for agricultural development.

Adaptive livestock and fish production measures: Adaptive strategies for livestock production, as indicated by Richard (2008); Gordon (2008), include integration of agricultural and livestock activities or aquaculture and agriculture, community land management and development of agro-forestry. Other factors include paddock establishment and rotational grazing system for the animals; and the promotion of a participatory approach to livestock park management, and optimising cooperative strategies developed by the agro-pastoralists to increase their resilience (Jacques, Wahab & Patrice, 2008). Fisheries management, as indicated by Gordon (2008), must move from seeking to maximise yield to increasing adaptive capacity; and research needs to be innovative to further improve the existing adaptability of fishers and aquaculturists.

Synchronisation of seasonal farming calendar: Adaptive farm enterprise production measures, as opined by Bello (2008), entails appropriate synchronisation of the seasonal farming calendar with rainfall pattern, and more importantly, with the moisture regime component (actual water availability, evapotranspiration and crop water use) of the crops-soil relationships. Where the seasonal farming calendar is well articulated with the soil-water regime, it is apparent that even crop with longer growing periods than the period of effective water availability would most likely to perform better based on the fact that such articulations ensure that the total water requirements of the cultivated crops are adequately met at every critical stages of growth during the moist period (Bello, 1983; 1997). With this essentiality in mind, extension agencies would become responsive to farmers information need on adaptive farm enterprise production by which they can mitigate the effect of climate change on their productivity.

Conclusion

Given the background information on climate change and its implications for sustainable agricultural production, it becomes essential to ensure that weather elements are intentionally and carefully monitored for data collection and analysis, based on which agro-information that would help mitigate the effects of agroclimate change on farm enterprise production can be can be generated. Such information must however become incorporated in the planning of seasonal farming activities of the rural farmers through the support of the extension services. In addition, the crop-weather relationship could be modelled (Bello, 2008) such that it becomes possible to identify and relate the climatic parameters that are critical to the growth of particular crops at different stages of the phonological growth. For instance, modelling of maize-weather relationship by Bello (2008) shows that factors such as inter-diurnal variability of rainfall during the establishment stage; evaporation during the vegetative stage; mean length of dry spells during the flowering stage and during the grain filling stage; total rainfall during the flowering stage; and relative humidity during the flowering stage are critical and significantly correlated with maize yield at 95% probability. With this development, the extension agents must be able to educate and appropriately guide the rural farmers on when to commence crop cultivation, cropping system to be adopted, crop varieties to be cultivate and soil-water conservation measures to adopt. This technical information must reach the farmers on time and through the information and communication media that is readily accessible to them.

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Assessment of Rural Women's Awareness of Climate Change Adaptation Strategies in Aboh-Mbaise Local Government Area, Imo State

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Abstract
This study assessed rural women's awareness of climate change adaptation strategies in Aboh Mbaise Local Government Area (LGA) of Imo State. Sixty randomly selected women constituted the sample size for the study. A structured questionnaire was used to collect data. Both descriptive statistics namely; frequencies, percentage and mean score and inferential statistics were adopted in data analysis. The findings reveal that majority of the women (26.67%) fell within the age bracket of 30-39. Majority (96.67%) of the women were married. 51.67% finished secondary school while a few (20.00%) had no formal education. Majority of the farmers (45%) had farm size measuring up to 2ha and most of the women (60%) were into petty trading in addition to farming. The average mean income of women was ₦42, 416. 67. Majority of the women (98%) belonged to one social organization or the other. Most of the women were aware of all the listed effects of climate change and were also aware of many climate change adaption strategies, but were most aware of the use of suitable mulching materials (96.67%) and irrigation (60%) to help reduce drought damage. Only 5% of the respondents had extension as their source of information about climate change adaptation strategies. Multiple regression analysis showed that there was no significant relationship between respondents' socioeconomic characteristics and their level of awareness of climate change adaptation strategies. The study therefore recommended that the extension workers should put more efforts in giving out information on climate change adaptation strategies to rural women. Results of weather forecast should also be made available to women early enough either through personal contact or cell phone.
Key Words: Rural Women, Climate Change, Adaptation Strategy, Awareness.

Introduction

Agricultural production remains the main source of livelihood for most rural communities in developing countries and sub-saharan Africa in particular. Agriculture is the mainstay of the economy, contributing about 45 per cent of GDP and providing the means of livelihood for over 70% of the population (IFAD**,** 2009). Most farmers in Nigeria operate at the subsistence, smallholder level in an extensive agricultural system; hence in their hands lies the country's food security and agricultural development. Particularly striking, however, is the fact that rural women, more than their male counterparts, take the lead in agricultural activities, making up to 60-80 percent of agricultural labour force in Nigeria, depending on the region and produce two-thirds of the food crops (Ogunlela *et al, 2009*)

Women are responsible for very high proportion of food crop production in Nigeria, they are the gate keepers of food in the home, and are involved in production, processing, preservation, preparation and service of food in the home (Shelton 2009), they work to put food on the table. Women are the small holder farmers who cultivate hugely variable proportion of land across developing countries (Shelton 2009).

According to United Nations data, about 80 percent of the continent's smallholder farmers are women. While they are responsible for the food security of millions of people, agriculture is one of the sectors hardest hit by climate change (Palitza, 2011). The negative effects of climate change are likely to hit the poorest people in the poorest countries hardest. It is generally accepted that women constitute the majority of the world's poor since they are often more dependent upon natural resources and the adverse effects of climate change disproportionately affect women. For example, with increasing drought it is women who have to walk longer distances to collect water (LEG, 2002). (Olawoye *et al,* 2010) Their vulnerability to climate change comes both from being predominantly located in the tropics, and from various socio-economic, demographic, and policy trends limiting their capacity to adapt (Morton, 2007).

Adaptation is the process of improving society's ability to cope with changes in climatic conditions across time scale from short term(e.g. seasonal to annual)to long term (e.g. decades to centuries) Adaptations are also adjustments or interventions which take place in order to manage the losses or take advantage of the opportunities presented by a changing climate(IPCC 2001). Adaptation measures are therefore important to help these rural women in the rural communities to better face extreme weather conditions and associated climatic variations (Adger et al 2003). According to IPCC (2001), a wide variety of adaptive actions may be taken to lessen or overcome adverse effects of climate change on Agriculture. According to Bradshaw et al (2004), some of the important adaptation options in the agricultural sector include: crop diversification, mixed cropping-livestock farming system, using different crop varieties, changing planting and harvesting dates and mixing less productive drought resistant crops with high yield water sensitive crops.

Nigeria does not currently have a national adaptation strategy or cross-cutting institution empowered to guide national response to climate change (Moran *et al* 2011). The impacts of climate change on agriculture, food availability and livelihood security have intensified, people especially women may have heard the words 'climate change', but they don't have enough clue about what to do about it and where to access information and fund even though they are the ones working in the fields. It is only when farmers can understand the negative effects of climate change and its impacts can they prepare for and adapt to them. While many farmers are already coping with varying climatic conditions, the weather is becoming less predictable, and some of their strategies may no longer work. Effective communication approaches are critical to help farmers adapt to climate change (McKay, 2008). This will include taking into consideration the peculiarities of women as home runners, including the responsibilities of taking care of the children and other care giving responsibilities that make it difficult for them to have enough contact with extension personnel, lack of consultation of women who make up majority of smallholder farmers in the area. To take into account the gendered

nature of energy consumption and domestic labor patterns in a resource-poor context women need to be consulted when designing and implementing climate change mitigation and adaptation initiatives (Palitza, 2011). Current adaptation initiatives in Nigeria have positively impacted food security, but must take additional steps to address security risks that could arise from conflict contagion and unequal resource distribution.

The general objective of this study was to assess rural women's awareness of climate change adaptation strategies in Aboh-Mbaise Local Government Area, Imo State. The specific objectives were to:

1. describe the socio-economic characteristics of women;
2. assess women's level of awareness of the effects of climate change on crops;
3. ascertain women's level of awareness of climate change adaptive strategies;
4. determine the relationship between the socio-economic characteristics of women and their level of awareness of adaptation strategies.

Hypothesis

Based on the above objectives the following null hypothesis was tested.

1. There is no significant relationship between the socio-economic characteristics of women and their level of awareness of adaptation strategies.

Methodology

The study was carried out in Aboh-Mbaise L.G.A, Imo state. Aboh Mbaise Local Government Area is one of the Local Government Areas created in 1976; however, two Local Government areas have been carved out from it since its creation. They are: Ezinihitte Mbaise and Ahiazu Mbaise Local Government Councils. Aboh-Mbaise LGA is situated latitude 5'7i north and longitude 6'36i and 7'2i east. It occupies a total area of 182 kilometer. The people are predominantly farmers. Most of the farmers practice subsistence agriculture while few are into commercial farming. Crop production and animal husbandry are practiced. The crops produced include maize, cassava, yam, cocoyam, fluted pumpkin, pepper, garden egg, etc. The animals reared include poultry, goat and sheep. The population for the study comprises all the women farmers in Aboh-Mbaise; A multi-stage sampling technique was used in selecting the sample for the study. First, 10 communities were randomly selected out of the 28 autonomous communities. The communities were Ibeku, Lagwa, Obetiti, Umuhu, Mbutu, Nguru-Nweke, Nguru-Nwafor, Nguru-Nwekeoha,Nguru-Nworie and Nguru Nwenkwo. Secondly, 10 villages were selected randomly from the 10 communities, Out of the 10 villages selected, 6 respondents were randomly selected giving a total of 60 respondents. Structured questionnaire was used in collecting data.

Objective 1, was measured by asking respondents questions on their socio-economic characteristics. Objective 2 which elicited information on the level of awareness of the effects of climate change on crops was measured using a four-point likert type rating scale of fully aware = 3, aware = 2, partially aware = 1 and

not aware = 0. These values were added to get a value of 6 which was divided by 4 to get a mean score of 1.50; the respondents' mean was obtained on each of the item. Any mean score below 1.50 implies not aware (NA) while any mean value equal to or above 1.50 implies aware (A).

Objective 3 which elicited information on the level of awareness of climate change adaptive strategies was measured using a four-point likert type rating scale of fully aware = 3, aware = 2, partially aware = 1 and not aware = 0. These values were added to get a value of 6 which was divided by 4 to get a mean score of 1.50; the respondents' mean was obtained on each of the item. Any mean score below 1.50 implies not aware (NA) while any mean value equal to or above 1.50 implies aware (A).

Simple statistical tools such as percentage, frequency, mean was used to analyze objectives 1, 2 and 3 while objective 4 was analyzed by use of inferential statistics such as multiple regression analysis.

Results and Discussion

Socio-economic characteristics of women farmers in Aboh-Mbaise

Findings in Table 1 showed that 23.33% of the women were between the ages of 40-49. Majority (58%) were married. A greater percentage of the women had their secondary education while few (5%) attended tertiary institution. About 18% of the women had up to 3hectares of farm land and above and most of them had household size between 4 -7 and this may help in the provision of family labour on the farms. Majority of women indulged in petty trading which should help increase income for better adaptation. Greater percentage of women (28%) earned 50,000-60,000, this should increase adaptive capacity of these women. Few women (14%) had 40 years farming experience and above. Majority (55%) admitted belonging to one organization or the other implying that in the course of constant interaction with ther members, information exchange will be encouraged thus ideas on climate change adaptive strategies may spread. However, Unnayan (2010) noted that promotion of farmer' organizations will enhance access to improved services.

TABLE 1: Percentage distribution of women by socio-economic characteristics

Variables	Frequency	Percentage(%)
Age (years)		
20-29	2	3
30-39	13	21.67
40-49	14	23.33
50-59	15	25
60 and above	16	26.67
	60	100
Marital status		
Single	2	3.33
Married	58	96.67
	60	100
Education level		
No school	12	20
Primary school	12	20
Secondary school	31	51.67
Tertiary school	5	8.33
	60	100
Other occupations		
Civil servant	10	16.67
Trading	36	60
Artisan	14	23.33
	60	100
Income level		
10,000-20,000	3	5
20,000-30,000	11	18.33
30,000-40,000	14	23.33
40,000-50,000	5	8.33
50,000-60,000	28	46.67
	60	100
Farm size		
0.5ha	2	3.33
1ha	13	21.67
2ha	27	45
3ha and above	18	30
	60	100
Household size		
0-3	18	30
4-7	34	56.67
8 and above	8	13.33
	60	100
Farming experience		
10 years	10	16.67
20 years	19	31.67
30 years	17	28.33
40 years	14	23.33
	60	100

Level of awareness of the effects of climate change on crops by women

Rural women were highly aware of the effects of climate change. They were fully aware of the reduction in growth of crops, variation in fruiting, alteration in length of growth of crops, increased evaporation, increased food spoilage, and reduction in income with mean values of 3.00, 2.98, 2.88, 2.98, 2.93, and 2.96 respectively.

TABLE 2: Mean score distribution of level of awareness of the effects of climate change on crops by women

Effect of climate change	Mean (x)	Remark
Reduction in growth rate	3.00	A
Variation in fruiting	2.98	A
Alteration in length of growth	2.88	A
Cassava and yam have better increases in production than maize	2.41	A
Weeds grow faster	2.50	A
Increased evaporation	2.98	A
Proliferation of pests and diseases	2.55	A
Reduction in nutritional value	5.91	A
Increased food spoilage	2.93	A
Reduction in income	2.96	A

Source: Field Survey 2011

Level of awareness of climate change adaptation strategies by women

In level of adaptation strategies, women were most aware of adaptation strategies like alteration in planting dates, application of local manure, raised bed cultivation, use of bio pesticides, crop replanting intensifying multiple cropping etc. while they had low level of awareness of tree planting, zero/minimum tillage, use of shallow wells etc. They were not aware of local irrigation to help reduce drought.

Table 3: Mean score distribution of level of awareness of climate change adaptive strategies by women

Adaptation strategies	Mean (x)	Remark
Alteration in planting dates and fertilizer application	3.00	A
Intensifying Multiple cropping	2.71	A
Application of local manure	2.86	A
Tree Planting	1.93	A
Reduction in fuel wood usage	2.26	A
Crop Replanting	2.80	A
Use of shallow wells	1.68	A
Intercropping	2.75	A
Zero/minimum tillage	1.61	A
Availability of other indigenous techs/knowledge	1.88	A
Avoid new plantation in likely flood prone areas	2.66	A
Local irrigation should help reduce drought damage	1.26	NA
Raised bed cultivation	2.93	A
Protect the newly planted crops with suitable	2.95	A
Use of bio pesticides and organic formulation	2.83	A

Source: Field Survey 2011

Multiple regression analysis of the relationship between socio-economic characteristics of women and their level of awareness of climate change adaptation strategies

The result of the multiple regression analysis showed that level of income was found to contribute to women's level of awareness of climate change adaptation strategies. Age, marital status, education, household size, farm size, farming experience, other occupation and membership in an organization, were found not to contribute significantly to women's level of awareness of climate change adaptation strategies. There was a positive and significant relationship between income and women's level of awareness of climate change adaptation strategies at 5% level (t=1.8650). This implies that women with higher income were aware of climate change adaptation strategies and thus were able to afford the services that would ensure climate change adaptation. Based on the fact that most of the socioeconomic characteristics were not significant at 5% level and also the value of R^2 (0.1414) being low, we hereby accept the null hypothesis that says that there is no significant relationship between the socio-economic characteristics of women and their level of awareness of adaptation strategies.

TABLE 4: Test of hypothesis on the relationship between socio-economic characteristics of women and their level of awareness of climate change adaptation strategies

Explanatory	Linear function	Cobb Douglas function	Semi log function	Exponential
Intercept	3.778191	1.108485	2.974463	1.32805
	(22.34216)	(6.85854)	(4.853841)	(29.78002)
Age(X_1)	6.21e-06	-0.00061	-0.00565	2.89e-05
	(0.007045216)	(-0.01989)	(-0.04876)	(0.636075)
Marital status(X_2)	0.060964	0.0158	0.060533	0.015877
	(0.840366)	(0.827202)	(0.835822)	(0.829893)
Education level (X_3)	-0.0225	-0.01411	-0.05413	-0.00588
	(-0.97295)	(-1.171169)	(-1.18548)	(-0.96367)
Household size (X_4)	0.000978	0.005561	0.022989	0.006159
	(0.106092)	(0.531809)	(0.57984)	(0.665585)
Farm size (X_5)	-0.02028	-0.01719	-0.06424	-0.00543
	(-0.68361)	(-0.9247)	(-0.91135)	(0.69431)
Income level (X_6)	3.34e-06	0.027584	0.102099	8.96e-07
	(1.543046)	(1.86505)	(1.820697)	(1.56929)
Farming Exp. (X_7)	-0.00233	-0.01689	-0.06269	-0.00064
	(-0.61226)	(-0.86959)	(-0.85101)	(-0.637851)
Other occup. (X_8)	0.005571	-4.1e-05	-0.00115	0.001607
	(0.194657)	(-0.00294)	(-0.02195)	(0.212907)
Organizational Membership (X_9)	0.029383	0.007922	0.0029652	0.007839
	(0.770357)	(0.804833)	(0.794471)	(0.779254)
R^2	0.111334	0.141497	0.13991	0.113691

Figures in first rows are coefficient, while figures in parentheses are t-values.

Source: Field Survey 2011

Conclusion and Recommendation

The study revealed that most of the women were aware of the effects of climate change on crops and most climate change adaptive strategies; however most women were not aware of the use of local irrigation to reduce excess drought as an adaptive measure. Those women with higher income level showed to be more aware of climate change adaptation strategies.

This paper recommends therefore that extension services be intensified towards giving information and technical assistance to rural women by making sure that field extension staff visit farmers more frequently than they are already doing, this is in order to help them adapt well to the effects of climate change. Results of weather forecast should be made available to the women early enough. This will also require the services of extension personnel in order to help the rural women to increase climate change adaptive capacity.

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Potential Roles of Farmer Field School Extension Approach in Climate Change Mitigation and Adaptation In Sub-Saharan Africa

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Abstract

This paper explored the potential roles of farmer field school (FFS) extension approach in climate change mitigation and adaptation in sub-Saharan Africa. It reviewed literature on some research findings focusing on the impact of climate change on agriculture and impact of agriculture on climate change. It also x-rayed various local adaptation and mitigation strategies to climate change. The paper shows that climate change and agriculture affect each other significantly. It also reveals that the impact on and from both sides will persist even at an increasing rate in sub-Saharan Africa should there be no drastic measures taken to reverse the trend. These measures should aim to increase agricultural production while reducing the contribution of agriculture to climate change. Farmer field school on the other hand, is an agricultural extension approach in which the principle of participation and experiential learning is utilized in developing and transferring location-specific farming technologies. It is a group based learning technique in which local farmers are guided through the help of a well trained facilitator, who in most cases is a fellow farmer or an extension personnel, to carefully observe their farming processes, conduct their own field experiments and proffer solutions to their farming problems. This paper shows that FFS has the potential to serve as a platform for conveying recommended adaptation and mitigation strategies to climate change. It can also serve as an avenue for continuous education of the local farmers on how to adjust effectively to the various changes that may likely occur in their farming environments as a result of climate change. The paper therefore recommended that FFS should be adapted and mainstreamed into climate change adaptation and mitigation programmes in sub-Saharan Africa.

Keywords: Climate Change, Farmer Field School, Adaptation, Mitigation, Agriculture

Introduction

Nowhere on the planet are people more vulnerable to the impacts of climate change than sub-Saharan Africa (World Bank, 2010). The region is already prone to erratic rainfall, droughts, floods and cyclones. At the same time, Africa is grappling with the burden of poverty, environmental degradation, inequitable land rights, heavy reliance on the natural resource base for livelihoods, and the HIV & AIDS epidemic – all of which limit the ability of people and institutions to adapt to climate change. Also, a similar report by African Agricultural Technology Foundation (AATF) (2005), noted that sub-Saharan Africa has a population of over 600 million people, and the highest hunger and malnutrition rates in the developing world. Nearly two-thirds of these people live in rural areas and depend on farming, hunting, fishing, felling of trees for fuel, rearing of domestic animals, etc for their living, and climate change will only exacerbate these challenges.

Meanwhile, it is a common knowledge that human activities are responsible for the increasing concentration of green house gases (GHGs) in the atmosphere, causing global warming. Fossil fuel combustion, deforestation, agriculture, etc, are among human activities that are responsible for the emission of major anthropogenic GHGs (carbon-iv-oxide, methane and nitrous oxide) into the atmosphere (Aja *et al,* 2009; Eheazu, 2011). In low-income countries especially in sub-Saharan Africa, agricultural practices, land-use change and forestry constitute the main cause of GHGs emission (World Bank, 2010).

While efforts are currently on top gear to stabilize or at least reduce global GHGs emission, it has been predicted that most emissions growth in the next few decades will occur in developing nations, whose current carbon footprint is disproportionately low and whose economics must grow rapidly to reduce extreme poverty (World Bank, 2010). The challenge therefore lies in the ability of these nations to maintain the desired balance between meeting these developmental demands including the need for increased food production, and the need for sustainable environmental management. This is the reason behind the recent calls for a paradigm shift in approach to responding to climate change phenomenon. The activities of small holder farmers in Africa are no doubts very crucial in climate change mitigation and adaptations.

Since the advent of farmer field schools (FFS) in the 1980s for rice-based cropping systems, (and with their evolution for other crops as well), there is a huge potential to use this farmer training and learning methodology in farming communities affected by climate change. As an adult learning methodology, FFSs have been used to train millions of farmers worldwide, and its influence is still growing. A global survey in 2005 estimated that by 2008, over 20 million farmers would have graduated from FFSs (Braun and Duveskog, 2008). The basic concept of FFS is such that allows farmer participants to learn and share knowledge using a participatory/bottom-up approach. The idea is that once farmers understand the biological processes of their production environments, and adjust their cultivation and cultural practices accordingly, the desired long-term resilience to climate change can be achieved.

Unfortunately, despite the usefulness of this learning methodology and its global appeal, its potential roles in responding to climate change are yet to be properly documented. This has however created a knowledge gap, which this paper tends to fill up. To achieve this purpose however, the relationship between climate change and agriculture was reviewed. The responses to climate change by local farmers were also explored, and lastly the paper identified various areas in which FFS could be exploited in climate change mitigation and adaptations in sub-Saharan Africa. It is hoped that this paper will be a useful document for other researchers, students and policy makers in climate change and agriculture.

Climate change impacts on agriculture

There are several ways in which climate change may impact small holder agriculture (Morton, 2007; Nelson *et al*, 2010). Four types of direct impact can be discerned – impacts on (i) biological processes affecting crops and animals; (ii) environmental and physical processes, which affect production at the landscape, watershed or community levels, (iii) human health and (iv) non-agricultural

livelihoods. There will also be indirect impacts including: (i) off-site impacts and (ii) impacts of adaptation and mitigation interventions (Lamboll *et al,* 2011).

Climate change in sub-Saharan Africa is projected to be accompanied by greater variability in rainfall and temperature (Ofoh, 2009; Eheazu, 2011). Temperature increases will have detrimental effects on agriculture because of an increase in the number of extremely hot days, a reduction of rainfall and soil moisture, and an acceleration of crop development that would lead to premature ripening of fruits and lower yields in crops such as cereals. Increased rainfall variability would result in more frequent floods and droughts and larger runs of wet and dry years giving rise to frequent changes in agro-climate characteristics and increased variability in the yields of crops in the different ecological zones. Heavier than normal rainfall would lead to destruction of crops in the field, greater post-harvest losses, loss of arable land and increased growth of weeds (Ofoh, 2009). Significant reduction of rainfall in the Sudan-Sahelian belt would make the region drier with consequent reduction in crop productivity. Decreased rainfall in the region would also reduce the primary productivity of grassland areas and thus affecting grazing areas for livestock. Indirect effects of climate change on agriculture include the effects on pests and diseases and the impacts of these on agricultural production, health and agro-related socio-economic activities. Various pests including the tobacco cutworm, rice stink bug, rice weevil and soybean pod borer would probably expand their distribution areas in the event of climate change (Eheazu, 2011). In support of the scenario above, Ofoh (2009) and Eheazu (2011) both argued that warmer and more humid conditions would enhance the growth of bacteria and would have effects on many stored food and this would increase food spoilage and create some toxicological health hazards. The sea level rise would lead to submergence of the low lands along the coast, and much of the land currently used for agriculture would be lost. The impacts of climate change on agriculture are enormous. Agriculture also contribute to the cause of climate change.

Impacts of agriculture on climate change

Agriculture is one of the major contributors of GHGs emission. At the global scale, agriculture alone accounts for 14 percent of the total GHGs emitted into the atmosphere (Aja *et al*, 2009; Ram, 2009; World Bank, 2010). This figure is slightly higher in low-income countries (including sub-Saharan Africa), where agriculture is responsible for 20 percent of GHGs emissions (see figure 1.0 below).

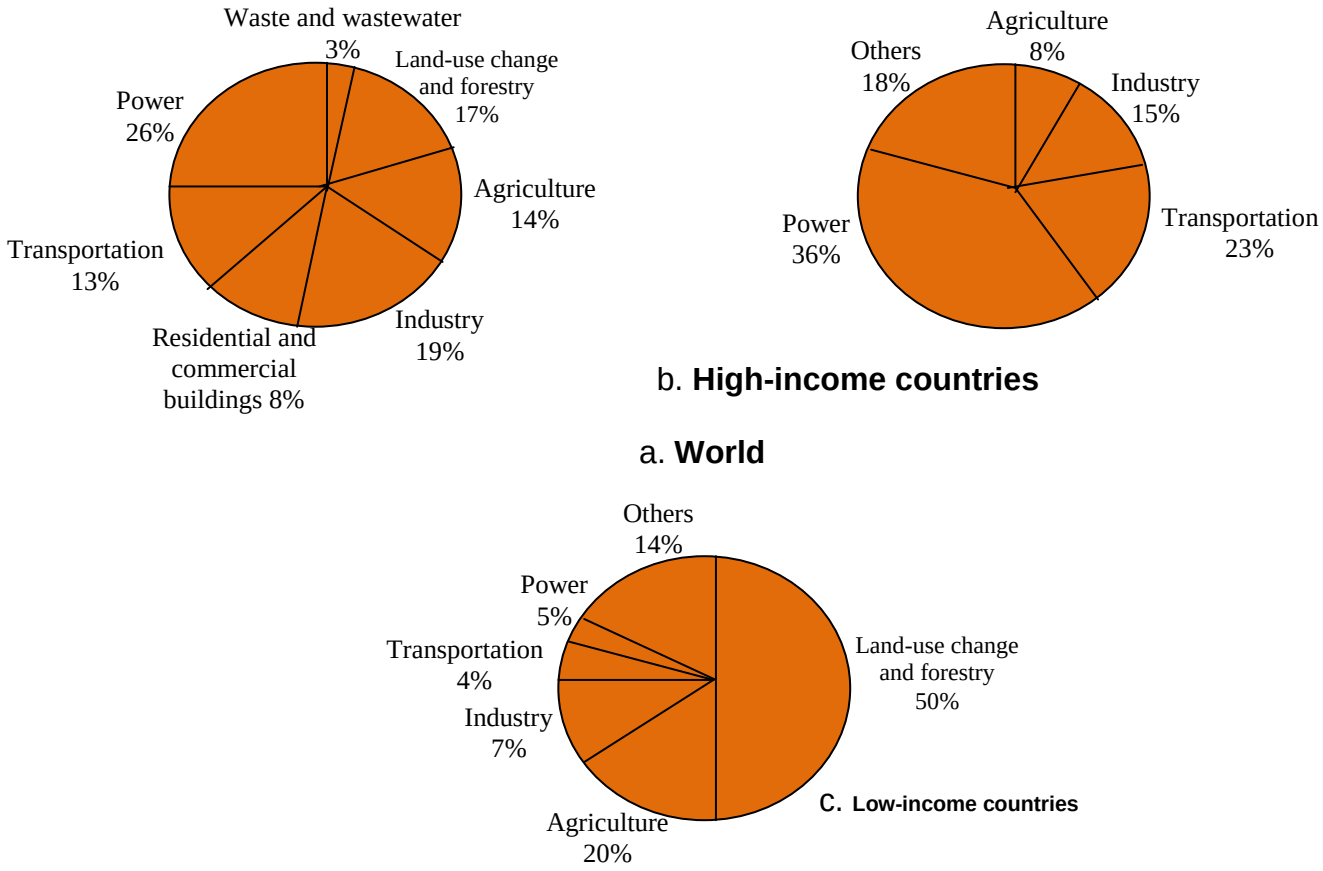


Figure 1.0: Greenhouse gas emissions by sector, world, high and low-income countries

Source: World Bank, 2010.

According to the World Bank (2008), agriculture contributes about half of the global emissions of two of the most potent non-carbon dioxide greenhouse gases: nitrous oxide and methane. Livestock manure, nitrogenous fertilizers and irrigated paddy are said to be responsible for producing most agricultural nitrous oxide and methane emissions.

Destruction of forests for agricultural purposes also contribute immensely to GHGs emissions especially in Africa. In view of this, Sara (2001) stated that whenever a forest or grassland is converted to agricultural usage, a lot of carbon is lost, and after conversion, much less carbon is usually stored in the soil and in crops and pasture, and carbon is released when crops are harvested and processed. Limiting the loss of carbon due to agricultural practices is one way that farmers can begin to help mitigate the problem of climate change. In addition, the farmers are also expected to develop resilient systems that can contend the shocks associated with climate change (adaptation).

Responding to climate change in agriculture

Responding to climate change is either by addressing the causes (mitigation) or addressing the effects (adaptation). Climate change mitigation and adaptations in agriculture will require new technologies, farm-level innovations and changes in broader institutional arrangements. According to Lamboll *et al* (2011), progressive climate change is likely to require more major responses such as complete changes

in farming systems, livelihood diversification and migration. They further argued that the diversity of farming contexts, the complexity of livelihood strategies and the uncertainties of climate change, combined with other factors, suggest a need to support localized innovation to enhance and sustain agricultural performance and resilience. Promising options for mitigating climate change in agriculture include improved crop and grazing-land management, restoration of organic soils and restoration of degraded lands (Lamboll *et al,* 2011). The implication is that climate change adaptation in agriculture will definitely involve a lot of modifications in current farming practices. According to Onyeneke and Madukwe (2010) and the Building Nigeria Response to Climate Change (BNRCC) report (2011), important adaptation strategies may include:

- changing planting dates, including early planting and early harvesting of improved varieties,
- changing tillage operations (full tillage, digging ridges across farms, minimum tillage),
- Planting trees to serve as shade and act as a wind break,
- Water harvesting,
- Portfolio diversification (planting improve crop varieties, intercropping, crop rotation),
- adoption of soil conservation techniques (cover cropping, mulching, application of fertilizers),
- irrigation,
- bush fallowing,
- domestication of forest products,
- diversification of crops produced,
- use of early maturing crops,
- expanding skill sets,
- building storage facilities for various farm products,
- attending field schools to improve cultivation methods,
- construction of culverts to enhance water passage to/from farmlands,
- improved transportation to point of sale to prevent spoilage of produce, and
- introducing and expanding the production of hydrophytes (like water lettuce) and halophytic crops (like groundnut-Ex-Dakar cultivar).

Both climate change mitigation and adaptation would definitely involve a series of decision making at the farmers' level. Empowering farmers (through training in FFSs) will help them in making rightful decisions whenever faced with climate

change problems. According to Gershon *et al* (2003), FFS training aims to affect farmers' knowledge, which can be interpreted broadly to include the possession of analytical skills, critical thinking, and ability to make better decisions, as well as familiarity with agricultural practices and understanding the interactions within the agricultural ecosystem. Improved knowledge is in turn reflected in farmers cultivation procedures, input decisions and crop yields

FFS and its potential roles in climate change mitigation and adaptations

The farmer field school (FFS) is a group based learning process. It involves simple experiments, regular field observations and group analysis. The knowledge gained from these activities enables participants to make their own locally-specific decisions about their farming practices. Asiabaka (2010), stated that "this approach (FFS approach) combines field–based and location specific training with experimentation to equip farmers with skills, knowledge and attitudes required to make ecologically sound and cost effective decisions in growing healthy crops. FFS will play important roles in climate change mitigation and adaptations. These roles may range from serving as platforms for conveying recommended strategies for climate change mitigation and adaptations to providing farmers with practical form of education. It is one thing to propose adaptation and mitigation strategies but another thing to properly convey it to the intended end-users especially when it involves a heterogeneous environment like sub-Saharan Africa. According to Narteh *et al* (2010), it is common for technocrats, governments and researchers to think through and propose new technologies to combat climate change, but how to effectively convey such ideas is probably more difficult than developing the technology itself because of the sociological and economic circumstances of the clientele. Often times, new technologies or innovations end up as documents in government agencies or departments without getting to the intended beneficiaries.

In addition to serving as platforms for conveying climate change response strategies, FFS offers good opportunities for effective farmers' education on issues pertaining to climate change. Farmers need to understand how their activities can contribute in the causing of climate change or how they can manage their farming environments for growing healthy crops during this climate change regime. Although, the Food and Agricultural Organization (FAO) of the United Nations is currently proposing an adaptation of the FFS methodology to enable farmers manage the changes in their cropping and farming environments (Narteh *et al*, 2010), it is believed that only through participatory learning methodology like FFS that farmers can be effectively empowered with the skills, attitude and the knowledge needed to handle the series of changes in their farming practices occasioned by climate change. For example, sehle and Garba (2009), noted that farmers need to know how soil amendments promote the action of soil-based organisms, which facilitate access to key nutrients and suppress plant diseases; how insects and worms help build a healthy soil structure, which in turn promotes water and nutrient–holding capacities and recharges groundwater resources; or how native pollinators and predator insects can be conserved to enhance key ecosystem services that contribute to more efficient farming systems. Thus, without some practical form of education, farmers rarely have access to this kind of knowledge. Without a clear understanding of these processes, it will be difficult for farmers to appreciate the changes that may occur in their farming environment and to make the necessary adjustments for them. According to Asiabaka (2010), when

agricultural development leads to undesirable side-effects in terms of environmental pollution, erosion, and destruction of habitats and landscapes, practical form of education comes handy to influence the farmers' behaviour in directions which are in accordance with public interest. The success stories of FFS approach in addressing similar problems have been documented in countries where the methodology is popular such as in Indonesia, The Philippines, Kenya, Ghana, and Nigeria (Gershon *et al*, 2003;Braun and Duveskog, 2008; Asiabaka, 2010; Aja *et al*, 2011).

Conclusion and Recommendations

Developing countries especially sub-Saharan Africa will bear the brunt of the effects of climate change. Both climate change and agriculture affect each other significantly, and for effective adaptations to and mitigation of climate change, adjustments in agricultural practices are inevitable. And for small holder farmers in low income countries to effectively adjust their farming practices in response to climate change, there is need to strengthen various educational programmes available to them especially the FFS Programme. The idea is that once farmers understand the biological processes of their production environments, and adjust their cultivation and cultural practices, the desired long-term resilience to climate change can be achieved. To this end therefore, it is recommended that FFS methodology should be adapted and mainstreamed into climate change adaptations and mitigation programmes in sub-Saharan Africa.

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Mainstreaming Women and Youths in Climate Change Mitigation and Adaptation in the Less Developed Countries

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Abstract

Climate change today is negatively impinging on many nations, peoples, cultures groups, systems and individuals, but the intensities vary. It is generally understood that this phenomenon is disproportionately affecting the poor. Because of their reliance on local ecological resources, in addition to existing stresses from health and well-being pursuits, limited financial, institutional and human resources, the poor are the most vulnerable and least able to adapt to climate change impacts. Women are more susceptible to these adverse effects of climate change because they constitute the majority of the poor. Whereas women contribute about 80% of the global human labour force, they control only about 1% of the earth's wealth. They do not own land and can hardly purchase one, due to poverty as well as political and social deprivations. Similarly, the youth though full of energy, are unemployed, under-employed and poor, especially in the less developed countries. So making women – who are closest to nature than men – and the youth, the pivot for climate change mitigation and adaptation programmes, will invariably raise living standards, reduce poverty, facilitate employment and eliminate or at least minimize social, political and economic disparities in societies. To achieve these, women and the youth should be given innovative education and training. They should have greater access to productive resources, and enhanced socio-political significance. Poverty reduction or elimination programmes should be focused on them. They should be more mobile than they are today. Women should not be encumbered with large family upbringing and maintenance. Women and the youth should have easy access to information, knowledge and skills, and participate actively in decision-making. These would be achieved through women and youth advocacy groups, such as women and youth climate change mitigation and adaptation networks (WYCCMAN).

Key Words: Androcentrists, Ecofeminists, Vulnerable,Vicissitudes, Strategies, Intergenerational

Introduction

In many cultures, until recently, women were to be seen, and not to be heard, especially in the less developed countries of the world. They were subjected to all forms of servitude as they struggled to care for their families and husbands. Consequently, they are poor, powerless and always pregnant as they bear the brunt of pronatalist pressures (Cunningham, Cunningham and Saigo, 2005).

Thanks to the impact of the Sahel drought of the late 1960s to the early 1970s, for stimulating the recognition of the role of women in environmental conservation issues in Africa and even globally. For the men in this region's countryside migrated en-masse, as the drought ravaged, leaving the women clogged with family and child care. (Oladipo and Tseayo, 1992).

There have been plaints and counter plaints between the Androcentrists, who believe that the main cause of mankind's environmental problems is the women, and the Ecofeminists, who maintain that a main cause of our environmental problems and the oppression of women are not just human activities broadly speaking, but specifically male-centeredness or male-dominated societies (Miller, 1996). The Androcentrists posit that, because women perform 80% of the human labour power, they are to be held responsible for the increasing environmental problems-"human mothers defiling an idealized Earth Mother" (Andersen, 2009:220). The Androcentrists suggest that human mothers should be schooled on how to stop degrading the idealized Earth mother.

Whereas, the ecofeminists, lament that "men generate environmental problems; women deal with the consequences" (Ibrahim, 1982) Echoing this, Oakley (2002) observes that, we live in a toxic world which posses a major threat to public and personal wealth. It's a world which is intrinsically and perpetually exploitative of human and natural resources, including ecosystems.

That the most culpable are men and male-dominated transnational corporations. The major victims are the poor, women and children and the populations of Third World countries.

Indeed the exigency for mainstreaming women for climate change mitigation and adaptation is because they are very vulnerable, and are most likely to be disproportionately affected by the adverse impacts of climate change, because they constitute the majority of poor people (Gaye, 2009). More so, the youth are the leaders of tomorrow and should be actively involved in shaping their tomorrow, so as to avert the ugly consequences of inaction to this raging anthropogenic environmental degradation. This was aptly expressed by Pau Pau, a youth from the Philippines, who asserted that nothing could be more important than the future of our world. And that because the youth are the owners of tomorrow, they should step up as the major stakeholders and stand up for the type of future they want. (Partington, Corriero, Ghomeshi, Griffiths, *et al.*, 2007). Moreover, well articulated climate change mitigation and adaptation programmes have the potential for reducing the number of work-shy unemployed youths who turn to crime. (Haralambos, Holborn and Heald, 2008).

Objectives of the Study

This research is aimed at developing the following:

(i) Strategies for making women and the youth the centre stage in climate change mitigation and adaptation.

(ii) Methods for the recognition of women's and youth's knowledge and roles in environmental management.

(iii) Means of building on and strengthening women's and youth's experiences, knowledge and coping capacities in adaptation policies.

Methodology

The researchers consulted books and journals that dwelt on women and youth affairs, especially on women and youth empowerment. Books on sociology exposed the socio-economic status of women and the youth especially in the less developed countries (LDCs). While books on psychology depicted the sterling quantities of women of the youth that should be harnessed in climate change mitigation and adaptation efforts. Facts from the internet detailing current roles of women and the youths in environmental conservation in the LDCs were retrieved. These formed the guide for this qualitative research.

The Rationale for Women and Youth Mainstreaming in Climate Change Mitigation and Adaptation

The need for making women and the youth the pivot for climate change mitigation and adaptation programmes is underscored by the fact that, they constitute a major percentage of the poor, the unemployed and under-employed. Again, in most societies, especially in the less Developed countries (LDCs) they suffer many economic and social deprivations. So, mainstreaming them would remove or reduce these anomalies. Because, invariably, it would raise the communities' living standards, reduce poverty, facilitate employment, and thereby eliminate or at least minimize social and economic disparities (Lister, 2004;Oladipo and Tseayo,1992). Women in the course of farming and provision of food, fuel, water, health-care, child-bearing, sanitation and other basic needs are closer to nature than men. Some women who engage in mercantile activities use local resources that are prone to environmental degradation and most environmental degradations have "gender bias" effects. Women usually bear the burden due to extra labour to overcome or ameliorate the negative effects.

Thus, because much of the economic welfare of women and their families especially in rural areas is intricately tied to harnessing of natural resources, they need to know the current vicissitudes affecting these resources, the most crucial today being climate change. So, far any development and environmental protection to be genuine, enduring and stable, women must deeply be involved in them.

By women's extensive involvement in agriculture, they have, over the years, acquired extensive knowledge about natural resources. They have also developed different harmonious ways of relating with the environment, which are by far superior and more relevant for climate change mitigation and adaptation than the men's. For example, from their experience, women have developed adaptive strategies for efficient water management, classification and purification because of their flair for cleanliness and healthy living.

Because of women's greater exposure to the natural environment, diseases incidental upon exposure to such places affect them more than men. Moreover, women, nay the youth, have pivotal roles to play in the effort to assert the needed balance between population, and environmental resources' exploitation for sustainable development.

It is therefore evident that, as environmental problems increase, the problems of women increase; they become enervated and further impoverished. For instance,

as ponds, springs, and streams dry up, women travel longer distances at extra energy cost to source for water for domestic use. Whereas, when an environment is harshly un-bearable, the men out-migrate, leaving behind the women and children. So, as managers of environmental resources at the local levels, for their families, women have the capacity and the responsibility to solve environmental and population problems (Garg *et al,* 2007; Huffman, 2009).

Truly, women's and youth's wellbeing is the index of development (Wright and Nebel 2004). And, as Thomas Sankara succinctly puts it "decision makers must concern themselves with women's issues. To devise development planning without the participation of women is like using four fingers when you have ten" (Oladipo & Tseayo, 1992). Corroborating this, Durning (1990), asserts that "True development puts first those that society puts last". Undoubtedly, women and environment are decisively connected because they are closer to either the protection or destruction of it. So, they should form the hub of any discourse on environmental conservation.

Baring his soul, Juan Hoffmaister, a youth from Costa Rica deploring today's incautious actions of man laments that "Climate change is an issue of intergenerational justice. If we know how our actions affect our planet, it would be criminal to keep acting like we are now, knowing that it jeopardizes future generations" (Partington, Corriero, Ghomeshi, Griffiths, *et al*., 2007). Young people therefore have a very important role to play in demanding action and being a part of positive change. They are the future and climate change is their future.

Young people, for example, have lots of opportunities to engage with and impact environmental policymaking. They should not be "free riders", who prefer others to do the work of mitigation, so long as they can still enjoy the benefits of such efforts. They should be part and parcel of the collective action plan and implementation. (Partington, Corriero, Ghomeshi, Griffiths *et al*. 2007). The essence of women and youth mainstreaming effort in climate change mitigation and adaptation, should therefore, be to harness the potentials of women and empower them, and the youths.

The Goals of Women and Youth Mainstreaming in Climate Change Mitigation and Adaptation

When facing a new selective pressure, such as a different climatic condition, species generally, whether plants, animals or humans have three and only three alternatives: adaptation, migration, or extinction. Since the incidence of climate change is global reducing the effect (mitigation) and adjusting to it (adaptation), are the two reasonable options, not migration, otherwise we would head towards extinction of some species including humans (Wright & Nebel, 2004).

The women and youth mainstreaming efforts should contribute solutions for the continued existence of the social and natural environments. Such efforts should aim at assisting them identify their passions, and further stimulating them to turn such inspiration into effective actions. According to Gauthier (2007), (a teenager from Montreal, Canada), climate change programmes for the youth and indeed the women, should educate and encourage them towards sustainable lifestyles; tasking them to visualize the world they would want for their children.

The schemes should motivate them to unite and create this desired tomorrow. More importantly, they should aim at reducing women and youth vulnerability, and increasing their resilience to changes that threaten welfare, which can come in the

form of sudden shocks, long-term trends, or seasonal cycles. Such changes usually bring increasing risk and uncertainty (Moser, 2011).

Methods for Effective Women and Youth Mainstreaming in climate change mitigation and Adaptation

Women and Youth need adequate information and innovative educational progammes to cope with the vagaries of climate change. Such education should be site-specific, to be conducted at the women's and youths' vocational locations with varied intensity. The most intensive should be in the vocations' slack seasons (Durning, 1990).

The mainstreaming project should identify and commence with adaptive women, who can effectively combine paid work and family work, without prioritizing one or the other. And who are flexible and can, vary the balance between the two depending on current realities. The work-centered women, who focus more on career development, and the home-centred women, who prefer not to do paid work, can be keyed in systematically later (Hakim, 2004).

The project should adopt an asset-based adaptation approach, which would not simply provide for the women and youth "resources that they would use to build livelihoods, but would also give them the capability to be and act" (Bebbington 1999) That is, a basis of their power to act to reproduce, challenge, or change the rules that govern the control, use, and transformation of resources.

Moreover, comprehensive and integrated approaches, which include both mitigation and adaptation strategies, and the synergies between them, are needed to fully address the climate change challenge for women and youths. This is because, they also offer opportunities for the people to identify and take advantage of the associated and incidental co-benefits (Hoornweg, Freire, Lee, Bhada-Tata, *et al*., 2011). To facilitate this, women and youth groups need be galvanized to campaign and pressurize governments for the provision and use of sustainable energy sources. They also must spread awareness about the environmental effects of afforestation, deforestation, and factors influencing water supply, and efficient water management..

Women and youths should be encouraged to belong to existing global climate change networks, and form local ones, to enable them access information and opportunities about climate change readily, so as to strengthen their passions and actions. They should also be aided to belong to and form coalitions-an association of different groups or networks. This further enriches them in knowledge, approaches, actions and skills about the environment. Examples of such global coalitions are the Sierra Youth Coalition, Campus Climate Challenge, etc.

Conclusions And Recommendations

Ecological decline perpetuates poverty, because degraded ecosystems offer diminishing yields to their poor inhabitants, who are mainly the women and youths. This underscores the need to put women and youths first, in any ecological management and development plan, not only as intended beneficiaries, but as active participants, advisors, and leaders. This is because, true development does not simply provide for the needy, it enables them to provide for themselves. (Durning, 1990; Kumar and Hotchkiss, 1988).

The 1994 Cairo conference emphasized the need to enhance women's rights and needs for education, reproductive health care, economic and political equality, as part of attaining the world's goals of development and population stabilization. This is instructive and exigent. Increased women's and youths' participation, and investment in them should not be seen as philanthropic gesture, but as sine-qua-non for achieving effective climate change mitigation and adaptation (Wright and Nebel, 2004; 0ladipo and Tseayo, 1992).

It therefore behoves the government and all relevant agencies to ensure effective participation of women and youth in environmental issues. They must be empowered through better education and political participation, especially in public policy formulation. There should be women and youth co-operative societies, networks and coalitions, to help harness the potentials of women and youths, and thus, empower them through sustainable environmental resources use, which would be abreast with the present climate change realities. Such organizations must be spurred to act as educators, opinion, and consciousness stimulators and trendsetters.

These and other community institutions should be strengthened to help women and youths provide social safety networks, and develop new coping mechanisms. In all, they should not be given superficial environmental roles, but should be active participants at all levels and times (Internal Institute for Environment and Development, IIED 2007; Miller, 1996). The mainstreaming activities should strive to achieve sustainability. That is, "the mitigating and adaptive strategies must allow generations after generations to use the environmental resources in more or less the same manner" (Jordan-Bychkov and Domosh, 1999). Therefore, the programmes should pass through Adaptation, Goal attainment, Integration and Pattern maintenance as functional prerequisites (Haralambos, Holborn and Heald, 2008).

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Employing Indigenous Knowledge for Climate Change Adaptation

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Abstract

Climate change is impacting seriously on all peoples of the world. The impact is more on the less developed peoples who live in marginal and high-risk areas. However, over the years indigenous peoples have evolved ways of living with the vagaries of climate. This is why they should be incorporated in any climate change discourse. There is the need to tap from their wealth of experiences because they are closest to nature. Their knowledge would be researched on, fine-tuned and used to proffer ameliorative strategies for all. Working with the indigenous people will not only improve their resilience to climate change impacts but will also help preserve the world's cultural and natural resources, by checkmating climate-change and socio-economic stresses. For any adaptation projects for indigenous people to succeed, it should start with a bottom-top approach, focusing on what local response options are appropriate, and complemented with a top-down approach. All communication methods should be employed. The other-directed people, who have reactive-adaptive dispositions, and the trendsetters, who can influence the direction of change, should be used in adaptation awareness creation. Because awareness creation is built on interpersonal and inter-institutional interactions, nongovernmental and local organizations should be involved. An indigenous environmental network should be formed, to monitor all local environmental disasters and, specifically research and produce Local Indicators on climate change, and use same to prepare local climate change action plans, to be incorporated in a national climate change action plans. The action plans should focus more on adaptation than mitigation measures.

Keywords: Alleviate, Apposite, Capacity, Enhance, Harnessing, Opportunities.

Employing Indigenous Knowledge for Climate Change Adaptation

Introduction

Climate change due to global warming has potentially far-reaching consequences for all countries and for all peoples. Some of its changes pose particularly serious dangers to certain groups and places. Some islands are at the verge of being submerged, because the ice-caps are thawing. Rainfall is becoming erratic. Incidents of flooding and drought are exacerbating, just as the incidence of some diseases is in the increase. Crops are failing and environment-dependent occupational regimes have altered. The Sahara desert is expanding at the expense of the Sahel etc. (Marstrand, Attard, Brown, Geethakrishnan, *et al.,* 1991). All these call for precaution and behavioural change as well as concerted efforts by the high

and the low in order to ameliorate the effect of this change in climate. There is therefore the need to bridge the knowledge gap between indigenous and popular culture, in the understanding of this phenomenon. It is obvious that the poor natural-resource dependent peoples in the developing countries are the most vulnerable to climate change, especially those living in marginal, and high-risk areas, such as small Islands or low lying coastal areas (Intergovernmental Panel on Climate Change, IPCC 2007a; Adger, 2006).

Indigenous people have diverse origins and cultures. They also have accumulated traditional knowledge about the various vocations that sustain their societies. They have as well been exposed to different kinds of environmental changes and have developed coping strategies for them. This is why there is the need to incorporate them in climate change adaptation strategies, so as to draw from their wealth of indigenous knowledge for universal utilization. Such knowledge would be fine-tuned and strengthened by research.

Objectives of the Study

This study is aimed at:

i. Highlighting the need to actively involve indigenous people in international, regional and local climate change discourse;

ii. Recognizing and promoting indigenous adaptation strategies;

iii. Building awareness of indigenous adaptation and mitigation strategies;

iv. Depicting the need to incorporate indigenous knowledge and perceptions into climate change policy and research.

Methodology of the Study

The researchers consulted books on paleontology and paleoclimatology which showed that there had been dramatic changes in climate and life on earth. These were compared with facts on the present global changes in climate and life styles using other secondary sources and the internet. With these cognitive framework, this qualitative research was developed.

Indigenous Knowledge and its Place in Adaptation Strategies

The International Labour Organization, 1989 Convention (No 169) defines indigenous peoples as “peoples, who descended from the population which inhabited a country, or a geographical region to which the country belongs, at the time of conquest or colonization or the establishment of present state boundaries and who, irrespective of their legal status, retain some or all of their own social, economic, cultural and political institutions” Indigenous knowledge, is derived from indigenous peoples. It is the knowledge unique to a given culture or society, which has been acquired through accumulation of years of experiences of local people. Indigenous knowledge is also acquired through informal experiments, and intimate understanding of the natural systems as stressed by climate change and socio-economic development (Srinivasan, 2002).

Over the past, these peoples have adapted their livelihoods to a wide variety of disturbances caused by environmental variability and change, in order to survive. Their adaptation practices have the potential to alleviate adverse impacts and to capitalize on new opportunities brought about by the change. Therefore, it is

advisable to include in any climate discourse, the indigenous peoples. This would enhance investigation, documentation, and dissemination of traditional adaptation strategies to climate change globally. (Minard, 2010; Macchi, Oviedo, Gotheil, Cross, *et al,* 2008).

Losing such knowledge, would be a major loss for mankind. Harnessing it will not only improve their adaptability to climate change, but also help preserve the world's culturally and biologically most diverse areas. Durning (2003), surmises that "indigenous homelands harbour more biodiversity than all the world's nature reserves and that greater understanding of nature is encoded in the languages, customs, and practices of native people than is stored in all the libraries of modern science." Indeed, local ideas, and the potentials in indigenous culture should be employed in any resource-use planning, because more often than not, indigenous inhabitants already know the capacities and limitations of their environment. More so, recent evidence indicates that ordinary people probably knew better than the "experts" (Evans, 1999; Hess, Markson and Stein, 1993). Restoring to the indigenous people, the responsibility that was originally theirs may be mankind's only hope for the future protection of our soil, water, fisheries, pastures, forests, and wildlife, because they have evolved ways of managing them properly. And when they have failed to do so, the people, the resources, or both have disappeared (Fagan, 2008; Swaminathan, 1985).

There is a reversible relationship between indigenous knowledge and natural systems according to the Institute for Global Environmental Strategies (Srinivasan, 2002), because natural systems enhance indigenous knowledge and indigenous knowledge conserves the natural systems. In the contrary, climate-change related stresses have irreversible relationship with natural systems, so do socio-economic stresses (Garg, Garg, Garg, 2007). This justifies the need to develop and harness indigenous knowledge, for it would checkmate, not only climate change stresses but also socio-economic stresses.

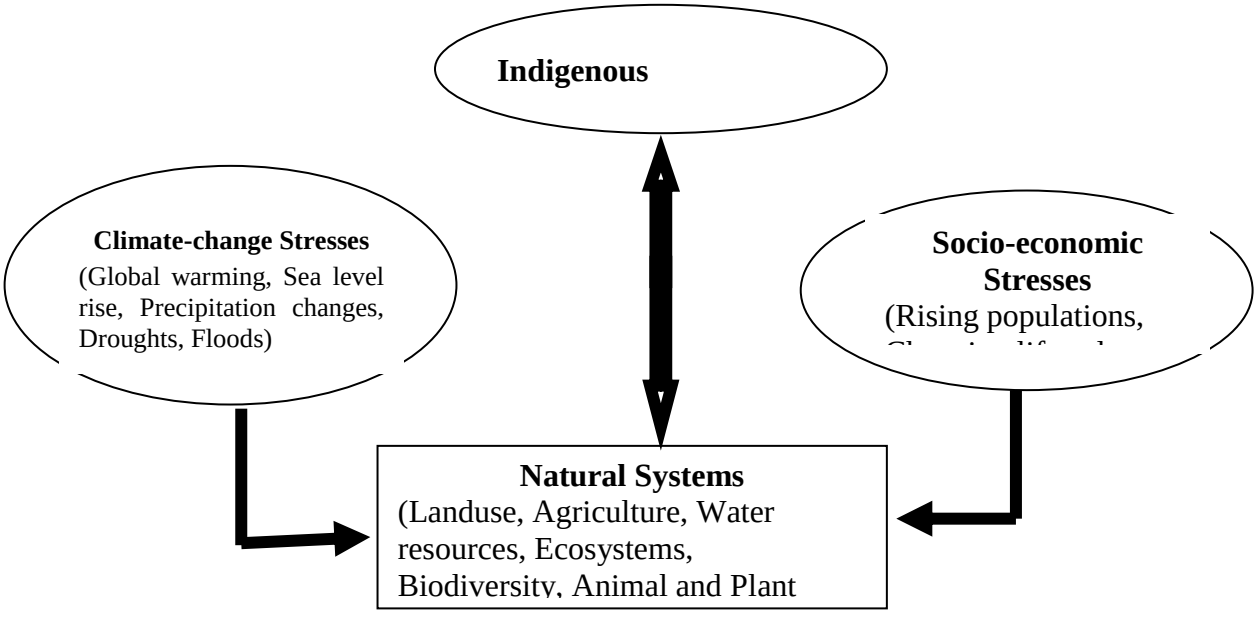


Fig.1: Natural systems, indigenous knowledge, climate change and socio-economic stressors interplay

Factors Influencing the Capacity to Adapt to Climate Change

For climate change adaptation projects for indigenous people to succeed, the purpose and value should first be described and discussed with those affected, just as it is apposite for the indigenous people to participate fully, in the projects. (Heinrichs, Aggarwal, Barton, Bharucha, *et al.,* 2011). Acceptance of adaptive innovations depends therefore on the following:

(i) The extent to which the new behaviour or idea is consistent with what already exists in the culture;

(ii) The perceived costs of adopting the new item or giving up old ways of thinking, behaving or doing things;

(iii) Resistance by those with a vested interest in the status quo;

(iv) A general fear of the long-term effects of the change;

(v) The influence of the events producing the change. (Hess *et al,* 1993).

Adaptation procedures must proceed by small steps or increments-gradual, or incremental, change that may be subtle until a major transformation has occurred-and not by sudden imposition. Such changes should help the people improve their environment, stop retrogressive behaviour, and become less stressed. In effect the capacity of indigenous people to adapt depends on their physical location, entitlements of the use of certain resources and land, and access to knowledge, technology, power, decision making, education, health care and food. (Macchi, 2008;Huffman, 2004).

Goals of Indigenous Knowledge for Climate Change:

There is no gainsaying the fact that there is low level of awareness on climate change, and the impacts, among the indigenous people. This underscores the need to enhance their knowledge through environmental education seminars and workshops. They should be made to know how situations produced by people, such as pollution, or overuse and overkill of natural resources bring changes in natural events. Such indigenous knowledge should aim at promoting community safety by minimizing disaster impacts and reducing factors which hinder adaptation. (Jordan-Bychkov and Domosh, 1999).

The goals of indigenous peoples and climate change were summarized by IUCN thus:

- To improve understanding of the potential impacts of climate change on vulnerable communities and cultures and their associated ecosystems;
- To identify further research required to reduce the risks of climate change; and
- To develop appropriate adaptation and mitigation measures, particularly in areas with high risk of socio-cultural impacts.

It is really crucial to build the capacity of the indigenous peoples because, even though they may have developed important strategies to adapt to current environmental hazards, the magnitude of future hazards may exceed their adaptive

capacity (Macchi, Oviedo, Gatheil, Cross, *et al.*, 2008; International Institute for Sustainable Development IISD, 2003).

Enhancing Indigenous Knowledge for Climate Change

Human beings arrive at knowledge in both subjective and objective ways. Subjective knowledge comes from the individuals own frame of reference either based on faith or on personal observation or by intuition-a gut feeling. Subjective knowledge sees the world as it is experienced by others. To reinforce subjective knowledge, it must be supported by objective observations, precise measurements, and full disclosure of the research techniques and the results; for others to repeat, confirm, or disconfirm the studies and the findings.

Climate change adaptation programmes for indigenous people should involve experts from different disciplines. It should also recognize the effect of social structure on personality. That some people are tradition-directed and their behaviour is governed by customs; some are inner-directed, whose behaviour is governed by an internal mechanism not upset by external forces, while some are other-directed who are equipped with psychological radar that scans the environment for appropriate messages to guide behaviour. The other-directed person constantly anticipates new roles and is aware of the need to adapt swiftly. He is constantly reacting and adapting to others. He has a reactive-adaptive disposition (Hess, Markson and Stein, 1993).

Moreover, in any group, there are opinion leaders, who exercise great influence in the group. They are the trendsetters, who can influence the direction of change. It is therefore imperative that, the other-directed persons and the trendsetters must be identified in the localities and used as the vehicles of enhancing indigenous knowledge for climate change.

Because it is difficult today, to consider changes within any society without referring to the broader trends in the world systems, and because the transfer of ideas, knowledge, and insight is done not only through internal networks, but also through external networks; the efforts at enhancing indigenous knowledge should adopt an admixture of bottom-top and top-down approaches., but always starting with the former. The duo would emphasize the links between the local effects of climate change, “mainstream” development, and individual consumption and lifestyles (Heinrichs, Aggarwal, Barton, Bharucha, *et al.,* 2011).

Historical climatic disaster and current indigenous experiences should be drawn from to reinforce predictions about climate impacts. From these, awareness creation of the need for and adequate methods of adjustment will be communicated using all relevant means. The bottom helps the top identify the impacts, the top researches on them, and returns the findings with recommendations to the bottom (Fagan, 2008).

The top-down approach moves through the following:

(i) Description, which tells “what” occurred, names it and classifies it;

(ii) Explanation, tells “why” that which occurred, occurred. It depends on discovery and understanding of the causes of that, which has happened;

(iii) Prediction, shows the conditions under which a behaviour or event is likely to occur;

(iv) Change, which means applying acquired knowledge to prevent unwanted outcomes or bring about desired goals (Huffman, 2004).

Nevertheless, these should focus on what local response options are appropriate to confront the impacts. The adjustment plans should be used to support and prioritize already existing amelioration strategies. By so doing, the new action is integrated among the people, and thereby serves as an opportunity to further develop existing indigenous development goals. This guarantees continuity and acceptability instead of a radical change in local priorities. (Haddad, 2005). It is in recognition of this that the world's indigenous peoples declared that "We, the Indigenous Peoples, have historically played an active role in the conservation of eco-systems crucial to the prevention of climate change such as forests, wetlands and coastal and marine areas. Long ago, our sciences foretold of the severe impacts on Western "development" models based on indiscriminate clear-cutting, oil exploration, mining, carbon-emitting industries, permanent organic pollutants and the insatiable consumption of the industrialized countries. Today, these unsustainable models threaten the very life of mother earth and the lives of all of us who are her children" (International Indian Treaty Council 2000).

Conclusions and Recommendations

It is exigent that the indigenous people should be carried along in any developmental or adaptation projects, for such projects to succeed. They have roles to play and ideas to contribute right from the formative stages. Where they are deficient, awareness creation should be used to upgrade them. Such indigenous re-orientation requires strong local leadership, which is apolitical (Haddad, 2005).

Awareness creation is built on interpersonal and inter-institutional interactions. So it should involve both non-governmental and community-based organizations. Those in charge should be dedicated climate experts drawn from all relevant sectors. Their efforts should focus more on adjustment rather than mitigation. (Burch and Robinson, 2007).

There is the need for the formation of Indigenous Environmental Network (IEN) to research and identify each locality's short and long-term challenges of climate change, for them to be incorporated in the national climate change action plan (NCCAP). Such research should produce local indicators on climate change (LICC) for the rural areas. There should also be local climate change action plans (LCCAP), to be made relevant to the vicissitudes of each locality (Hoornweg, Freire, Lee, Bhada-Tata, *et al.,* 2011; Heinrichs, Aggarwal, Barton, Bharucha, *et al.,* 2011). The IEN should monitor the whole environment, and work in liaison with the relevant environmental agencies to spread awareness not just on climate change and its impacts, but on all other environmental incidents, and their mitigation and adaptation measures (Moore, 2009).

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Climate Change: Implications for Household Food Security in Ideato North Local Government Area of Imo State, Nigeria

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Abstract

Climate change has been implicated to have significant impacts on global and regional food production, particularly among the common staple food crops. This paper examined how the shift in climate in conjunction with other determinants affects the household food security in the study area. Data were collected through the use of structured questionnaire and subsequently, analyzed with simple descriptive statistics. Major findings of the study show that climate change affected food security of households in the study area in the following manner; reduction in production of crops and livestock 18.0%, changes in land suitable for production 18.3%, storage of planting crops and food item 8.9% and diseases infested of crops and livestock 15.6%. And they adapted the following strategies to mitigate the effect on their agricultural activities; changes in distribution of land under cultivation 8.9%, changes in land management 8.4%, increasing/decreasing planting materials 9.8%, fallowing 14%, mulching 15.4%, intercropping 16.3%, mix cropping 14.8% and indigenous agroforestry 4.9%. Based on the findings of this study, there is evidence that climate change affects agricultural production of the respondents which in turn will lead to a decline in output of their products. The implication is shortage of food supply to the households and the nation in general.

Key Words: Climate Change, Rural Households and Food Security

Introduction

Climate refers to the characteristics conditions of the earth's lower surface atmosphere at a specific location; weather refers to the day to day fluctuation in this condition at the same location (IPEC, 2007).

Mean global temperature have been increasing since about 1850 mainly owning house gases in the atmosphere (FAO, 2008). The main causes are burning of fossil fuel (coal, oil and gas) to meet increasing energy demand and the spread of intensive agriculture to meet increasing food demand, which is often accompanied by deforestation. These changes will have serious impact on the four dimensions of food security: food availability, food accessibility, food utilization and food system stability (FAO, 2008). Effects are already being felt in the markets and are likely to be particularly significant in rural communities where crops fails and yields decline. For example, a cup of bread-fruit selling for ₦100.00 in 2012 was ₦40.00 between 2002 and 2004.

This will disrupt supply chain, market price increase, assets will be lost, purchasing power falls and these communities will be unable to cope. The possible impacts of

climate change on food security have tended to be viewed with most concern because rain fed agriculture is still the primary source of food and income.

FAO's view of a world without hunger is one in which most people are able, by themselves, to obtain the food they need for an active and healthy life, and where social safety nets ensure that those who lack resources still get enough to eat (FAO, 2004). Agriculture is important for food security in two ways: it produces the food people eat, and perhaps even more important, it provides the primary sources of livelihood for 75 percent of Nigerian total work force. In heavily populated countries of Asia and the pacific this share ranges from 40 to 50 percent, and in some sub-Saharan Africa, two third of the working population are still making their living from agriculture (ILO, 2007). If agricultural production in the low-income developing countries of Asia, Africa and Nigeria in particular is adversely affected by climate change, the larger number of the rural poor will be at risk and their vulnerability to food insecurity increased. This paper will therefore, identify the effect of climate change on households food security and strategies adopted by farmers to mitigate the effect, with the following specific objectives to:

1. identify the socio-economic characteristics of the respondents.
2. identify the effects of climate change on household food security in the study area.
3. ascertain the strategies adopted by farmers to mitigate the effect of climate change in the study area.

Methodology

This study was conducted in Imo State, Nigeria. The state has a total of 27 Local Government Areas (LGAs), with 3 agricultural zones, namely, Okigwe, Owerri and Orlu. It is located within latitude $4^{0}45^{1}$N and $7^{0}15^{1}$N and longitude $6^{0}5^{1}$E and $7^{0}25^{1}$E.

Imo State has its total land area as 5,100sqkm and the population of the people is estimated to be 4.8 million (NPC, 2006). The major occupation of the people is agriculture and civil services. The people practices both crop farming and animal farming. The average annual rainfall of the area is between 1990 and 2200mm, and the annual temperature is between 20^{0}C and 27^{0}C with a relative humidity of 75% (Wikipedia).

A multi-stage random sampling technique was used in selecting the sample size. From the three agricultural zones, one agricultural zone (Orlu) was purposively selected. From these zone, one LGA – Ideato North was randomly selected from the 12 LGAs. They are Orsu, Orlu, Nwangele, Isu, Ideato South, Ideato North, Nkwere, Oru West, Oru West and Njaba. From this LGAs, a community (Urualla) was also randomly selected, and from this community – three villages, namely Eziokwu, Ukwualilu and Amanato with 50 respondents each were selected. Data were collected with the use of structured questionnaire and Focus Group Discussion and subsequently analyzed with the use of simple descriptive and like frequency distribution.

Results and Discussion

TABLE 1: Distribution of Respondents According to their Selected Socioeconomic Characteristics

Variables	Frequency	Percentage (%)
Sex		
Male	83	55.3
Female	67	44.7
Total	**150**	**100**
Marital Status		
Single	**50**	33.3
Married	**76**	50.7
Separated	**10**	6.7
Divorced	**14**	9.3
Total	**150**	**100**
Education		
No Formal Education	22	14.7
Primary	18	12
Secondary	63	42
Tertiary	47	31.3
Total	**150**	**100**
Household Size		
1 – 5	78	52
6 – 10	55	36.7
11 – 15	10	6.7
16 – 20	7	4.7
Total	**150**	**100**
Income 'N,000' Per Annum		
20 – 40	49	32.7
60 – 80	28	18.7
100 – 120	20	13.3
140 – 160		
Total	**150**	**100**
Age		
20 – 25	20	13.3
30 – 35	30	20.0
40 – 45	45	30.0
50 – 55	35	23.3
60 – 65	19	12.7
Total	**150**	**100**

Field Survey, 2011

Socio-economic Characteristics of Respondents

This section contains the socio-economic characteristics of the respondents. The socio-economics characteristics selected are based on their relevance to agricultural production, climate change and food security. They are age, sex, marital status, educational level, farm size and income.

Sex

Table 1, shows the distribution of respondents according to sex. The table, shows that majority of the respondents were female 55.3% while 44.7% male. This is against most finings in most studies carried out in the south-eastern region of the country (Iheke, 2006 and Ogbe, 2009). This is because access to land for farming is mostly through inheritance which is partilinear in this part of the country. As a result of some socio-cultural factors that prevent women from having title to land, and with little tracts of lands for farming, there is need for proper information on climate change adaptation and mitigation in order to increase their agricultural output so as to boost their food security.

Marital status

Table 1, also revealed the distribution of the respondents according to their marital status. The table, shows that majority of the respondents 77.7% were ever married while 33.3% were single. The implication is that there are more stable households which are better positioned to practice serious agriculture (Adaigbo *et al.,* 2009). Climate change have been implicated to have a significant impacts on global food production among the common stable food crop performance (Ayoade, 2003). There is need to identify ways of mitigating the effect of the climate change because lack of adequate food for the family will lead to food insecurity.

Education level

The number of years spent in school by respondents is shown in table one also. About 31.3% of the respondents had no formal education while the rest had at least one form of education or another. The implication is that these respondents are better positioned to take advantage of new techniques and innovations that could mitigate climate change and boost food security.

Household size of the respondents

With large household size, farm labour is assured. But (Ayoade, 2003) cited two main factors that affect the availability of labour for the farm families, rural – urban migration and quality of household. With rural – urban migration able bodied young men of productive age migrate to urban centres in search of non farm employment, leaving the families with only the aging, possibly the very young children. The implication is that since they rely mostly on “household labour, absence of these people will cause scarcity of labour and inadequate food product. The high dependency ratio however, indicates the pressure placed on household resources and this according to Echebiri (2002) reduces both per capita income and savings that could be used to acquire more food for the family.

Income

Table 1 further revealed the income of the respondents. Out of the 150 respondents interviewed, 32.7% of the respondents had no income, about 18.7% earned between (N20 – 40,000) and 13.3% earned between (N60 – 80,000). The result indicated that the respondents are low income earners. The implication is that adoption of agricultural techniques that will help to cushion-off the effect of climate change, if it is cost effective will be very difficult to adopt, and (Cerda, 2009)cited that food insecurity.

Food insecurity, therefore is not just due to failure of agriculture to produce enough food as a result of weather conduction but failure of households to procure and guarantee sufficient food for the family (Cerda, 2009).

Table 1, further revealed the age of the farmers, from the result, majority of the respondents 30.0% were middle aged and therefore still energetic and innovative and will be able to face the challenges of the climate change. Okurut and Batezeka (2005) described this age as the 'working age' explaining that when the head of household is of this working age, there is the likelihood of his participating in different climate change reforms in order to break-even and the family food security will be highly assured.

TABLE 2: Distribution of Respondents on the Effects of Climate Change on Household Food Security

Variables* **	**Frequency**	**Percentage**
Reduced production of food crops and livestock	137	18.03
Reduction in local supply	118	15.53
Storage of planting crops and food items	68	8.95
Change in demand for agricultural labour	71	9.34
Adoption of new cropping patterns	108	14.21
Trend changes in vectors and natural habitants of plants and animals disease.	119	15.66
Trend changes in suitability of land for crops and livestock production.	139	18.29

Source: Field Survey, 2011

*** *Multiple Response*

Results on table 2, shows the distribution of respondents on the effects of climate change on household food security. From the result, 18.3% of the respondent stated that there is now a trend changes in suitability of land for crops and livestock production. According to the respondents, irregularity of weather conditions had affected forage availability and quality, and cassava crops planted last year had stated decaying before harvest as a result of flooding.

Also 18.0% of the respondents stated that, they are now experiencing reduced production in food crops and livestock. Many crops have annual cycles and yields fluctuate with climate variability, particularly rainfall and temperature. So maintaining the continuity of food supply when production is seasonal is challenging. Therefore, in this community that depends on rain fed agriculture for an important part of their local supply, changes in the amount and timing of rainfall within the season and

increase in weather variable are likely to aggravate the precariousness of local food system (Lal, 2004).

The table further reveals that 15.66% of the respondents complained about diseases and pest attack on their animals and crops reducing the quality and quantity of the products which later results to low harvest and food insecurity.

Also, some of the respondents, 15.53 complained of reduction in local food supply from the neighboring villages. “If infrastructure is affected by climate through either heat stress on road or increases frequency of flood events, there are impacts on food distribution, influencing peoples access to markets to sell on purchase foods, (Abdulai and CroleRees, 2001) and Prebty *et al* (2005) supported this finding by stated that food often travels very long distance and this has implications for cost”. Increasing fuel costs and bad roads resulting from flooding and landslide as a result of climate change is expected to have implications for food security.

From the same table 2, some respondents 14.21% complained about adoption of new cropping patterns (land management) which contributes to soil moisture retention, maintain appropriate amount of nutrients in the soil so as to strengthen resilience and enhance productivity, thereby diversifying our little income to purchase fertilizer instead of buying food for the family. Some of the respondents, 8.95% in the same table 2, complained about storage of planting crops and food items. According to (Maxwell and Slater, 2003) depending on the prevailing temperature regime, however a change in climate conditions through increased temperature on unstable moist weather conditions could result in grain being harvested with more than 12 to 14 percent moisture required for stable storage. Therefore, because of general lack of drying facilities about from the normal sun-drying, the situation could create hazard for food safety or even cause complete crop losses resulting from contamination with microorganisms and their make solve activities. It could lead to a rise in food price which the average rural household cannot afford. An increase in prices has a real income effect, with low-income households often suffering most as they tend to devote larger shares of their income to food than higher income households (Thomson and Metz, 1998).

Finally, 9.34% of the respondents complained about change in demand for agricultural labour caused by changes in production practices in response to climate change. Most food is not produced by individual households but acquired through buying trading and borrowing (Du Toit and Ziervogel, 2004). So climate impacts on income generating opportunities can affect the ability to buy food.

TABLE 3: Distribution of Respondents according to Strategies Adapted for Mitigating the Effect of Climate Change

Variables	Frequency	Percentage
Changes in distribution of land under cultivation	82	8.9
Changes in land management	74	8.4
Increasing/decreasing density of planting population	90	9.8
Fallowing	134	14.6
Mulching	142	15.4
Intercropping	150	16.3
Mix cropping	136	14.8
Bush fallowing	67	7.3

Indigenous Agro-forestry	45	4.9	

Multiple responses

Field Survey, 2011

Results on table 3, indicated strategies adapted by the respondents to mitigate the effect of climate change on their crops. About 8.9% of the respondents stated that they made some changes in distribution of land under cultivation. There has been a shift now towards the cultivation of crops with higher thermal requirement as a result of global warming. Also, according to one of the respondents, there is now a shift towards cultivation of more drought tolerant crops or crops with lower moisture requirement for changes in land management 8.4%, they practice irrigation when the rainfall is irregular and integrated pest management to reduce insect infestation. According to (Strange & Scott, 2005), diseases are responsible for losses of at least 10% of global food production, representing a threat to food security. The close relationship between the environment and diseases suggests that climate change will cause modifications in the current photosanitary scenario. Some of the respondents about 9.8% had decided to increased/reduce the density of planting materials while 14.6% practice fallowing method to reduce wearing away of the top soil, increase the soil fertility. The table 3, further revealed that about 18.4% of the respondents practices mulching to reduce the rate of evaporation of the water from the soil due to global warming.

Also, about 16.3%, of the respondents practices intercropping among others in order to minimize the adverse effects and to exploit to the optimum, the beneficial effects of new climate regimes. This practices is linked to soil regeneration based on the regrowth of deep-noted trees and shrubs that recycle plant nutrient. About 14.8% also practices mix cropping. According to them, they see their choice and practice as a better hedge against crop failure resulting from climate change effect and also that the practice yield a larger returns per unit of farm space. Some of the respondents 7.3% practices bush fallowing retention while about 5% of the practices indigenous agroforestry. This is a low input soil management practiced by the farmers to replenished nutrient, inhibit weed growth and increase moisture retention.

Conclusion

From the results of this study, there were evidence of climate change effects on the food security of the households in the study area. The households food security were affected in the following manner, reduction in production of food crops and livestock 18.3%, reduction in local food supply resulting from bad road network 15.3%, poor storage facilities for planting crops and food items 8.9%, change in agricultural labour demand 9.3%, adoption of new cropping patterns 14%, increase in pesticide diseases intensive 15.7% and changes in land suitable for cultivation 18.3%.

Recommendation

If farming activities is no longer feasible owning to low or uncertain rainfall and increasing temperature or if agricultural opportunities are declining, the most

suitable adaptation might be to develop off farm sources of income as a secondary occupation, even though people will shift from producing to purchasing food most of the time.

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Emerging Global Climate Change Impacts on Crop Husbandry and Practices

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Abstract
Broad scientific agreement exists that continued accumulation of heat-trapping green house gases in the atmosphere will eventually lead to changes in the global climate. Small changes in climate change can have significant impacts on agricultural productivity. Current variation in crop productivity and yields among different regions are likely to become greater as the effects of climate change are felt by farmers. Climate change is already being observed through rising temperatures, melting glaciers, shifting rain patterns, increased storm intensity and rising sea levels. In this paper potential climate change impacts on agriculture are examined on a global scale. Such changes impact negatively on global food security Its effects are also felt in reduced crop growth cycles, grain quality, increased erosion and reduced soil fertility due to global warming. Pests and disease insurgence and increased poverty are also attributable to climate change. Antidotes for mitigating these adverse effects include innovative agricultural practices, favourable policies requiring local responses and modest adjustments to farming including change in planning dates.

Introduction

Climate change and agriculture are interrelated processes, both of which take place on a global scale. Global warning is projected to have significant impact on conditions affecting agriculture including temperature, carbon dioxide, glacial run-off, precipitation and the interaction of these elements. These conditions determine the carrying capacity of the biosphere to produce enough food for the human population and domesticated animals.

Agriculture has been shown to produce significant effects on climate change primarily through the production and release of greenhouse gases such as carbon dioxide, methane and nitrous oxide and also by altering the earths land cover which can change its ability to absorb or reflect heat and light thus contributing to radiance forcing Lobell (2008) stated that despite technological advances such as improved varieties, genetically modified organisms and irrigation systems, weather is still a key factor in agricultural productivity as well as soil properties. The effect of climate on agriculture is related to variabilities in local climates rather than in global climate patterns.

Climate change induced by increasing green house gases is likely to affect crops differently from region to region. For example average crop yield is expected to drop down to 50% in Pakistan whereas corn production in Europe is expected to grow up to 25% in optimum condition (Fraser, 2008).

Most agronomist believe that agricultural production will be mostly affected by the severity and pace of climate change not so much by gradual trends in climate.

Rapid climate change could harm agriculture in many countries especially those that are already suffering from rather poor soil and climate conditions because there is less time for optimum natural selection and adaptation. According to Easterling (2007) Africa's geography makes it particularly vulnerable to climate change and 70% of the population rely on rain-fed agriculture for their livelihoods.

Broad scientific agreement now exists that continued accumulation of heat trapping greenhouse gases in the atmosphere will eventually lead to changes in the global climate and in the climates of regions around the world.

Land use change such as deforestation and desertification together with use of fossil fuels are the major anthropogenic sources of carbon dioxide, agriculture itself is the major contributor to increasing methane and nitrous oxide concentrations on Earth's atmosphere. The Intergovernmental Panel on Climate Change (IPCC) Third Assessment Reports Published in 2001 concluded that the poorest countries would be hardest hit, with reductions in crop yields in most tropical and sub-tropical regions due to decreased water availability and new or changed insect pest incidence. In Africa and Latin America many rainfed crops are near their maximum temperature tolerance, so that yields are likely to fall sharply for even small climate changes, falls in agricultural productivity of up to 30%, over the 21st century are projected. Marine life and the fishing industry will also be severely affected in some places.

Adaptation and mitigation potential is more pronounced in developing countries where agricultural productivity remains low,: poverty, vulnerability and food insecurity remain high; and the direct effects of climate change are expected to be especially harsh. Creating the necessary agricultural technologies and harnessing them to enable developing countries to adapt their agricultural systems to changing climate will require innovations in policy and institutions as well.

Statement of the Problem

Changes in climate occur as a result of both internal vanability within the climate system and external factor (both natural and anthropogenic) it has been observed over the years that climate has some impacts on agriculture this is seen in crop and livestock production. Therefore it become necessary to study the global climate change impacts on crop husbandry and practices.

Objective of the Study

The aim of the study is to find out the impact of climate change on agriculture with particular reference to crop and livestock production.

Impact of Agriculture on Climate Change

It is necessary to discuss impact of agriculture on climate change. Green house emission from human activities mainly for fossil fuel use, deforestation and agriculture can cause climatic change. According to Inter-Governmental Panel on Climate Change, the three main causes of the increase in green house gases observed over the past 250 years have been fossil fuels, land use and agriculture.

It is necessary to discuss the impact of agriculture on climate change green house emissions from human activities mainly fossil fuel use deforestation and agriculture can cause climate change.

Land Use

1. Agriculture contributes to green house gas through land use in four main ways
2. Co_2 releases linked to deforestation.
3. Methane releases from rice cultivation.
4. Methane release from enteric fermentation
5. Nitrous oxide releases from fertilizer application. Together these agricultural processes comprise 54% of methane emissions, roughly 80% of nitrous oxide emissions and virtually all carbon dioxide emissions tied to land use.

Deforestation also affects regional carbon re-uptake which can result in increased concentrations of Co_2

Land clearing methods such as slash and burn compound these effects which directly releases green house gases and particular matter such as soot into the air.

Livestock

Livestock and livestock related activities such as deforestation and increasingly fuel intensive farming practices are responsible for over 18% of human made greenhouse gas emissions including:

1. 9% of global carbon dioxide emissions
2. 35-40% of global methane emissions
3. 64% of global nitrous oxide emissions (chiefly due to fertilizer use)

Livestock activities also contribute disproportionately to land use effects since crops such as corn and alfalfa are cultivated in order to feed those animals.

Global Effect of Climate Change on Agriculture

IPCC (2007) stated that climate change could affect agriculture in several ways:

- Productivity in terms of quantity and quality of crops.
- Agricultural practices through changes of water use (irrigation) and agricultural inputs such as herbicides, insecticides and fertilizers.
- Environmental effects in relation of frequency and intensity of soil drainage (leading to nitrogen leaching), soil erosion, reduction of crop diversity.
- Rural space through the loss and gain of cultivated lands, land speculation, land renunciation.
- Adaptation, organisms may become more or less competitive as well as humans may develop urgency to develop more competitive organisms such as flood resistant or salt resistant varieties of rice.

Also IPCC's Fourth Assessment Report projected the potential future effects of climate change on agriculture. They concluded that for about a 1 to 3 ^{o}C global mean temperature increase, there would be productivity decreases for some cereals in low latitudes and productivity increases in high latitudes. Climate change have some impacts on the following:

1. Food Security

Food security could cause decrease in farm product (Thorton, 2001) when food is not sufficient people will become undernourished and there is bound to be hunger in the nation. Climate change would likely increase the number of people at the risk of hunger compare with the area with no climate change. Rosenzweig (2007) suggests that climate change could cause farm output in sub Saharan African to decrease by 12 percent by 2080 Easterling (2007) looked at studies that made quantatine projections of climate change impacts on food security. It was noted that these projections were highly uncertain and had limitations. The finding was that climate change would likely increase the number of people at risk of hunger. Projected climate change impacts depend strongly on future social and economic development. In 2006, the global estimate for the number of people under-nourished was 820 million. Easterling concluded that sub-Saharan Africa would likely surpass Asia as the most food insecure.

2. Temperature Potential Effect on Growing Period

Duration of crop growth cycles are related to temperature. An increase in temperature will speed up development. In the case of an annual crop, the duration between sowing and harvesting will shorten (for example the duration in order to harvest corn could shorten between one and four weeks). The shortening of such a cycle could have an adverse effect on productivity because senescence would occur sooner.

3. Effect of Elevated Carbon Dioxide on Crops

Omorogbe (2001) have looked at the impact of elevated Carbon dioxide concentration on whole farming system and concluded that the purported benefit of elevated carbon dioxide concentrate are likely to be far lower than previously estimated when factors such as increasing ground level ozone are taken into account the authors are of the view that when forest are cut down the carbon stored in the forest escapes to the atmosphere again when coal oil and natural gas are burn or utilized for powering engine and cars large amount of carbon dioxide are spewed into the air, all these have potential effect on agricultuure. Rising Co_2 concentration in the atmosphere can have both positive and negative consequences. Increased Co_2 is expected to have positive physiological effects by increasing the rate of photosynthesis. Currently the amount of carbon dioxide in the atmosphere is 380 parts per million. In comparison, the amount of oxygen is 210,000ppm. This means that often plants may be starved of carbon dioxide, due to the enzyme that fixes Co2, rubisco also fixes oxygen in the process of photo respiration. The effects of an increase in carbon dioxide would be higher on C3 crops (such as wheat) than on C4 crops (such as maize) because the former is more susceptible to carbondioxide shortage. Studies have shown that increased Co2 leads to fewer stomata developing on plants which leads to reduced water usage.

Omorogbe (2001) have looked at the impact of elevated carbon dioxide concentrations on whole farming systems and concluded that the purported benefits of elevated carbondioxide concentration are likely to be for lower them previously estimated when factors such as increasing ground level ozone are taken into account. The authors were of the view that when forests are cut down, the carbon stored in the forests escapes to the atmosphere. Again when coal, oil and natural

gas are burnt or utilized for powering engines and cars, large amounts of carbondioxide are spewed into the air, all these have potential effect on agriculture.

4. Effect on Quality

According to Intergovernmental Panel on Climate Change, the importance of climate change impacts on grain and forage quality emerges from new research. For rice, the amylose content of the grain – a major determinant of cooking quality – is increased under elevated Co2. Cooked rice grain from plants grown in high Co2 environments would be firmer. However concentrations of iron and zinc which are important for human nutrition would be lower. Moreover the protein content of the grain decreases under combined increases of temperature and Co2. Increases in Co2 lead to decreased concentrations of micro-nutrients in crop plants. This may have knock-on-effects on other parts of ecosystems as herbivores will need to eat more food to gain the same amount of protein. Higher Co2 levels lead to reduced plant uptake of nitrogen resulting in crops with lower nutritional value. This would have impact on populations in poorer countries less able to compensate by eating more food, more varied diets or possibly taking supplements. Reduced nitrogen content in grazing plants has also been shown to reduce animal productivity in sheep which depend on microbes in their gut to digest plants which in turn depend on nitrogen intake.

5. Agricultural Surfaces and Climate Change

Mendelson (1994) stated that sea levels are expected to get up to one metre higher by 2100, through this projection is disputed. A rise in the sea level would result in an agricultural land loss. The writers of this paper are worried that if sea levels are predicted to rise threatening low costal areas near sea level, it is estimated that there will be changes in rainfall patterns and wind patterns which invariable affects crop production. Climate change may increase the amount of arable land in high-latitude region by reduction of the amount of frozen lands.

6. Erosion and Fertility

Soil fertility is affected by global warning. Because the ratio of carbon to nitrogen is a constant, a doubling of carbon is likely to imply a higher storage of nitrogen in soils as nitrates thus providing higher fertilizing elements for plants, providing better yields. Due to the extremes of climate that would result, the increase in precipitations would probably result in greater risks of erosion whilest at the same time providing soil with better hydration according to the intensity of the rain. The increase in the temperature would induce a greater rate in the production of minerals:

Lessening the soil organic matter content, the atmospheric Co_2 concentration would tend to increase it.

The authors were of the view that if fertility of the soil is reduced, there would be low productivity and also hunger.

Potential Effects of Global Climate Change on Pests, Diseases and Weeds.

Global warning would cause an increase in rainfall in some areas, which would lead to an increase of atmospheric humidity and the duration of the wet seasons. Combined with higher temperatures, these could favour the development of fungal diseases similarly because of higher temperatures and humidity, there could be an increased pressure from insects and disease vectors. Weeds undergo the same acceleration of cycle as cultivated crops and would also benefit from carbonaceous fertilization. Since most weeds are C3 plant, they are likely to complete even more than now against C4 crops such as corn.

Karousakis, S. (2007) stated that weeds undergo the same acceleration of cycle as cultivated crops and would also benefit from carbonaceous fertilization.

If there is increase in pests and diseases and weeds this will affect the farm productivity hence food insecurity occurs

7. Ozone and Ultraviolet B

Agriculture could be effected by any decrease in stratospheric ozone which could increase biologically dangerous ultraviolet radiation B. Excess ultraviolet radiation B can directly effect plant physiology and cause massive amounts of mutations and indirectly through changed pollinator behaviour. In addition a possible effect or rising temperature is significantly higher levels of ground-level Ozone which would substantially lower yields.

The IPCC report estimates climate change impacts on grain production at the global level and then zeros on the estimated effect on the developing countries.

Grain is often used as a proxy for all food because it accounts for over half of all food calories consumed in the world.

The authors were of the view that the thickening of the ozone layer means that there is likely to be increased global warming of 1 to 3.5^{oc} over the next one hundred years.

8. Poverty Impacts

The IPCC have investigated the potential impacts climate change would have an agriculture and how this would affect attempts at alleviating poverty in the developing world. The effects from moderate climate change may likely to be mixed for developing countries.

If the climate change continues, the writers of this paper worried of what will become the fate of the people as this will led to world food crises.

9. Impact on Water Resources

Climate Change will affect the availability and use of water and will amplify the competition for water resources. The climate related changes to hydrological patterns are expected to increase leading to high levels of uncertainty in water availability and some regions will be far more affected than others. This will have a profound impact on agriculture, as approximately 70% of global freshwater is used for agriculture.

Conclusion

Climate change is already being observed in many parts of the world. All climate sensitive systems of society and the natural environment including agriculture, forestry water resources, human health coastal settlements and natural ecosystems will need to adapt to a changing climate or possibly face diminished productivity. Assessment of the effects of global climate changes on agriculture might help to properly anticipate and adapt farming to maximize agricultural production.

Nigeria should continue to adopt those measures that would help her to reduce emission of gases as this have a great impact on crop and livestock production. All climate sensitive systems of the society and natural environment including agriculture, forestry, water resources, human heath, coastal settlement and natural ecosystems will need to adapt to a changing climate or possibly face diminished productivity, therefore there is need to sought out measures for reducing climate impact on agriculture.

Recommendations

The following are recommended

1. Innovative agricultural practices and technologies can play a role in climate mitigation and adaptation.
2. Policies and institutions that promote economic development and reduce poverty will often improve agricultural adaptation and may also pave the way for or more effective climate change mitigation through agriculture.
3. Adaptation and mitigation in agriculture will require local responses but effective policy responses must also reflect global impacts and inter-linkages.
4. Modest adjustments to farming as well as more ambitious adjustments such as shifting to an entirely different crop, changing the planting date by more than one month in response to a change in the length of the growing season are recommended.

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Impact of Climate Change on Bio-Resources Development in Nigeria: A Review

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Abstract

Hydro meteorological hazards such as floods, droughts, and tropical cyclones afflict many regions of the world, and cause unprecedented reversals in sustainable development. Plants and animals have evolved over millions of years to suit particular habitats where conditions are just right for them. Rise in temperature, change in precipitation regime, salinization due to increased tidal surges and rise in sea level are often close to threshold values beyond which most bio resources fail or die. Ocean ecosystem will be affected given that huge amount of global warming is absorbed by the sea. Global warming may cause extinction of estimated 15-37% of all plant and animal species by 2050. Coral reefs, a symbiotic home for coral polyps and specialized algae will be destroyed resulting in a terrible toll on the fish and other marine animals that depend on them. During the last century, the earth's average surface temperature rose by about 0.6℃ and is expected to rise further by about 1.1 to 6.4 ℃ by the end of this 21st century. Sea level rose by 17 cm in the 20th century and is expected to rise further by about 18 to 59cm.This paper highlights the impacts of climate change on agriculture with reference to bio-resources development. Adaptation and mitigation strategies towards the identified impacts were also discussed.

Key words: climate change, global warming, GHGs, Adaptation, Mitigation, temperature, bio-resources.

Introduction

Climate change is a deviation from the normal climatic conditions of an area due to land- atmosphere, land-ocean and ocean-atmosphere interactions which cause the alterations of the balance of gases in the earth's atmosphere, otherwise called radioactive forcing which are the factors responsible for the global warming and climate change (Okali, 2007).

All the hype around climate change and global warming does not mean that it is a new issue. Fossil and ice-core evidence shows that the earth has gone through many, regular climate changes which have been quite dramatic. The swings between ice ages and inter-glacial periods have been extremely dramatic and they were caused by a global average temperature change of only 2 or 3^{o}c (Wilson and Law, 2007). Biological or natural resources are important components for progress and economic activities of a nation. Bio-resources include genetic resources, organisms, populations or any other biotic component of ecosystems with actual or potential use or value for humanity. Ecosystem in turn is a dynamic complex of plant, animal and micro organisms and their non-living environment, interacting as a

functional unit and habitat where the population naturally occurs (Kannaiyan, 1999; Singh, 2004).

Climate change is projected to have significant impacts on conditions affecting Bio-resources. Increase in the concentration of Green House Gases (GHGS), carbon dioxide (CO_2), nitrous oxide (NO_2), methane (CH_4), chlorofluoro carbons, ozone and aerosols, are strongly implicated in the observed climate changes in this century. Climate change will erode the genetic store for agriculture and medical plants as well as useful animals which are irreplaceable. There is no longer any doubt .The earth's climate is changing and will continue if unchecked. The consequences are far reaching on every life. If the world future is to be secured, action is crucial. Deep cut in global emissions of GHGS are necessary to temper climate change from resulting in irreversible and potentially catastrophic planetary changes.

The objective of this paper is to highlight some impacts of climate change on bio-resources in Nigeria, with a view to recommending appropriate adaptation and mitigating strategies through the frontiers of agricultural extension. The information used for the compilation of this paper were obtained from assiduous review of past works carried out by stakeholders on climate change matters in different research and tertiary institutions both within and outside Nigeria. In most cases, these works were compared with most recent published works in journals in the same field. To obtain more recent information, internet materials were extensively used.

Causes of Climate Change

Human Activities*:* most GHGs are human induced. The main GHG, carbon dioxide (CO_2) which accounts for almost 70% total GHGs emission is human induced. 1.6 billion tonnes of CO_2 are produced by burning fossil fuels, principally petroleum for industry and transport. Added to this, billion tonnes of CO_2 is produced by deforestation. Burning of forest and working the soil releases carbon into the atmosphere.

Agricultural Activities: producing methane (CH_4, the second most important GHG. Methane is produced mainly by anaerobic fermentation especially in rice paddies, in flooded areas (marshes and pads) and in piggery production. Ruminating cattle emit nearly 100 million tonnes of methane into the atmosphere annually. Termites produce 15-35 million tonnes of methane by fermenting vegetable matter from tropical forests in their intestines with the aid of bacteria which lives there.

Fossil Fuels*:* In the African sub region 35-50% of the total region emissions are from fossil fuels and are accounted for by Nigeria Egypt and Algeria, with Nigeria being the largest contributor. 76% of total gas production in Nigeria is flared. Intensive and industrial cultivation uses chemical fertilizer, the manufacture which produces CO_2. Transhumant livestock accentuate the impacts of climate change. Their passages degrade plant cover as they nibble at young trees, shrubs, and grasses.

Forests: Forests are potential prime cause of climate change through deforestation. According to United Nation Environment programme (UNEP) 20-25% of all CO_2 emissions are caused by burning forests after land clearing. Poor forest management policies including unrestricted logging, harvesting of firewood, charcoal production and road construction aggravate the problem. The world is losing about 200km of forest a day according to FAO, with forests in Africa being felled at twice the global average. Some climate models indicate that towards 2050,

temperatures in tropical forest areas will increase by up to 2^{o}C from their 1970 levels.

***Livestock**:* livestock's global responsibility for climate change is now an established fact. In 2007, FAO's Deputy Director General, Alexander Muller estimated that this sector caused 37% methane and 9% CO_2 emissions. It also consumes about 8% of the world water. The belching and flatulence of ruminants release vast quantities of methane into the atmosphere.

Impacts /Effects of Climate Change on:

Biodiversity: Some species are generalist and are able to adapt to a range of conditions and habitats, example cockroaches and crows. Some species occupy specialized habitats and are found only in a single forest, valley or mountain top. Climate change will cause some species to migrate, if they can or disappear, if they cannot. They can experience deteriorating conditions and increased competition from new immigrants. Plant species are less mobile than insects and animals and therefore mostly affected by the winds of change. Warmer temperatures also mean that higher cooler altitudes will become warmer.

Livestock: It will change the yield and nutritional quality of forage crops/fodder, increase disease and disease spreading pest and reduced water availability. These will influence milk and meat production.

Fishery: Rise in sea level will likely exacerbate flooding, storm surge, erosion, higher intensity of hurricanes and typhoons etc. in coastal communities (Caribbean and Pacific Regions), where over 50% of the population live within 1.5 km of the shore. Raising GHG emissions threatens at least 75 % of key fishing grounds, as the ocean's natural pumping systems come under threat (UNEP, 2007). Increased CO_2 will raise the acid level in seas and oceans which will further damage coral and plankton. In the Caribbean, fish stocks have been depleted due to reduced coral ecosystem-dependent spawning.

Coasts and Oceans: A decline in circulation of the ocean's natural pumping system affects the 'washing and rinsing' mechanism of the continental shelf which keeps the waters healthy by flushing out growing levels of wastes and pollution and brings nutrients to fisheries. UNEP predicted that 80 to 100 % of the world's corals reefs may suffer annual bleaching events and death by 2080.

Marine deserts (areas of the ocean where life has completely disappeared) are becoming increasingly common. The ocean cover about 70% of the earth's surface with an average depth of 3,800m.These mass of water trap heat and releases it slowly into the atmosphere, thus regulating the temperature. The rising climate influences the marine ecosystem which in turn influences the overall climate. Global warming causes the polar ice caps to melt, leading to rise in sea levels.

Researchers calculated that since the end of the 19th century, the average level of oceans has risen by about 12cm. Sea level could rise by 15 to 80 cm between now and 2100. Associated problems of islands sinking, sea encroachment and coastal erosion can lead to forced migration (climate change refugees). The intrusion of salt water in the water table increases salinity in soils resulting in loss of fertility. Cyclones and tornados are also intensified.

Farmer's Best Practices: Farmers in Africa are likely to divest slowly toward livestock production especially goats and sheep as this may be more profitable than growing crops with the changing climate conditions. Goats and sheep are less sensitive to hotter and drier climates than cattle and chickens, which are suited to humid zones (UNEP, 2007).

The flowering and fruiting seasons are becoming less certain and there are long delays due to

erratic rainfall. Mountain species are tending to seek refuge in higher altitudes. Medicinal trees and shrubs are also disappearing.

Adaptation Strategies

Conservation agriculture and improved irrigation*:* This involves minimal soil disturbances and improved water use efficiency. Conservation agriculture or zero tillage traps CO_2, protects and restores soils while capturing CO_2 instead of releasing it into the atmosphere. Absence of tillage combined with crop rotation and permanent ground cover limits the oxidation of organic matter in the soil.

Zero tillage was pioneered in USA and Brazil on 22 million hectares and in Madagascar it is practiced on 3,000 hectares of land. In the past 5 years the pilot project has been launched in Southern and Eastern Africa. Farmers who practice it obtain higher yields and can benefit from 'carbon credits'

Change in times of planting and crop types: Sorghum may fare better than maize in the drier conditions forecast in parts of Africa. Planting time may be delayed to accommodate changing rainfall patterns. Climate-resilient crop varieties should be developed and introduced to farmers fields. Breeders should breed for disease and drought resistances to suit forecasted climate change constrained regions of the world. In Malawi, farmers are harnessing flood waters for irrigation and fish farming as a technique for climate change adaptation strategy.

Traditional technology*:* Store of indigenous knowledge has great ability in combating climate change. Farmers should select crop combinations (intercropping) that will survive harsh conditions, example, maize-beans, cowpea-sorghum and millet-groundnut. The ancient practice of making bunds to halt soil erosion and run off should be revived. Farmers should switch to crop varieties with shorter cycles and resistance to water stress e.g. sorghum grows in hotter weather with less water. Water conservation practices that favor infiltration and soil water storage and combat evaporation from the soil is essential, e.g. terracing, surface tillage, soil mulching and direct seeding.

Setting up alert systems to help foresee weather events: Seasonal forecasting to alert people in advance on conditions of the seasons will enable farmers to adapt their growing techniques and seeds. This should form a primary role of Agricultural Extension strategies for climate change adaptation. Broadcast at regular intervals to provide weather information based on satellite monitoring will help people adapt to the increasingly erratic climate conditions. In Nigeria, some radio stations are airing broadcast to inform small holder farmers of climate change adaptation measures.

Development of climate-proofing crops**:** Climate change has forced scientists to rethink priorities and focus on stress –tolerant rather than just high yielding varieties. At ICRISAT, researchers have developed pearl millet, sorghum, cowpea, pigeon pea and groundnut that can tolerate heat, high soil temperatures, low and variable rainfall and diseases. In International Rice Research Institute (IRRI), scientists have advanced in producing varieties that can withstand drought and salinity. In 2006, a team of scientists in IRRI made a break through with the discovery of a gene that allows rice to survive up to 2 weeks flooding.

Kenya's ministry of Agriculture recently launched high yielding drought and disease resistant varieties of maize, sugarcane and wheat, developed by Kenya Agricultural Research Institute (KARI). It is marketed by seed companies in Kenya, Congo, Sudan, Tanzania and Uganda.

Scientists at the International Maize and Wheat Improvement Centre (CIMMYT) and the International Centre for Tropical Agriculture (CIAT) have developed a hand-held sensor using light and infrared radiation which tells whether plants need more fertilizers or not. Use of less fertilizer means less nitrogen release into the atmosphere. Despite reservations, a large body of experts believes that genetic modification holds the key to developing climate-resilient crops.

Mitigation Factors

Deep cut in GHGS emission*:* The stakes in climate change mitigation is global. In 1997, 30 industrialized countries signed the Kyoto protocol which entered into full implementation in 2005. The protocol mandates the countries to cut their emissions of six GHGs by 5.2% compared with 1990 levels, by 2012. Greater use of renewable energies, energy savings and behavior changes is being upheld to fulfill the pledges especially in European countries. Brazil, China, India and Indonesia also signed the protocol but no commitment on reducing emissions so as not to hamper their economic development.

Clean Development Mechanism (CDM): As a step to cut CO_2 emissions through investment in clean technologies, European companies now have emissions quotas. A fine is paid for exceeding the quota, or emission credits should be purchased from other companies. They can also fund projects in developing countries to reduce or store GHGs as part of the CDM.

Emissions trading*:* This is a market-based approach that allows those reducing GHGs emissions below quotas to trade the excess reductions to offset emissions at another source inside or outside the country. The Least Developed Countries (LOC) fund and the special climate change fund both managed by the Global Environment Facility (GEF) should be made available to countries that have launched a national plan of action defining urgent measures and priorities.

New systematic projects and policies: design of river basin management, new migration systems and urban planning, strengthening local land right and encouraging investment in sustainable management that will help in adaptation to less rainfall, especially in Africa where the economies are highly dependent on natural resources and rain fed agriculture.

Animal cross breeding: This should aim at producing animals that adapt to being kept in stalls to limit their impacts on environmental degradation. Improving folder crops and other livestock feeds by making them more digestible will reduce flatulence in ruminants. Efforts to improve the management of animal wastes (manure and slurry) through more efficient conversion into biogas will reduce methane emissions.

Reforestation: A growing awareness of mitigating factor of forest against climate variation has sparked up tree planting initiates. In Nigeria, the government has launched tree planting in three zones. In Malawi, pupils have formed clubs to replant trees on bare land. The kabala community, in Lau, Fiji, has planted 2,600 Vesi trees (lntsia bijuga) as part of a reforestation effort. Illegal lodging should be combated through national schemes that will legally protect forests through designations such as protected areas, indigenous reserves, non-timber reserves, community reserves, etc. Carbon payments can be an effective stimulus in reducing forest degradation. Under the Kyoto protocol's Carbon Offset Schemes, credits are earned for planting new trees. CDM financing should extend to the preservation of old growth forests, so as to benefit the September 2007 Forestry Eight (Brazil, Cameroun, Costa Rica, DR Congo, Gabon, Indonesia, Malaysia and Papua New Guinea (PNG), which together house about 80% of the world's remaining tropical forests.

Implementation of Payments for Environmental Services (PES): Studies are being conducted into how to implement the Payment for Environmental Services.

The payment will benefit all stakeholders involved in managing forests from the grass roots (villages, communities, farmers, and forest enterprises). These also involve compensation for earnings lost due to forest conservation.

Capturing carbon: Carbon sequestration schemes launched by the Kyoto protocol's CDM, allow industrialized countries to offset CO_2 emissions by investing in forestry projects in developing countries. Globally, carbon sequestration projects are worth an estimated 300 million dollars (196 million pounds), but Africa, accounts for a tiny share with just 19 projects. Planting trees between crops and around plots help prevent erosion, restore soil and provide shade. Trees and shrubs absorb more carbon than other crops and have the potential to sequester nearly 600MT CO_2 a year by 2040 (IPCC). They help the soil retain more water and pump out excess water from the soil during heavy rainfall though their high evaporation rates.

***Coral transplantation as a management tool*:** Corals that would have been smothered if left in their original environment with elevated water surface temperature of over 30^{oC} and severe bleaching of 50-95% of coral colonies could be saved. Viable hard corals could be carefully severed and transplanted to new site (Marine park), where conditions are more favourable. This technique offers possibility of re-populating damaged reefs. Several coral transplant projects in Barbados, the Grenadines, Jamaica and St. Lucia recorded survival rates of over 90%.

Carbon sinks*:* Significant contribution to mitigating climate change could be made by investing in carbon sinks, otherwise known as the rainforests of the world. Estimates of the total amount of carbon stored in the forests vary greatly. One calculation, based on research by the IPCC puts the total at about 1,000 billion tonnes. Africa contains about 15% of the worlds remaining forests. The vast forest of DR Congo alone is estimated to contain as much as 8% of all the carbon stored in the earth's vegetation.

Conclusion and Recommendation

In spite of the global rapid advances using Geographical information system (GIS) and simulation models, there is no clear picture on the direction of climate change policies in Nigeria. The policies are felt in principle and not in practice as implementation strategies are not being appropriately implemented. The Agricultural Extension Services that are supposed to be the pivot of implementation strategies, being closer to the farmers who are the primary beneficiaries to research results in climate change matters, are not well intimated in the programme.

There is now a wide consensus that changes in weather patterns are inevitable and will have disastrous impacts on biological/natural resources (agriculture, forestry and fisheries) as well as on infrastructures and life styles of nations, especially those that depend mainly on natural precipitation for their bio-resources development. A more measured climate change forecast envisages a future with entirely, new climate zones which will put significant strains on bio-resources.

The 4th assessment of IPCC widely predicted that food production in Africa could halve by 2020. An increase of 5 to 8 % of arid and semi-arid land in Africa is projected under a range of climate change scenarios. A $3^{o}C$ rise in temperature would lead to famine for over 150 million people and in Uganda would decimate

coffee producing areas. Many useful wild species could disappear leading to significant losses of genetic resources.

The river basin development authorities should be adequately funded as a mitigation factor towards the conservation and development of the bio- resources of the nation.

Lack of information could be a great barrier to better climate change adaptation and in this regard, the roles of Agricultural Extension cannot be compromised. The government should sponsor the media houses to broadcast jingles meant to educate the populace on climate change issues. Printed matters are also resourceful. Meteorological/weather stations should be charged with more responsibilities to keep pace with the global trend in terms of expertise and modern technological equipment.

Nigeria should be actively involved in the proposal by rain forest coalition of 2005, lead by PNG and Indonesia, currently being debated for post 2012 action plan tagged 'avoided deforestation' which meant paying direct compensation to developing countries that reduced deforestation compared with previous levels or a projected scenario.

Structural measures to address the fundamental causes of deforestation should be funded through creation of carbon tax. Encroachment of crop cultivation in forested areas of the country should be slowed down. There is a great need for adequate sensitization of the populace on the opportunities that abound in climate change mitigation strategies especially in the area of forest conservation. The government as a corporate entity should strive with the global trend to ensure that Nigeria is not left behind in benefiting from international funds that are mapped out for climate change policies. The local programmes and implementation framework should be appropriately instituted.

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TABLE1: Global climate change programmes from RIO to Bali

1967	First predictions of global warming
1987	Adoption of the Montreal protocol relating to substances which reduce the ozone layer.
1988	Creation of the Intergovernmental Panel on Climate Change (IPCC) charged with scientific monitoring of climate change.
1992	The earth summit in RIO (Brazil) adopts a Framework Convention on Climate Change, ratified by 50 countries and entering into force in 1994.
1997	Adoption of the Kyoto protocol (Japan) which commits industrialized countries to cutting GHGs emissions by an average of 5-2% by 2012 compared with 1990 levels. Flexible mechanisms were created to enable polluting countries to avoid targets by funding reductions in other countries.
2007	The 13th United Nations climate change conference in Bali (Indonesia) reaches a last minute agreement on a 'roadmap' aimed at producing a new treaty in 2009 in Copenhagen (Denmark). This treaty will replace the Kyoto protocol in 2012. The parties recognized that severe reductions in global GHGs emissions are needed but did not take up the target of cuts of 25 to 40 % in GHGs countries for industrialized countries between then and 2020 proposed by EU and rejected by USA.

Source: La documentation fracaise. In: Spore special issue 2008

TABLE 2: Predicted rise in temperature and CO_2 in 2080

IPCC Scenarios	Relative to 1980-1999 avg. temp (^{o}C)	Relative to preindustrial temp (^{o}C)
Constant year 2000 concentrations	+0.6 ^{o}C (0.3-0.9 ^{o}C)	+1.1 ^{o}C
B1 Scenario	+ 1.8^{o}C (1.1-2.9^{o}C)	+2.3^{o}C
AIT Scenario	+ 2.4^{o}C (1.4-3.8^{o}C)	+2.9^{o}C
B2 Scenario	+2.4^{o}C (1.4-3.8^{o}C)	+2.9^{o}C
AIB Scenario	+2.8^{o}C (1.7-4.4^{o}C)	+3.3^{o}C
A2 Scenario	+3.4^{o}C (2.0-5.4^{o}C)	+3.9^{o}C
AIFI Scenario	+40^{o}C (2.4-6.4^{o}C)	+4.5^{o}C

Scenario A1: rapid economic and population growth combined with reliance on fossil fuels (AIFI), non fossil energy (AIT) or a combination of both (AIB).
Scenario A2: lower economic growth, less globalization and continued high population growth.
Scenarios B1 and B2: some mitigation of emissions, through increased resource efficiency and technology improvement.

Source: IPCC, 2007

TABLE 3: Policies relating to climate change and production/trade scenarios

Scenario	Policies making this scenario more likely	Policies making a better outcome more likely
Export agriculture declines	• Neglect of "climate change proofing" technology for export agriculture; • Transport and related policies that discriminate against sub-Saharan African transport modes; • Subsidies to domestic producers; • Restrictions on global trade in bio-fuels	• Early shift in emphasis for technical support from doomed crops to more climate change-proof ones; • Tackling the (large) domestic footprint of food consumption before the (small) external one; • Taxes on domestic use of climate change-adverse inputs (e.g. artificial fertilizers); • Removal of all import restrictions (an subsidies limited to domestic suppliers) of bio-fuels.

Capital-intensive (hi-tech) agricultural exports increase	• Failure of public provision of support for smallholders and labor intensive, climate-change-proof production methods; • SPS and other regulations that are more difficult for smallholders to meet.	• Early and marked shift in public support to R&D, extension, market development, rural infrastructure and services so as to benefit directly smaller farmers able to produce for export.

Source: Ludi et al. 2007

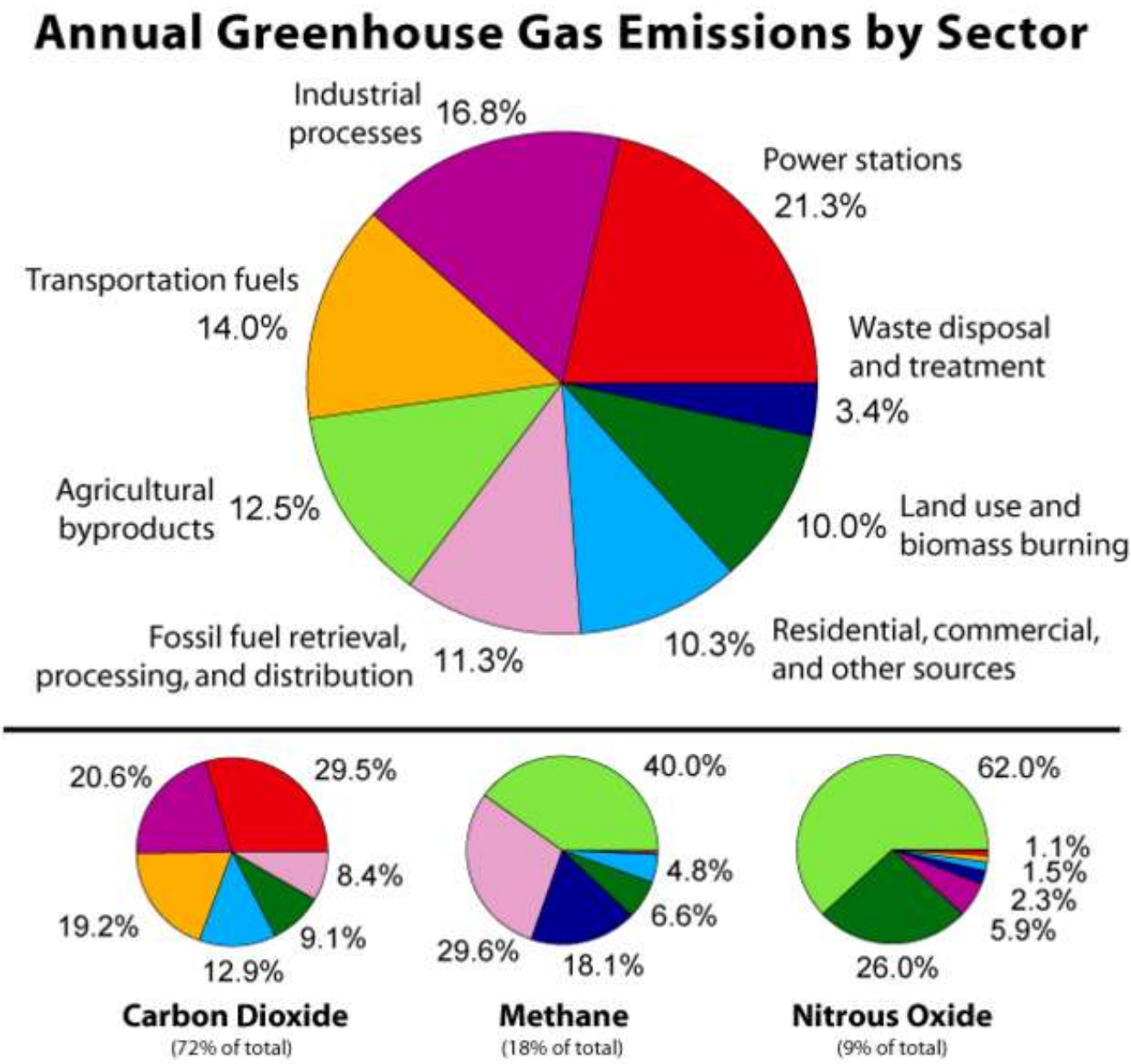


Fig.1: annual green house gas emission by sector

Source: en.wikipedia.org/wiki/climate change

Socio-Economic Characteristics of Women Farmers and Their Family Nutrition In Kakiyeye Village In Kaduna State, Nigeria

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Abstract

The study assessed the socio–economic characteristics of women farmers and their family nutrition in Kakiyeye village area of Kaduna State. A survey research design was adopted for this study. Data were collected using structured questionnaire, and personal observation. Purposive sampling technique was used to select five women organisation from ten (10) organizations in the village. This was based on their farming activities. From each organisation twenty women were randomly sampled giving a total sample size of hundred (100) respondents.

Research instrument used was interview schedule. Variables considered for this study includes, income, occupation, education, farm ownership, gardening and family feeding profile. Finding shows that majority (52%) of the respondents were secondary school certificate holders. Many (47%) of the respondents were also petty traders along with hand craft (33 %) of the population. Results also shows that majority of respondents earn one thousand naira (N1000) and below (71%) per month as their income, 82% had farm while 18 % had no farm. The results further show that 52% of the respondents had food to eat before bed while 48% had no food before bed, 11% often did not get what they want to eat. The study revealed that socio – economic status of women farmers are relevant in family nutrition, therefore home gardening and farm ownership should be encouraged among women farmers to enhance proper nutrition of the family.

Key- words - Women farmers, Family nutrition, Socio- economic characteristics

Introduction:

Women farmers contribute directly to family nutrition through producing, processing and selecting purchased foods, and through seeking and providing care for their family members through nutritional quality of foods and increase dietary diversification (Bisgrove *et a*l 1996). Women contribute to family nutrition by bringing food into the household through farming and other income generating ventures engaged in. Rural women are responsible for more than 55% of the food grown worldwide and for 70% in Africa. Women also comprise 67% of the agricultural labour force in developing countries (Longhurst 1996, IFPRI 2000) Women farmers also play a major role in safeguarding family nutrition. Again Technical Centre for Agriculture and Rural Cooperation (CTA, 1993) pointed out, that women farmers in Africa are more than one-third of the agricultural work force. They account for 70% of agricultural workers, 80% of food producers, and 100% of those who process basic foodstuffs. They also undertake from 60% to 90% of the marketing. Their ability to do this effectively is some times hindered by their access

to important resources like income, land availability, production power and education. Bernise, 1994 have shown in her study, that most women farmers have no land ownership rights. In some communities, they have only yearly or annual rights of use of individual fields given to them by the community head or head of the household, some women farmers obtained their farm land from their husbands or his family. Often this land is "given" to the women for a short period, perhaps just one growing season (Modupe, 1990 ,FAO,1993, the World Bank 1992) Annabel, 1994 and Freeman 1993 have shown that increasing women accesses to resources to carry out these roles— will lead to income growth, production-yields and improvements in the nutritional situation of families, particularly children. Smith et al 1999 stressed the importance of experts in nutrition and other relevant fields to collaborate to design different interventions aimed at increasing women farmers' resources for improve nutritional benefits. Maxwell, (1993) pointed out that women engagement in agriculture is largely a way of providing some measure of food security for themselves and their families, which has a beneficial impact on the families nutritional status particularly within the low income categories. .He also stressed the importance of women farmers, as they play a big role in supplying food to the family and in most cases the families depend on them for basic staples and varieties (nutritional balance). Gardens also save cash that would otherwise have been spent on food purchases. Such cash is used to provide family needs, particularly among the poor and the low income earners who may have large families and may have to spend more on other necessities. Quisumbin *et al* (2003) is of the opinion that educating women (increased awareness) is a major way to increase the activities of women farmers with regards to family nutrition. As they are aware of the impact of improved nutrition on the health of the family but are sometimes constrained by low income to embark on this. Against this background, this study was designed to achieve the following objective.

Objective of the study

The general objective of the study is to assess the socio economic status of women farmers and their family nutrition. Specifically, the study was designed to:

1. Examine the socio economic status of women farmers; and
2. Ascertain problems being faced by women farmers in accessing nutritional food.

Research Question: How did socio economic status of women farmers influence their family nutrition?

Materials and Methods

The study involved several visits to the community and meeting and interacting with the women in those communities over a period of time. In order to have unrestrained access, the researcher visited with the community leaders several times before this study in Kakieye village.

A survey research design was adopted for this study. Data were collected using interview schedule, and personal observation. Purposive sampling technique was used to select five women organisation from ten (10) organizations in the village. This was based on their farming activities. From each organisation twenty women were randomly sampled giving a total sample size of hundred (100) respondents.

Data were collected from women using interview schedule and the questions were mostly to cover important information's about socio- economic characteristic of women farmers and their family nutrition such as age, farm ownership, having garden, secondary occupations, income, educational level, period of no food and family feeding profile. Data were compiled in an Excel spread sheet and analyzed using the SAS statistical package.

Results and discussion

The socio–economic characteristic of women farmers measured include age, occupation, farm ownership, having garden, secondary occupation, income, level of education, period of no food at all in the home and family feeding profile. Table 1shows that 49 % of the women farmers were within the ages of 21 to 30 years, 82% had farms, 79 % had no garden around the houses and reason for not having a garden is harassment from animals on free range and others gave reasons such as leaving in rented houses. By secondary occupation, trading was the single dominant secondary occupation accounting for 47.0% of the respondents. Though 13.0% of the respondents ought to be classified along the traders, they chose to distinguish themselves as food vendors. The remaining 33.0% of the respondents were involved in what could be described as miscellaneous occupations (Hand craft). For income levels of the respondents per month, those who earned between N500 and N1000 were in the dominant range and accounted 71 % of the total respondents. Earners of income within the other ranges in the table were relatively small. This indicates that most of the respondents have very low income on a monthly basis. More than half (52.0%) of the respondents had only secondary school certificate or what could be called the General Certificate of Education ordinary level (GCE O/L while 14.0% had post secondary school education. Also, 60% of the respondents do not feed because there is no food for the family while 40% had food available all through.

As indicated in the Table 2, more than half (52%) of the respondents claimed they have never gone to bed hungry. The remaining 48% have at one time or the other have gone to sleep without supper because there was no money to purchase food. Also 57% of the respondents said they always had all the food they wanted to serve to their family while 11% of them said they often get such food and 36% said they sometimes got the food they want to serve to their families. Only 33% of the respondents claimed they have never eaten consecutively the same type of food for several days. For 57% of the respondents, they had at one time or the other depended on one type of food for days because it is either from their farms or because it was the only food available in the house or could be afforded by the family.

The result also indicates that majority (75%) of the respondents were assisted by their spouse towards the purchases of food in their homes. For most (69.0%) of the respondents, they do not really reduce their children's food because of inadequacies. Only (31%) of them said they resort to reducing their children's food because of the inadequacy of resources in the family. In the same vein most (68%) of the respondents claimed that their children never have to go to bed hungry but (25%) of them said such incidence is rare in their homes. Only 7% of the

respondents said their children go to bed hungry at times because there is no enough money to buy food for the family.

Conclusion and Recommendations

The study shows that socio- economic status of women farmers influenced their family nutrition. The results indicated that home gardening and farm ownership should be encouraged among women farmers to enhance proper nutrition of the family. It also revealed that women empowerment (financially) for sustainable development towards economic security is necessary to equip them with the capacity to live meaningfully. The government should provide scholarship to encourage women farmers' education to boost production and hence better nutrition for the family. Policy on land allocation concerning women should be reviewed for women to have and also inherit land freely in the community or from they spouse. Extension agent should link the women farmers to credit facilities provided by the government. Based on the findings, the study recommends more research into women farmers gardening and landownership to boost family nutrition.

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TABLE 1: Socio-economic Characteristics of respondents

Socio-economic Variable	Frequency	Percentage
Age		
20 years and below	34	34
21 - 30	49	49
31 - 40	9	9
41 and Above	8	8
Total	**100**	**100**
Farm ownership		
Own	82	82
Not own	18	18
Total	**100**	**100**
Have garden		
Yes	21	21
No	79	79
Total	100	100
Secondary occupation		
Trading	47	47
Tailoring	7	7
Food vendor	13	13
Hand craft	33	33
Total	100	100
Income(Naira)		
1000 and below	71	71
1001 – 2000	14	14
2001 – 3000	9	9
3001 – 4000	1	1
4001 – 5000	1	1
Above 5000	4	4
Total	100	100
Level of formal Education		
Non	1	1
Primary	33	33
Secondary	52	52
Post secondary	14	14
Total	100	100
Period of no food		
No	40	40
Yes	60	60
Total	100	100

Source: Field survey, 2009

TABLE 2: Family Feeding profile of the respondents involved in the study

Items on feeding pattern of the respondents	Always	Very often	Some Times	Rarely	Never
1. How frequent is the time you could not eat because there was no money to purchase food	1	3	17	27	52
2. ow frequent do you always have the food type you want to serve to your family	57	11	32	-	-
3. How frequent do you and your children eat the same type of food for several days because it comes from your farm and it is available	9	3	36	19	33
4. How often does your spouse contribute towards the purchase of food	75	10	15	-	-
5. How often do you have to reduced the size of your child's usual meals for lack of money	2	5	24	29	40
6. How often do your children go to bed hungry because there is no enough money to buy food	-	1	6	25	68
7. How often do you have enough money to buy fruits and vegetables as part of the family meal	28	8	55	5	4

Impact of Climate Variability on Household Food Utilization in Nigeria

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Abstract

Adequate food utilization is achieved when food is properly used; when adequate food processing and storage methods are employed. Food utilization involves how food is used, such as how often meals are eaten and of what nutrients these consist. Constraints to food utilization include loss of nutrients during food processing, inadequate sanitation, improper care and storage, and cultural practices that negatively impact consumption of nutritious foods for certain family members. This paper thus examines how climate variability impact on household food utilization and change with seasonal variation in Nigeria.

Keywords: climate variability, household food utilization, Nigeria

Introduction

Climate refers to the characteristic conditions of the earth's lower surface atmosphere at a specific location; weather refers to the day-to-day fluctuations in these conditions at the same location. The variables that are commonly used by meteorologists to measure daily weather phenomena are air, temperature, precipitation (e.g., rain, sleet, snow and hail), atmospheric pressure, humidity, wind, sunshine and cloud cover. Therefore, climate variability refers to the climate changes taking place around the globe. Climate variability can also refer to the year-to-year variations of atmospheric conditions around a mean state or a measure of the frequency distribution of the value of climate variables and their range over a given period of time (WMO, 1992).

World Bank, 2008; Herren *et al*., 2011; ILO, (2007) in recent times have been observing drastic climate changes around the world. Climate change variability in, for example, temperature, rain, flood, drought and sunshine have the ability to damage irreversibly the nutrients in the different food resource bases on which households depend, so much that such households become food insecure. Household food refers to the existence of food stocks for consumption by the household. Household food is determined by the physical quantities of food that are produced, processed and stored for household use.

FAO (2007a) has defined household food as the net amount of food remaining after production, stocks and imports have been summed and exports deducted for each item included in the food balance sheet. Household food activities such as production, processing, distribution, preparation and consumption of food and the outcomes of these activities contribute to food sufficiency of the household. The

sum of all the processes in a household food use is sometimes referred to as “from plough to plate” or “from farm to fork”. Food sufficiency depends on availability of food, access to food, and utilization of food (FAO, 2000a).

On the other hand, household food utilization refers to the use of food and how a person is able to secure essential nutrients from the food consumed. It encompasses the nutritional value of the diet, including its composition, methods of preparation and the social values of foods, which dictate what kinds of food should be served and eaten at different times of the year and on different occasions; and the quality and safety of the food supply, which can cause loss of nutrients in the food and the spread of food-borne diseases if not of a sufficient standard (McConnell and Moran, 2000). Simply put, food utility involves how food is used. This can include how often meals are eaten and of what they consist. Constraints to food utilization include loss of nutrients during food processing, inadequate sanitation, improper care and storage, and cultural practices that negatively impact consumption of nutritious foods for certain family members.

According to Raskin et al. (2010), the number of people suffering from chronic hunger and malnutrition as a result of inadequate food use has increased from under 800 million in 1996 to over one billion in 2009; and that adequate nutrition and sound agricultural practices are important to human and environmental well-being. FAO (2009) also stated that despite increased world food production in the last few decades, world effort to meet the Millennium Development Goal of halving hunger by 2015 appears unimpressive.

Adequate food utilization is achieved when food is properly used and good processing and storage methods are employed. At times family members that constitute a house hold may try to put everything in place in order to ensure proper utilization of food but constraint to food utilization such sun, cloud, rain and temperature, that constitute climate variability affect it. Climate variability, with its ability to damage food nutrients in food resources, may eventually have negative effects on the consumption and utilization of food that a household have taken Therefore, understanding household food, the impacts of climate variability, as well as the possible changes in this variability on food uses is important to making improvements in household food plans

The objectives of the paper are:

1. To know the effects of climate variability on household food utilization
2. To review the availability and accessibility of food with seasonal variation in Nigeria.

Climate Change and Variability: Concepts and definitions

Climate change can be long-term changes in average weather conditions, while climate viabilities refer to the year to year variations of atmospheric conditions around their mean states, such as temperature, rainfall, storm, drought, etc (WMO,1992). Climate change and variability are major threats to food use in many regions of the developing world, which are largely dependent on rain-fed and labour-intensive agricultural production (Parry et al., 1999, 2004; Döös and Shaw, 1999; IPCC, 2001). Variability can also be a measure of the frequency distribution of the value of climate variables and their range over a given period. Any measure

that is below normal, with regard to weather, its intensity and frequency, rainfall and drought would affect food utilization not only at the household level but also at the global level. When conditions like climate, soil, water and land use differ in the environment, food production and, subsequently, food use are drastically limited. When food production in the low-income countries of Africa, including Nigeria, is negatively affected by climate change, the livelihood of huge numbers of the rural poor is put at risk, such that they become susceptible to hunger and malnutrition.

Moreover, household resources can be unnecessarily diverted. For example, resources that could have been used to support core household development needs, such as education, health care and employment, are diverted to ensure meeting basic food needs. Climate is thus specifically an important tool of food classification arrangement at the farm end of the food use, affecting the quantities, quality and types of food produced.

Household Food Utilization in Nigeria

Adequate food utilization ensures good nutrition and long life; hence, there is a direct relationship between what people eat and their health. It is common knowledge that Africa suffers lack of food amidst plenty of natural resources more than any other continent in the world. The lack of adequate food at the household level is a chronic problem, which, unattended to, soon affects every member of the household. A survey on Nigeria's food consumption and nutrition pattern is regularly carried out by IITA to determine the nature and extent of food consumed in the country, for both rural and urban populations. The data for 2004 (IITA, 2004) showed that most households indicated that staple foods were available to them for 9–12 months and that the most available major sources of energy (calories) were rice (14.8%), cassava (12.9%), maize (10.6%), and yam (10.1%). Cowpea, groundnut, and soybean were major sources of plant proteins—of these, cowpea was the most available, followed by groundnut, and then soybean. Also, the most available non-staple foods were meat products (14%), non-leafy vegetables (13%), leafy vegetables (9.5%), and fats and oils (8.9%). And the foods most consumed nationally are cassava (16.5%), rice (14.9%), cowpea (11.8%), groundnut (11.1%), and yam (10.4%).

Among the staple food crops for the dry savannah, the most frequently consumed was sorghum, followed by maize and rice; for the moist savannah zone, it was maize, followed by sorghum, cassava, and rice. In the humid forest, it was cassava, maize, rice, and yam. Among the legumes (which are major sources of plant protein), the most frequently consumed was cowpea, followed by groundnut (for dry savannah); and groundnut, followed by cowpea (for the moist savannah). Generally, there were no differences in the pattern of consumption of the major staples.

Food usage is sometimes affected by a number of things, one of which is seasonal or climate variation. Seasonal variation in weather and its impacts on food usage put undue stress on household food utilization, thus precipitating severe malnutrition among household members (Martorell et al., 1992). Repeated annual cycles of variation in nutritional status that are in line with patterns of rainfall have been documented in several populations throughout tropical and subtropical zones, although the observed patterns differ. Extreme climate changes in the form of extreme rainfalls, droughts, and warming temperatures have been shown to

increase the incidence of diarrheal diseases (Checkley et al., 2000; McMichael et al., 2006) In areas with limited access to clean water and sanitation, diarrheal diseases are a leading killer, contributing directly to child mortality and poor food utilization by limiting absorption of nutrients.

Seasonal climatic variation may also represent a significant risk factor in terms of household survival. In rural Nigeria, the rainy season is accompanied by food shortages, increased labour demands, and high prevalence of under-nutrition (Cole, 1993, FAO 200b). In arid and semiarid savannah regions of the country, the critical period in terms of adult and child under-nutrition is most frequently the dry season, characterized by reduced milk production, high temperatures and aridity, and increased energy expenditure associated with crop planting and watering (Lindtjorn et al., 1993). The environment is sometimes characterized by extreme dryness and food supplies may decline throughout the dry season. Another major contributory factor in Nigerian communities is difficult distribution chain due to poor road networks and underdeveloped communication channels. Thus, food distribution to people living in rural and informal urban areas is a barrier to proper utilization of food and nutrition at household, regional, national levels (Garrett and Ruel, 2003).

Effects of Climate Variability on Household Food Utilization

Climatic conditions have both negative and positive impacts on dietary patterns and hold new challenges for food safety. These impacts and challenges may affect nutritional status in various ways. In many areas where food is produced and consumed locally, food utility changes with seasonal variation, while food availability changes throughout the year. The 'hungry season' is the time between crop planting and harvest. At harvest time, there might even be festivals in which a lot of food is consumed or wasted. If there were a drought and food availability were low, the range of food available often decreases, and so the meal frequency can decrease and the balance of nutrients can be inadequate. This can lead to malnutrition in both children and adults. It is also important to note that climate can impact positively on food utility. Where there are hot dry days, crops and vegetables can be preserved through drying and then keeping for use at a later date.

The main impact of climate change on nutrition is to be felt indirectly, through its effects on income and capacity to purchase a diversity of foods. The physiological utilization of foods consumed also affects nutritional status, and this, in turn, is affected by illness. Climate change will cause new patterns of pests and diseases to emerge, affecting plants, animals and humans, and posing new risks for household food use, safety and human health. Increased incidence of water-borne diseases in flood-prone areas, changes in vectors for climate-responsive pests and diseases, and emergence of new diseases could affect both food utilization and people's physiological capacity to obtain necessary nutrients from the foods consumed. Vector changes are a virtual certainty for pests and diseases that flourish only at specific temperatures and under specific humidity and irrigation management regimes (Mortimore, 1998). These will put humans at new risks to which they have not yet adjusted. They will also place new pressures on caregivers within the home, and will challenge healthcare institutions to respond to new parameters.

Health risks can also be linked to changes in diseases from either increased or decreased precipitation, lowering people's capacity to utilize food effectively or often resulting in the need for improved nutritional intake (IPCC, 2007b; IPCC, 2007).

The social and cultural values of foods consumed will also be affected by the availability and affordability of food. The social values of foods are important determinants of food preferences, with foods that are accorded high value being preferred, and those accorded low value being avoided. In many traditional cultures, feasts involving the preparation of specific foods mark important seasonal occasions, rites of passage and celebratory events. The increased cost or absolute unavailability of these foods could force cultures to dump their traditional practices, with unforeseeable secondary impacts on the cohesiveness and sustainability of the cultures themselves. In many cultures, the mutual giving of gifts or sharing of food is common. It is often regarded as a social responsibility to feed guests, even when they visit without prior notice. In conditions of chronic food insufficiency, households' ability to honour these responsibilities will break down and this trend is likely to be reinforced in locations where the impacts of climate change contribute to increasing incidences of food shortage (Fischer et al., 2001, FAO, 2003).

In general, food safety can be compromised in several ways. Higher temperature may cause food quality to go bad, unless there is adequate investment in cooling and refrigeration equipment or more reliance on rapid processing of perishable foods to extend their shelf-life. Decreased water availability has implications for food processing and preparation practices, particularly in the subtropics, where a switch to dry processing and cooking methods may be required. Changes in land use, driven by changes in precipitation or increased temperatures, will alter how people spend their time. In some areas, children might have to prepare food, while parents work in the field, increasing the risk that good hygiene practices may not be followed.

In particular, climate change impacts heavily on food utilization in two broad ways: availability of and accessibility to food and food resources. These two broad issues would be discussed somewhat exhaustively in the following paragraphs.

Climate variability and food availability/Utilization

Food uses can only take place where the food is, first of all, available. Hence, if there is no access (accessibility) to food, there can be no utilization. It is in this regard that the impact of climate variability on food availability will be look into. Household food refers to the existence of food stocks for consumption by the household. Household food is determined by the physical quantities of foods that are produced, processed and stored for household use. FAO (2007b) defines household food as the net amount of food remaining after production, stock and import have been summed and exports deducted for each item included in the food balance sheet.

Laurence and Williamson, 2001). Other climate variables such as rainfall, soil moisture, temperature and Adequacy are assessed through comparison of availability with the estimated consumption requirement for each food item. High market prices for food are sometimes a sign of inadequate availability; high prices force poor people to reduce consumption below the minimum required for a healthy and active life, and may lead to food riots and social unrest. Moreover, growing scarcities of water, land and fuel can put increasing pressure on food prices.

Most of the time, scarcities are compounded by the outcome of climate change and a general increase in the cost of an average food basket for household consumption (radiation can affect crop thresholds beyond which growth and yields are compromised (Porter and Semenov, 2005). For example, cereals and fruit trees' yields can be damaged by a few days of temperature above or below a certain threshold (Wheeler et al., 2000), thus limiting household utilization. In the European heat wave of 2003, when temperatures were 6ºC above long-term means, crop yields dropped significantly, such as by 36 per cent for maize in Italy, and by 25 per cent for fruits and 30 per cent for forage in France (IPCC, 2007b). This situation also increased intensity and frequency of storms, and altered hydrological cycles.

Wild foods are important to households that struggle to produce food or secure an income. A change in the geographic distribution of wild foods, resulting from changing rainfall and temperatures, could therefore have effect on the availability of such foods and on the concerned household consumption. Levin and Pershing (2005) reported that changes in climatic conditions will lead to a significant decline in the provision of wild foods by a variety of ecosystems, and other impacts can be expected as the world climate continues to change. They went further to say that, for the 5,000 plant species examined in a sub-Saharan Africa (Nigeria inclusive), between 81 and 97 per cent of the suitable habitats would decrease in size or shift owing to climate change. They concluded, therefore, that by 2085, between 25 and 42 per cent of the species' habitats would be lost altogether (Parry et al., 1999). The implications of these changes are expected to be particularly great among communities that depend solely on plants for food and medicine (Gleick, 1993; World Bank Poverty Net, 2008; Du Toit and Ziervogel, 2004).

Climate variability and food accessibility

Household food access is the ability to acquire sufficient quality and quantities of food to meet all household members' nutritional requirements. Access to food is determined by physical and financial resources, as well as by certain social and political factors (Sen, 1989, cited in FAO, 2003a). Individuals can have sufficient access to food only when they have "adequate incomes or other resources to purchase or barter to obtain appropriate foods needed to maintain consumption of an adequate diet nutrition level (USAID, 1992). Food access depends on the ability of households to obtain food items through purchases, gathering, current production or stocks, or through food transfer from relatives, members of the community, the government, or other donor. The mere presence of an adequate supply does not ensure that households can obtain and consume food; hence, household access to food is a factor depending on its affordability factor. Increased risk exposure resulting from climate change will reduce people's access to food and undermine their food sufficiency.

After food is produced, it is moved from where it was produced to where it would be utilized or consumed. These processes involve transport. For example, increased heat stress may reduce the life of roads, and windstorms can impact transit at air and sea port terminals as well as damaging infrastructure which may lead to delays (Perry and Symons, 1994; IPCC, 2001). Moreover, in droughts, people move into marginal lands. Such marginal lands may not have good road access, so that transporting food from such locations can cause a huge problem (Thomsen and Metz, 1998). In Africa, inefficient and ineffective transport systems compromise effective delivery and increase prices of food, thus limiting utilization. Changes in

relative prices for major food items may result in people either changing their food needs, or spending more of their earnings on food when prices of preferred food items double.

Also, food preferences determine the kinds of food that households will want to obtain more; while changing climatic conditions may affect both the physical and the economic availability of certain preferred food ingredient, which might make it difficult to meet some food needs of the different people in the household. A family might reduce the daily amount of food consumed equally among household members, or allocate food preferentially to certain members, often the able-bodied male adults, who are assumed to need it the most to stay fit and continue working to maintain the family (Ruel et al., 1998; Ellis and Sumberg, 1998). In southern Africa, for example, many households eat maize as the staple food; but when there is less rainfall, sorghum becomes food for every household and people consume more of it (FAO, 2007a). When households cannot afford sufficient food, they adjust by eating less of their preferred foods or reducing total quantities consumed; and because less food is consumed, there may be nutritional deficits (Pretty et al., 2005).

Conclusion and Recommendations

In conclusion, there are clearly many pathways through which climate change impacts food utilization (availability and accessibility). Climate forces change in food production, which affects incomes and food prices, with the major effect on food usage. And the quality and safety of foods often affect their nutrients and the health of a given household. Climate variables can impact on physical/human capital– such as roads, storage and marketing infrastructure, houses, productive assets and human health, which indirectly change the socioeconomic factors involved in food availability and accessibility, and thus food utilization patterns of households. Moreover, climate impacts on income-earning opportunities; hence, it affects the ability to buy food. Also, a change in climate extremes may affect the availability of certain food products, which would then influence their prices. Consequently, high prices make certain foods unaffordable and/or inaccessible, which may also impact on individuals' health.

Based on this conclusion, this paper recommends the following:

1. Expansion of the coverage of climate change interventions, especially at household and community levels where knowledge on climate change is still highly limited.
2. Government should come up with detail and multi-sector programmes on the approaches to mitigating the effects of climate change on household food utilization.
3. Existing organisations such as UNICEF and WHO should expand nutrition interventions which successfully and sustainably tackle the direct causes of inadequate food utilization as a result of climate change, taking cognisance of such programmes as small-scale agricultural development, improved income generation initiatives, water sanitation procedures, nutrition education, etc.
4. All stakeholders should integrate the climate dimension into existing initiatives and programmes dealing with nutrition and food security, so as to

avoid food and economic crises, by making a policy that will involved all segments.

5. There should be more research and development initiatives to establish the links between climate and under-nutrition or malnutrition, and on projected effects and/or threats of specific climate change mitigation actions on nutrition, so as to guide future programmes on climate change and nutrition.
6. There should be inclusion of nutrition specialists in the various knowledge-building and peer review works of IPCC.

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Integrating Young Farmers' Club into Climate Change Adaptation and Mitigation Programmes in Nigeria

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Abstract

The paper highlighted the need for the involvement of youth (through Young Farmers' Clubs programme) in climate change awareness, adaptation and mitigation activities and strategies for effecting it was discussed. A framework for integrating young farmers' clubs into climate change adaptation and mitigation programmes in Nigeria was formulated. Possible constraints to effective integration of youth into climate change awareness, adaptation and mitigation programme were also discussed. It was then recommended that a virile and sustainable young farmers' clubs should be developed at primary, secondary and tertiary levels. Also an effective committee for proper coordination of the ministries of agriculture, Education and Environment should be constituted for climate change issues.

Key word: *Climate change, mitigation, adaptation, awareness, Young Farmers' Clubs*

Introduction

The term agriculture may be simply defined as partly a science and partly an art, with both parts interacting in the cultivation of crops/ plants and raising of livestock and fish, either for direct consumption as food, sale, export and/or industrial use (Ajayi, 2007). Prior to the advent of oil boom era, agriculture was the cornerstone of Nigerian economy. Nigeria was noted for its targeted production performance in terms of food and cash –crop as well as for the agro-allied industries. During that time, agricultural practice was purely subsistence in nature. Most people were living in the rural areas; fully engaged in agricultural production. Two persons were able to provide food for at least, ten people sufficiently. In fact, agriculture accounted for about 75-80% employment of our population and 18% of gross domestic product (GDP) and over 5% of our foreign exchange earning (Aribisala, 1983 in Ajayi, 2006).

Unfortunately, nowadays, ten farmers cannot sufficiently provide food for eight people in spite of the very good potentials we have for considerably increased agricultural production, both by expanding the areas under cultivation and by improving yields from the presently cultivated area by adopting intensive methods. The Nigerian agriculture has failed to produce enough food for meeting the needs of our rapidly growing population. Agriculture has been relegated to the bottom of the ladder and its popular bloomy state has been changed into a gloomy one. The downward trend of agricultural production has been attributed to such factors as the growth of oil production; population explosion; land tenure system and soil fertility problems; scarcity of labour; natural factors; negative attitude of the youths towards

farming as a carrer; the rural- urban drift of the young school leavers and a host of other factors (Okunaeye, 1985 in Ajayi, 2006).

Nigeria's agriculture has been on the decline and when compared with other sectors of the economy, the agricultural sector has been growing rather slowly. The index of per capital food production in 1969- 71 was 100 while it was 88 in 1980-81. This shows the seriousness of the food supply problem (Adekanye, 1985 in Ajayi 2002). This general decline in agricultural outputs, soaring food import bills, and others agricultural commodities can be attributed to such factors as population explosion, concentration on petroleum production by the government among others (Ajayi 2002).

To resuscitate agriculture from its gloomy state, the need arose for the development of various strategies aimed at boosting agricultural production in the country. Agriculture is still of importance to our economy and we must give it the topmost priority in our economy as it will sustain us for a very long time after the oil would have finished as it surely will some day. Agriculture will however not do so unless it is modernized and becomes an attractive economic undertaking, especially, to the youths. The world now possesses the knowledge of the pre-requisites for transforming a stagnant agriculture like ours into a highly productive and progressive one. What is required of us is to invest in the pre-requisites and at the same get the time, interest of our youths in farming and rural life.

Nigeria therefore, like many other developing countries, has for a long time been searching for policies and strategies for accelerating the development of agriculture. Among the various strategies which have been introduced by different administrations in the country are : the National Accelerated Food Production Programme (NAFPP-1973), River Basin Development Authority (RBDA-1975),Operation Feed the Nation (OFN) in 1976, Agricultural Credit Guarantee Scheme (ACGS-1977), Green Revolution(GR-1980), Integrated Rural Development (IRD-1980), National Directorate for Employment (NDE-1980), the operation Back to the Land (OBL- 1984); Agricultural Development Programmes (ADP-1985), Directorate of Food, Roads and Rural Infrastructure (DFRRI-1987), the National Land Development Authority (NLDA-1992),The First National Fadama Development Project (FNFDP-1992), and the National Special Programme for Food Security (NSPFS-2003), National Fadama Development Project phase II (Fadama II-2003), and National Fadama Development Project phase III (Fadama III 2009) (Ajayi 2001; Daudu 2008; Olaolu, 2010). Essentially, some of these programmes have proved abortive while some made meaningful impacts on the lives of those who benefited. Unfortunately, of recent agriculture is being faced with the problems of Climatic change and its devastating impacts on crop, livestock and fish production in Nigeria and all over the world as presented in Table 1. Hence this paper sought to explore possible strategies to be adopted in integrating young farmers' club into climate change adaptation and mitigation programmes in Nigeria. Specifically, the paper reviewed climate change adaptation and mitigation efforts; identified strategies for integrating young farmers' club into climate change adaptation and mitigation; and examined possible constraints to effective integration of YFCs into climate change programmes as well as suggested solution to the constraints.

TABLE 1: Summary of Climate change characteristics and their various impact

Characteristics	Impact
1. Increasing green house gas emission and global annual temperature at 2oC above pre-industrial levels in 2050 (Margulls, 2010)	• Rise in sea levels; changes in seasonal geographic precipitation patterns, characterized by more intensive rainfall more frequent floods, droughts and heat waves.
2. Trends of warming in Africa likely at a rate faster than the global average (IPCC, 2007)	• Ecosystem dislocation with high vulnerability in crop agriculture and water resources (Santhaye and Ravindranath 1998). • High temperature may be beyond the range of tolerance for current crop varieties and cultivars (Adajuwon, 2006)
3. Precipitation increases in high altitudes and decreases in most sub-tropical regions as much as 20% (IPCC, 2007).	• Erosion is exacerbated. • Flooding at low-lying areas become more vulnerable to inundation from sea level. • Damages to settlements and infrastructure (Rudd, 2010). • Rapid rate of organic matter decomposition. • Reduced crop growth (Agoumi, 2003)
4. Changes in onset of rainy season and the variability of dry spells.	• Reduced crop growth and may lead to crop failure (Kalu, 2008; Odo, 1999)
5. Destruction of forest ecosystems through deforestation, burning and cultivation methods that reduce tree density (Rajasekaran and Warren 1994)	• Drying up of streams. • Hot and humid environment within the forest eco-systems with high vulnerability exhibited by vegetable crops, spices, root and tuber crops. • Loss of genetic diversity. • Water logging and salinisation of irrigation lands. • More frequent drought, erosion and floods • Increased carbon dioxide emission • Retarded regeneration and crop failure • Accelerated desert encroachment. • Sequertial and cyclic impacts.
6. Combination of shifts in temperature, vegetation cover and species distribution as well as the associated alteration in the dynamics of drought, rainfall and heat waves (Ziervogel *et al.,* 2008): the interplay of deforestation and burning.	• Multiple stress on the biophysical, social and institutional environment underpin crop production. • Weakening of economics livelihood and food security (Smith and Barchiesi, 2009). • Secondary stresses leading to pest and disease complexes. • Increased competition for resources and degeneration of regional and ecotypic biodiversity.

	• High vulnerability in crops • Disastrous impacts on artisanal fishing, wildlife species and forest products.

Adapted from Kalu and Egbe 2011

Climate Change Adaptation and Mitigation Efforts

In principle, adaptation was established as a priority at the very start of the international climate effort. In the UNFCCC, all parties committed generally to undertake national adaptation measures and to cooperate in preparing for the impacts of climate change (UNFCCC, UD) The Convention also called for full consideration of the specific needs and concerns of developing countries—especially the least developed—arising from the adverse effects of climate change. More concretely, developed countries committed to help "particularly vulnerable" countries meet the costs of adaptation (UNFCCC, UD). Nearly 15 years after the Convention's negotiation, however, the international adaptation effort is more an irregularly funded patchwork of multilateral and bilateral initiatives than a fully conceived and functioning regime.

At the first Conference of the Parties (COP) to the Convention, in 1995, the parties established a three stage framework for addressing adaptation (Ian, *et al*, 2006). Stage I, to be carried out in the "short term," was to focus on identifying the most vulnerable countries or regions and consequent adaptation options. Stage II was to involve measures, including capacity building, to prepare for adaptation. Stage III was to entail implementing measures to facilitate adaptation. The latter two stages were to be implemented over the "medium and long term.**"** (UNFCCC, UD). Broadly speaking, the effort to date has centered primarily on Stage I- and Stage II-type activities, more often simultaneously than sequentially. Multilateral and bilateral support has focused on building the capacity of developing countries to assess their vulnerability to climate change and examine adaptation needs and options. For example, with assistance provided under the Convention, Bangladesh and small island states in the Caribbean and the Pacific have examined their vulnerabilities to climate change and are assessing options for adaptation. The U.N. Environment Programme has worked with about half a dozen countries on in-depth assessments of vulnerability, while the U.N. Development Programme is assisting scores of countries in assessing adaptation needs. By one recent accounting, bilateral programs have committed $110 million to more than 50 adaptation projects in 29 countries (Frankel-Reed (2006).

Recently, the emphasis has shifted to setting priorities among adaptation options. More than 40 least developed countries have received funding under the Convention to prepare National Adaptation Programmes of Action (NAPAs) addressing urgent need GEF (2006). The NAPAs are meant to draw on existing information and community-level input to assess vulnerability to current climate variability and areas where risks will be heightened by climate change, and to identify priority actions. The Global Environment Facility (GEF), which administers adaptation funding under the Convention, recently approved the first allocations for implementation projects through a $50 million Strategic Priority on Adaptation (SPA) initiative GEF (2006). Arguably, one significant constraint on adaptation efforts to date has been limited funding. At COP 7, in 2001, parties established three GEF-managed funds dedicated fully or in part to supporting adaptation Ian, *et al* (2006).

In a bid to mitigate climate change challenge, several programmes and efforts have been initiated in response to the challenge some of which include: Intergovernmental Panel on Climate Change(IPCC) established in 1988 by the world Meteorological Association and United Nations Environment Program; United Nation's Framework Convention on Climate Change (UNFCC) adopted in May 1992 with the ultimate objective of the stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthrogenic interference with the climate system; Bali Action plan- a 2 year plan lauched in 2007 under the UNFCC in Bali, Indonesia, aimed at negotiating long-term cooperative action on climate change beyond 2010 and to reach the agreed outcomes of 2009; Green Economy – which involes harnessing employment and wealth creation opportunities in the development and utilisation of clean energy, green environment; UNEP International Resource Panel- focused on resource efficiency through the economic life- cycle, these includes extraction, production, distribution/transmission, consumption/utilisation and disposal; Renewable Energy Options- for sustainable energy supply and use, such as solar energy, wind energy, bio energy, hydropower and geothermal energy; Global Convention on Biological Diversity aimed at conserving and projecting global biodiversity and uphold the ecological services; Polluter-Pay-Principle (PPP) first proposed in 1972- this involved allocating costs of pollution prevention and control measures to encourage rational use of scarce environmental resources and avoid distortions in international trade and investment. It means that the polluter should bear the expenses of carrying out pollution prevention and control measures; and Carbon markets- trade in carbon credits bought by governments seeking to meet emission reduction targets under the Kyoto Protocol and companies subject to emission regulations (Eboh 2011).

In most of these Climate change adaptation and mitigation programmes, not much effort was directed at involving the youth in them. The involvement of these young ones that have leadership potential in agriculture means founding a base for a solid and better agricultural technology/ information transfer, better relationship between farmers and agricultural extension workers (Ajayi, 1995; Siyanbola, 1997 in Ajayi 2002). Youths form at least 40% of a community, and because of their exposure to vocational agriculture and scientific knowledge acquired in schools, they may as well as help in the formation of various agricultural clubs for the transfer of agricultural technology and adoption of improved practices (Ogunlade, 1994 in Ajayi 2002). A typical example of these clubs is the Young Farmers' Club (YFC) in Nigeria.

The Need for the Integration of Young Farmers' Club in Climate Change Awareness, Adaptation and Mitigation Programmes

Young farmers' club form an important aspect of the Rural Youth Agricultural Extension Proramme (RYAEP) for boys and girls in the secondary schools and villages. RYAEP is a programme developed purposely to mobilize youth in order to do one particular useful work with the view of developing specific skills or careers in them. Young farmers' club (YFC) is an organization in which young people usually, between 9 and 20 years of age (no hard and fast rule) are engaged to learn about better farming and home-making technologies. The members are under the guidance of the agricultural extension personnel, the local club leaders and the agriculture teacher (Bradfield, 1966; Maunder, 1972; Ajayi, 1987; Ajayi, 1997; Ogunbemeru, 1997 in Ajayi, 2002).

For agriculture to actually regain its past glory and at the same time, for stakeholders to mitigate and adapt to the challenge of climate change, it is imperative to develop agricultural programmes for young ones (especially, the rural schools boys and girls) because the young people of today are the farmers and farmers' wives of the future. It is better to interest them in farming through vocational agriculture and also equip them to face the Climate change challenge facing us today while they are in school so that they will be able to farm on their own by employing climate friendly measures to reduce the adverse impact of climate change and be more responsive to the agricultural extension programmes after their schooling.

Strategies for Integrating Young Farmers' Clubs into Climate Change Mitigation and Adaptation Programmes

Young farmers' Clubs programmes should be allowed to form part and parcel of the Ministries of Agriculture, Education and Environment's programme of activities for the purpose of making Climate change adaptation and mitigation programme more meaningful and effective in areas of climate change awareness creation, adaptation and mitigation among the rural poor farmers. Hopefully, such a strategy will give room for complementing of the efforts by various agencies directed at Climate change awareness, adaptation and mitigation. The government should encourage cordial relationship between the ministries of Education, Environment and Agriculture for the purpose of effectively integrating the young people in their efforts on Climate change awareness creation, adaptation and mitigation.

The three major segments (The school authorities, the agricultural teachers and students) of the school system should interact mutually enough for the evolution of virile YFCs. The YFCs should be involved in climate change awareness adaptation and mitigation programmes and the agricultural technology transfer and training programmes of the research/ S.M.S. division of the ADPs. Besides, relevant information / technology can be passed on to the YFCs by the various units/ parastatals of the ministry of environment, BESs and or/VEWs for onward transmission to contact and/ or the non-contact farmers who invariably, are their parents (Figure 1).

For the members of the YFCs to develop the required competencies needed for effective climate change awareness, adaptation and mitigation, the leaders of YFCs/ representatives of YFCs and agriculture teachers should be provided with regular relevant trainings as these will enhance their effective participation in the climate change awareness creation, adaption and mitigation as well as complement both theoretical and practical agricultural knowledge gained from their school.

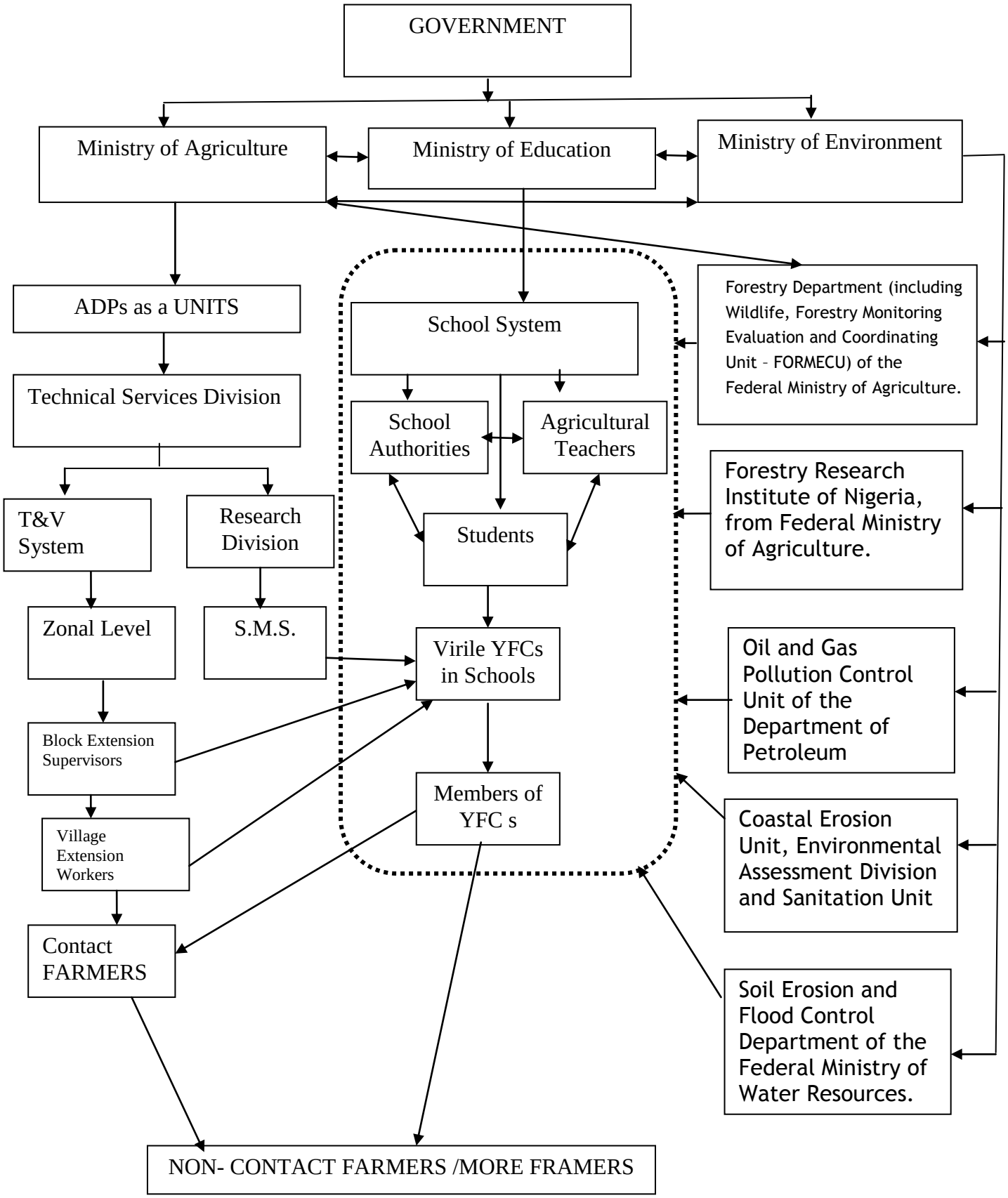


Figure 1: Framework for Integrating YFCs into Young Farmers' Club into Climate Change Adaptation Programmes in Nigeria

Possible Constraints to Integration of YFCs into Climate Change Programme and Suggested Solutions

1. Lack of proper coordination between the Ministries of Agriculture, Education and Environment. There is a need for the formation of coordinating committees, which should be involved in policy formulation execution and evaluation of such integration processes. The committees should be formed at the national, state and local government levels. Such committees should be encouraged enough for the best jobs.
2. Lack of functional YFCS in secondary schools-. The federal and /or the state government should make policy statement regarding the formation and organisation of YFCs in all secondary schools, and such policy statements should be backed-up by laws. The compliance of the school authorities with such policy statements should be stressed by setting up a monitoring team, like what was obtained in the then Rivers State of Nigeria in 1984/ 85 academic year (Ajayi, 1987 in Ajayi 2002)
3. Poor funding- Adequate and timely funds should be provided for school authorities and the research unit of both the ADP and various units of the Ministry of Environment to enable them give necessary support to the strategy.
4. Inadequate support facilities and logistics- There should be a cadre of well seasoned; dedicated agriculture teachers and subject matter specialist/ BESs, VEWs in climate change issues who are committed to helping the YFCs in achieving their objectives. They should be mobile and be given adequate audio-visual facilities to enable them to do their best. Adequate supply logistics for effective ways of climate change awareness, adaptation and mitigation should be provided.
5. Lack of continuous production-oriented research activities – the key to increased agricultural productivity through technology transfer is the conduct of research aimed at providing high yielding varieties of crops and livestock production techniques which members of YFCs can extend to their parents. The research unit of the ministries of Agriculture, Education and Environment should be geared towards turning-out improved practices, which are dependable and practicable to the YFCs and their parents. The improved practices must be economically viable, culturally compatible and technically feasible (Ajayi, 2002).

Conclusion

Nationally and internationally, none of the symposia and /or research works on climate change awareness, adaptation and mitigation activities has never made deliberate concrete efforts to involve the youth. The deliberate involvement of youth in climate change awareness, adaptation and mitigation programme, especially, through YFCs, is a sine-qua-non because the youth of today are the future leaders of tomorrow. They are better informed, digital, highty receptive and always seeking useful and practical current pieces of information. The YFCs are the nurseries for them to grow and develop. Hence it becomes imperative that virile and sustainable YFCs are developed at primary, secondary and tertiary levels. Also, effective committees for the coordination of the three ministries should be constituted.

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Impact of Climate Change on Food Security in Nigeria

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Abstract

Climate change which is a change in the state of the climatic properties such as rainfall, precipitation, humidity, temperature, sunlight and wind for an extended period of time, is undoubtedly the most topical and global environmental issue. It is caused by natural and human activities, which has posed serious threat to agriculture and food security (that is, food availability, its stable or sustainable supply, its access and utilization) world over and Nigeria in particular. This is as a result of reduced rainfall and humidity, increased solar radiation and temperature which have led to high evapo-transpiration, leaf dryness, poor photosynthesis, reduced microbial population, activities and Organic Matter (OM) content in the soil. The effect of one or a combination of two or more of these have the tendency to impact negatively on agricultural production thereby causing poor yield and consequently food insecurity. This paper recommends strict compliance to the Kyoto protocol by industrialized and developed nations. Efforts should be made to include those countries whose emissions have not yet been captured by this treaty. There should be population control, reduced deforestation and any form of burning in order to cut down emissions of greenhouse gases. There must be the enforcement of afforestation and reafforestation practices, investment into research to develop new varieties of crops and animals and adoption strategies that will adapt to the current climatic conditions. There must be green climate fund to assist developing countries to enable them mitigate and adapt to the impact of climate change and finally, a well strengthened agricultural extension to liaise efficiently and effectively between research and farmers on climate related issues must be in place by government.

Introduction

Agriculture remains the dominant sector of the economies of African countries where it contributes significantly to the GDP, export earning and providing employment to the active workforce than any sector of the economy (Thornton *et.al,* 2010). This is apart from providing food for her growing populace which is the basic and fundamental role of this sector. Though there are other causes of hunger and food insecurity, agriculture is an important contributor to food security at both micro and macro levels, because it makes food available and affordable to the people.

Because of Africa's favourable climatic and edaphic potentials that are suitable for agricultural productions, it is plausible to expect an African continent that is prosperous and food secure, but instead, Africa has a remarkable distinction of being the only region in the world, where a good number of her populace lives under one dollar per day and have no physical access to sufficient and safe food to live a healthy and productive life. This scenario is projected to increase rather than decline in the next decade, despite several laudable programmes such as: technological advances, improved crop varieties, genetically modified animals and

irrigation systems among others, put in place by successive governments. This is because the expected growth in agriculture to keep pace with the increasing demand for food has not occurred. There is the fear therefore that, Africa may not be able to achieve the Millennium Development Goal (MDG) “to eradicate extreme poverty and hunger by 2015”. This is in addition to the fact that, weather a key factor in agricultural productivity and the issue of climate change has remained another global and most serious developmental and environmental problem that threatens food security worldwide and Nigeria is not an exception. However, this is presented in the following order: Definition of concepts of climate, climate change and food security, causes of climate change, impact of climate change on food security, recommendations and conclusion.

Definition of the concepts of climate, climate change and food security

An understanding of the concepts of climate, climate change and food security is germane in this discourse. This is because any meaningful discussion is obviously based on the understanding of the given concept(s). To define or understand the concept climate change and its impact on food security therefore, one must first of all understand what climate is.

Climate

Climate is the average weather conditions of a place over a long period say 35 years or the average state of the lower atmosphere and associated characteristics of the underlying land or water in a particular region, usually spanning several years (WHO, 2003). Climate is also seen as the synthesis of weather over a given area or location over a long period of at least 30 years or the end product of the workings of the climate system which is made up of the atmosphere, lithosphere, hydrosphere, cryosphere and biosphere, all interacting together and powered by solar radiation (Ayoade, 2010).

The climate system is an open system that is in dynamic equilibrium or steady state over a given period and if this steady state is disturbed as a result of significant changes in one or more of the components making up the system or the amount of solar energy powering the system, the climate system will move over time to a new state of equilibrium to produce a new climate state and in such a situation, a change in climate is said to have occurred (Ayoade, 2010).

Climate Change

Climate change is any significant change, in the average weather or change in the statistical distribution of weather events or change in measures of climate such as temperature, precipitation, wind and relative humidity around average or change in the state of the climate that can be identified by changes in the means and, or variability of its properties that exists for extended periods typically decades or longer (IPCC, 2007).

The earth as an ecosystem is changing, attributable in great part to the effect of globalization and activities of man. There is evidence that precipitation patterns are changing, the sea level is increasing, the glacial are retreating worldwide, and the arctic sea ice is thinning and the incidence of extreme weather events are increasing in some part of the world owing to global warming (Watson, 2010). This is brought about by the layer of gases surrounding it which acts like the green house. These gases let the sun rays enter the earth, but stop much of the heat from

escaping, this natural process and these green house gases mainly CO_2 and water vapour keeps the planet earth warm enough to sustain life. Green house in the atmosphere are like a mirror and reflect back to the earth, a part of the heat radiation, which otherwise would be lost to the space.

More CO_2 is now in the atmosphere than has been in the past 650.00 years, thus the carbon that stays in the atmosphere, act like a warming blanket and hold in the earth hence the name global warming (Chio and Fisher, 2005).The higher the concentration of green house gases like CO_2 in the atmosphere, the more the heat energy is being reflected back to the earth and the warmer the earth becomes. This will have considerable impact on man, his economic activities (agriculture been most affected) and the environment in general. That is why climate change is seen as an environmental, social and economical challenge on a global scale (Schoze, Knorr and Prentice (2006) and Mendelsohn, Dinart and Williams (2006).

The vital role played by climate in human existence and affairs cannot be over emphasized, because man is on this planet earth as a result of its conducive climate and an atmosphere that can sustain life which is threatened by climate change. Climate change is a complex bio physical process and it is so impossible to predict precisely the future climate condition, but scientific consensus states that global land and sea temperature are warming under the influence of green house gases such as CO_2, CH_4, N_2O and fluorinated gases which will continue for at least the next decade regardless of any mitigating efforts to reduce the sources or enhance the sinks of green house gases (IPCC, 2001 & Hassan and Nhemachena 2008). Man should therefore be concerned with what happens to the earth's climate because man's existence depends on it. Because changes in the frequency and durability of extreme climate events such as heat stress, drought and flooding events will have significant consequences for food production and food security (IPCC, 2007), since food production depends largely on the quality of climatic and edaphic components of the plant environment. Therefore there is no doubt that, the increasing variability and change in organic elements coupled with land degradation are serious threat to food production and consequently food security (Bello, 2010).

Food security

Food security is defined as a situation in which one has both physical and economic access to adequate food both in quality and quantity and not at risk of losing such access so as to ensure a healthy, fulfilled, active and productive life (Oluyomi, 2009). By this definition, food security is conventionally viewed in terms of four components which are; food availability, food access, food utilization and stability of food production system (FAO, 2008) (Fig 1).

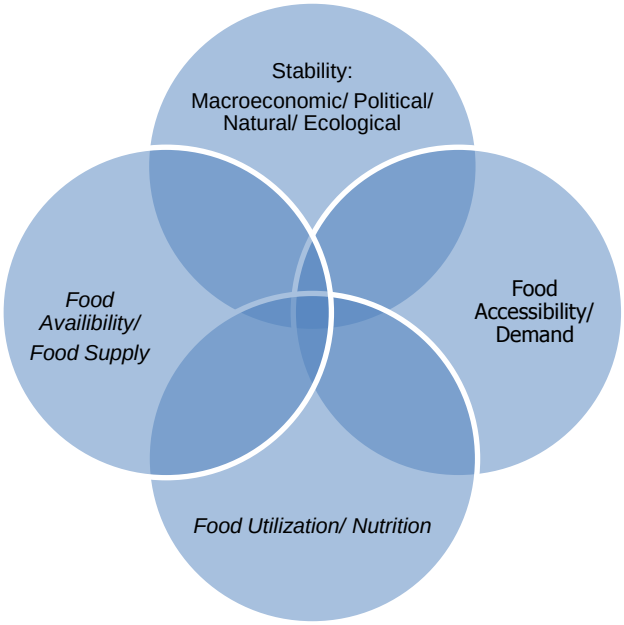


Fig 1: Food security concept
Source: FAO (2009)

The four components of food security highlighted above are affected by climate, but food availability and stability in production system are most intimately associated with climate variability and its changes. This has left almost 1 billion people world-wide hungry, as they are denied the most basic human right of all, the right to food and nutrition security. In many African countries for example, agricultural production as well as access to food will be negatively affected by the effect of climate change, thereby increasing food insecurity and malnutrition (Easterling *et.al* 2007). Tubiello and Fisher (2007) projected the following number of malnourished in the following regions between 1990 and 2080 (Table 1).

TABLE 1: Expected number of undernourished in millions incorporating the effects of climate change

Regions	1990	2020	2050	2080	2080/1990 ratio
Developing countries	885	772	579	554	0.6
Asia	659	390	123	73	0.1
Developing SSA	138	273	359	410	3.0
Latin America	54	53	40	23	0.4
Middle East & North Africa	33	55	56	48	1.5

Source: - Adapted from Tubliello and Fischer, 2007

Table 1 above shows the projected range of undernourished population in some continents of the world as a result of climate change. The case of SSA especially of which Nigeria is a part is more serious. To attain improved agricultural productivity, adequate and sustained food supply both in quality and quantity and to have a conducive environment for man, plants and livestock in Nigeria therefore, the causes of this global environmental issue which has been and continues to be a hotly contested phenomenon need to be determined.

Causes of climate change

Ayoade (2010) states that, the climate system is an open system that is in dynamic equilibrium of steady state and the state of the climate at any given period is determined by three vital factors which are; (a). The amount of solar energy input into the system. (b). The manner, in which the energy is distributed, reflected and absorbed over the earth surface and within the earth's atmosphere. (c). The nature of the processes and the interaction among the five components that make up the climate system (atmosphere, lithosphere, hydrosphere, cryosphere and biosphere). Any major variations in the above three factors overtime, may push the climate system into a new state of equilibrium i.e. produce a new climate system as a result of which climate change is said to have occurred, this changes can be brought about naturally and, or by human/man-made activities. This is corroborated by IPCC (2001) that 70 percent of climate change is caused by human activities while 30 percent is due to natural causes.

Natural causes of climate change: - Natural causes of climate change include; The way the ocean and atmosphere interact, changes in the earth orbit, changes in energy received from the sun and volcanic eruption.

Man-made causes of climate change: - Man-made or human induced causes are also referred to as anthropogenic causes. These include fossil fuels, land use and agriculture (IPCC, 2003). This is corroborated by Millennium Ecosystem Assessment (MEA) (2005), United Nations (UN) report (2007) and Food and Agriculture Organization (FAO) (2007) that there are very strong evidences that people are changing the climate with actions which create emissions of greenhouse gases like CO_2, CO and CH_4 How?

Increasing rates of deforestation: - When forest and woodlands are cleared to make room for urbanization, industrialization and agricultural activities, the albedo capacity of the affected area increases with respect to climate change, this can result in increased concentration of CO_2 which is the dominant greenhouse gas, since trees that could have absorbed the same have been removed. Deforestation is estimated to produce 5.9 billion tonnes of CO_2 per year or 18 percent of global CO_2 (IPCC, 2007). Table 2 below presents the annual rate of deforestation in some SSA countries according to (Bello, 2010). Other consequences of deforestation both to the forest and savannah ecosystem include: loss in soil organic matter, reduction of soil biological population and activities, disruption of nutrient recycling, and expansion of marginal ecological regions. All of these have implication for commercial food crop production in the affected area.

TABLE 2: Sub-Saharan Africa Country with threatened forests by deforestation

Country	Annual deforestation rate (thousand hectares)
Cameroon	100
Nigeria	150
Central African Republic	5
Congo	22
Cote de'ivore	290
Gabon	15
Madagascar	150
Zaire	182

Source: - Bello, 2010

Burning of fossil fuel: - The burning of fossils like coal, oil and gases to generate heat or to power transport for example, releases greenhouse gases estimated to about 27 billon tonnes of CO_2 in 2005 (IPCC, 2007). This quantity is alarming.

Annual bush burning: - African savannahs have burned naturally and under human influences for thousands of years. It is observed that fire, including burning of residue, tradition ash-fertitilization (Chitemene), charcoal production and slash and bush burning and pastoral acts particularly at the forest-savannah transition zones among others, does not only contribute to perturbations set in motion in the atmosphere, but have made SSA more vulnerable to climate variability and change. This is because, CO_2 released by fire may no longer be easily balanced by photosynthetic carbon assimilation. Since there is progressing decline in the rate of regulation re-growth and tree-grass relationship in savannah which is in a disequilibrium system in which domination by grasses is on the increase.

Population growth:- As human population grows so thus urbanization, for instance, just as urbanization grew from less than 30% percent in 1980 to more than 40 percent in 2009, so is Africans current human population of 800 million is expected to reach 1.8millon by 2050 (Thornton, *et.al* 2002). This rapid population growth, urbanization and associated income changes are driving the farming systems of Africa towards higher level of intensification and diversification to meet the increasing demand for food, thus leading to direct or indirect increased emissions of greenhouse gases. The major issue is that, human population will continue to rise and the increasing population must meet their needs for survival. It implies therefore that, the various circle of human activities (agricultural and industrial) ecological degradation, emission of greenhouse gases, global warning and climate change is a continuum. It is more worrisome that even if emission of greenhouse gases into the atmosphere were totally curtailed, the concentration of CO_2, CH_4 and nitrous oxide in the atmosphere might lead to many years of persistent anomaly in climate system due to uncontrolled population (IPCC, 2001)

Industrial revolution: - Attempt to improve the quality of life and standard of living of her citizenry, brought about technological advancement through industrial revolution. Since the industrial revolution which began in the 18^{th} century, the amount of CO_2 in the atmosphere increased by 35 percent (IPCC, 2001) and as of 2010, the concentration of CO_2 is about 50 percent higher than it was before the start of the industrial revolution (Atep *et.al* 2011). Table 3 below shows the emission of greenhouse gases ranked by countries with developed countries topping the list.

TABLE 3: Greenhouse gas Emission by country

Country	Change in greenhouse gas emissions 1992-2007) (%)	2007 per-capital CO_2 emissions (Metric tonnes per person)	Share of Worldwide 2007 CO_2 emissions (%)
World Total	39.22	4.52	100.0
China	154.42	4.75	21.01
USA	18.41	19.97	20.08
Russia	-17.41	11.83	5.59
India	110.99	1.25	4.68
Japan	17.13	9.91	4.22
Germany	21.62	10.13	2.79
Canada	75.34	17.91	1.97
UK	-2.62	9.28	1.89
South Korea	75.34	10.69	1.72
Iran	108.83	7.50	1.64
Italy	10.9	7.92	1.54
Australia	67.8	21.99	1.53
Mexico	44.48	4.17	1.51
South Africa	40.11	9.35	1.51
Saudi Arabia	84.29	15.73	1.45
France	5.84	6.36	1.35
Brazil	67.22	2.05 b	1.33
Spain	50.8	9.47	1.28
Ukraine	-33.8	7.65	1.18
Indonesia	76.38	1.36	1.06
Taiwan	133.01	13.47	1.03
Poland	-8.71	7.83	1.01
Turkey	99.86	3.71	0.93
Netherland	22.69	15.78	0.87
Thailand	145.82	3.81	0.83
Kazakhstan	-18.26	14.16	0.72
Venezuela	53.65	6.60	0.57
UAE	67.49	38.46	0.57
Argentina	50.91	4.14	0.55
Egypt	70.34	2.11	0.53
Malaysia	116.3	6.35	0.53
Singapore	126.35	33.86	0.52
Belgium	15.59	13.87	0.48
Pakistan	97.02	0.82	0.46
Uzbekistan	27.52	4.52	0.41
Greece	35.02	10.07	0.36
Nigeria	9.97	0.72	0.35
Romania	-20.83	4.63	0.34
Algeria	22.99	3.03	0.34
Remaining Countries	31.29	1.68	9.24

Source: United Nations, 2007 adapted from Ologunorisa 2010)

Agriculture: - Agriculture itself is a major contributor to increasing CH_4 and nitrous oxide concentration in earth's atmosphere (UN Report, 2007). The agricultural sector is a driving force in the gas emissions and land use effects thought to cause climate change through practices such as; release of CO_2 linked to deforestation, slashing and burning in land preparation, CH_4 from rice cultivation and enteric fermentation in cattle and nitrous oxide released from fertilizer application. Together, these agricultural processes comprise 54 percent of CH_4 emissions, roughly 80 percent nitrous oxide emissions and virtually all carbon emissions tied to land use (IPCC, 2003) as in table 4 and fig 2 below. All these causes of climate change have very serious negative impact on agricultural production and consequently food production/security.

TABLE 4: Agricultural Emission by regions, 1990-2020 (Mt CO_2-eq)

Country	1990	2000	2010	2020
Africa	664	934	1098	1294
China/CPA	1006	1159	1330	1511
Latin America	890	1097	1284	1505
Middle East	62	74	99	125
Non-EU Eastern Europe	21	19	21	24
Non-EU FSU	410	217	246	279
QECD 90 & EU	1346	1283	1306	1358
SE Asia	823	946	1084	7214
World Total	**5223**	**5729**	**6468**	**7311**

Source: Drawn from data used in USEPA (2006) in Okoruwa (2010)

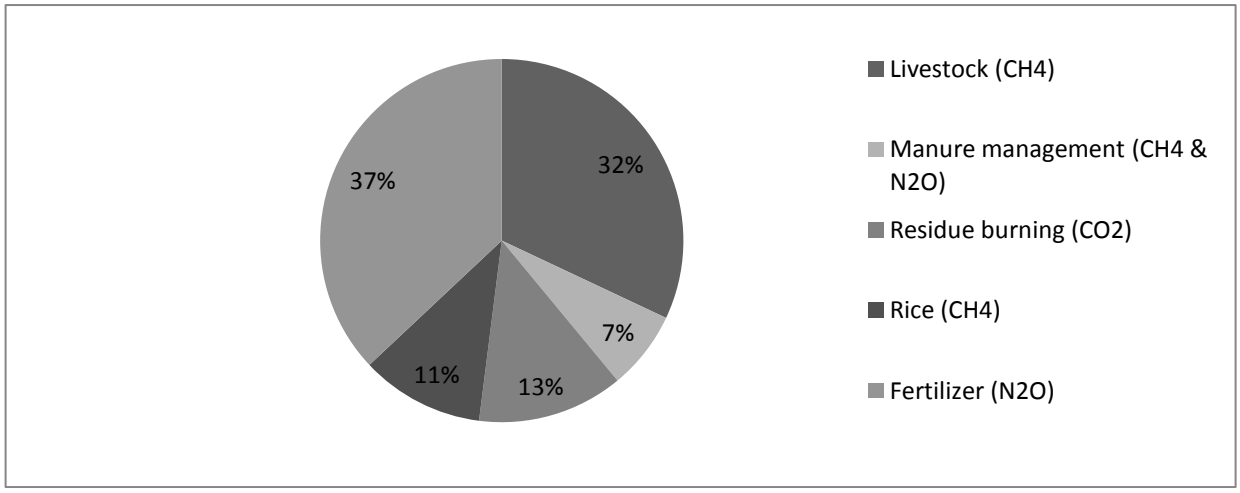


Fig 2: Sources of emissions from the agricultural sector
Source: Drawn from data from USEAP (2006) in Okoruwa (2010)

Impact of climate change on food security

If the current global warming persists unchecked, it will lead to more significant changes in global and regional climates more than is been experienced now. Some regions of the world may gain as a result of these changes, however the overall impact of climate change are expected to be negative. Although the pinch of climate change will be felt the world over, the tropical regions are more likely to suffer more than the temperate regions and the developing nations are likely to be more affected than developed nations while agriculture especially food production is more likely to be affected than other sectors thus threatening global food security (Okoruwa, 2010). This is because, global agriculture will be under significant pressure to meet the demands of rising populations using finite, often degraded soil and water resources that are predicted to be further stressed by the impact of climate

change. Climate change has significant impact on conditions affecting agriculture, including temperature, precipitation, wind and humidity. The condition determines the carrying capacity of the biosphere to produce enough food for the human population and domesticated animals. Climate change and soil are interrelated processes that occur on a global scale and affects agriculture in the following ways;

Increased temperature: - Climate change will increase surface temperature and the CO_2 content in the atmosphere due to more direct intense sunshine, this will increase the rate of evapo- transpiration in crops, reduce soil moisture availability that increased rainfall may not be able to compensate for (Okoruwa, 2010). This Ayoade (2010) refers to as increase in global average temperature between 1.4^{o}c and 5.8^{o}c, which will cause leaf dryness, stunted growth, wilting, end to photosynthesis and low or zero yield.

Reduced rainfall: - There will be change in rainfall pattern and regimes, causing reduced rainfall which could have potentially drastic consequences on the growing crops, thus causing reduced crop yield, depressed food production and agricultural output generally (Gwary, 2006).

Pests and diseases prevalence: - Climate change will influence the incidence, spread and distribution of crop pests and diseases, while new pests and diseases unknown before climate change may be introduced (Tubiello *et.al* 2008). This will result in increased crop losses to pests and diseases (Bradshaw, 2004).

Famine: - Due to higher temperature, low rainfall, increased incidence of crop pests and diseases all as a result of climate change, crop yield will be so low that it may degenerate into food crisis situation, famine and hunger in the land which is on the increase year after year as in Fig 2 below

Rural–urban migration: - Famine may result into disruption of socio-economic well-being causing population pressure in some areas (urban) and loss of human capital in others (rural) as a result of migration (Okoruwa, 2010). This is for those who may not want or be able to adapt, this will lead to change in livelihood system of rural dwellers that will make them to migrate in search for greener pasture (Ziervogel and Calder, 2003).

Revenue Losses: - Climate change may result into up to 50 percent revenue losses from agriculture production in Africa (IFPRI, 2009). Where agriculture contributes the bulk of her GDP and majority of the people are farmers and depends on it for their livelihood, then poverty and deprivation will increase thereby making the already poor region poorer.

Natural disasters: - Climate change will cause increase occurrences of extreme weather events such as; flooding, erosion, landslides and drought. Thus causing more destruction or loss of agricultural land and output (Okoruwa, 2010). Ayoade (2010) identified possible increase in the occurrence and intensity of tropical storms including hurricanes resulting from climate change.

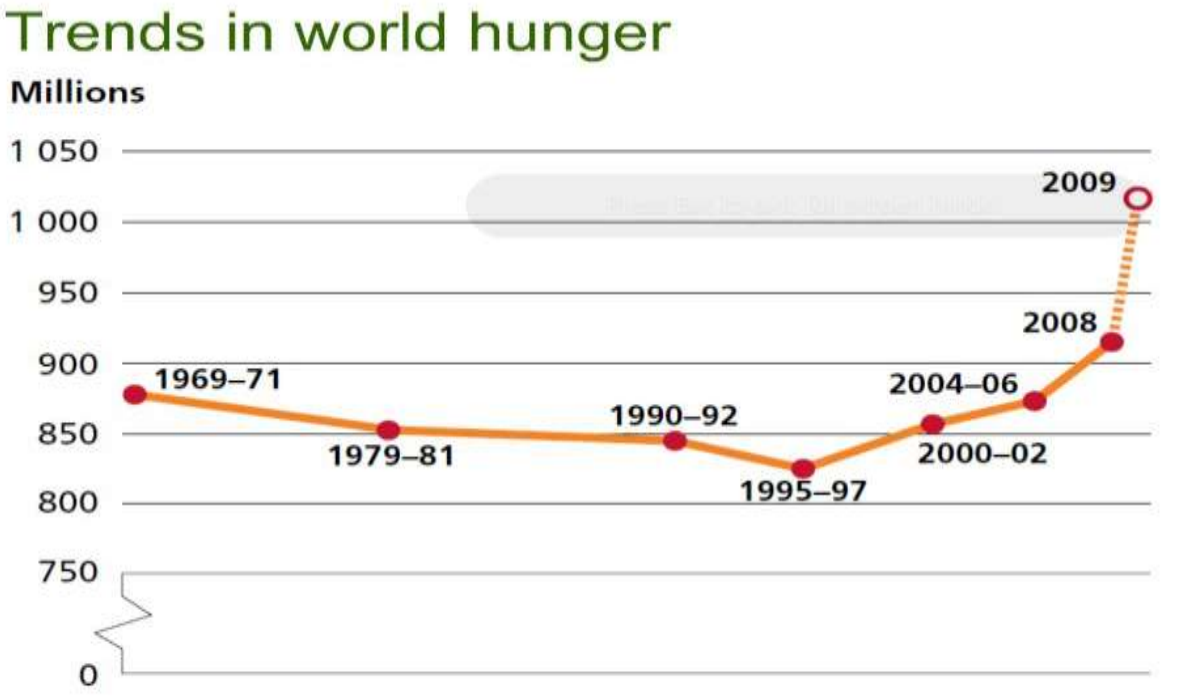
Lower nutritional value: - Studies have shown that, higher temperatures and CO_2 levels lead to reduced plant up take of nitrogen, resulting in crops with lower nutritional value (Grist, 2005). In addition, under combined increases of temperature and CO_2 due to climate change, protein content in the grain of crops decreases and malnutrition when taken by man(Ushuhe, 2010)

Loss of biodiversity: - Climate change will cause the loss of biodiversity and rare/valued ecosystem; this is a negative impact on agricultural biodiversity, by increasing the genetic erosion of land races and crop wild relatives (Jarvis *et.al*, 2008). So also will there be depletion of wildlife and other natural resource base because they will be wiped off due to the new climate they cannot cope with.

Exposure to ill-health: - There will be increased health risk, because of high temperatures, poor water supply and low nutritional value of crops. Also, food safety may be impaired by degraded hygiene in preparing food, particularly if good quality water is not used for its preparation. Ill-health will affect farm labour supply and consequently low food production and food insecurity since the most readily available source of farm labour is farm family.

Duration of crop growth: - The duration of crop growth is related to temperature, precipitation and humidity. An increase in temperature will speed up crop development. In

the case of annual crops, the duration between sowing and harvesting will shorten. The shortening of such a cycle could have adverse effect on productivity because, senescence would occur sooner. Climate change will cause substantial increase in the length of the growing season in middle and high latitudes (Ayoade, 2010).



Source: The State of Food Insecurity in the World, FAO (2009). Value for 2009 is a projection.

Fig 2: Trends of world hunger

Okoruwa (2010) states that, the SSA region of which Nigeria is an integral part, have all the threat signs mentioned above and this region has been identified to likely be the most affected by climate change as shown in fig 5 below.

TABLE 5: Regions "at risk" from climate change

Continent	Specific regions
Africa	Maghreb
	West Africa
	Horn of Africa
	South Africa
Asia	West Arabia
North and Central America	Mexico and Central America
South America	Part of East Brazil

Source: - Adapted from Ologunorisa, 2010

Already the region is experiencing higher temperatures which may adversely affect crop yield and consequently non availability of food, while changes in precipitation patterns may increase the likelihood of short-run crops failures and long-run production declines. This is in line with the prediction that climate change could cause potential crop yields from rain-fed agriculture to decline by 50 percent in some African Countries (IFPRI, 2009) and reduced by up to 50 percent by 2020 (IPCC, 2007). In the tropics and sub-tropics in general, crops

yields may fall by 10-20 percent by 2050 because of warming and dying but there are more places where yield losses may be much more severe, even catastrophic (Thornton *et.al* 2008). For instance Southern Africa where it is claimed that land suitable for maize will likely disappear by 2050 (Lobell et.al 2008), while by 2080 rain-fed cereal production will decrease by 3 percent (FAO, 2009). Consequently food production and access to food in many African countries is likely to be severally compromised, exacerbating food security problem and malnutrition (IPCC, 2007). As a result, the risk of food insecurity, food crisis, malnutrition and hunger in developing world, particularly in the highly vulnerable regions is predicted to increase during this century (Parry et.al 2004, IPCC, 2007 & FAO, 2009). Based on the foregoing the following recommendations were made to curb more negative impacts of climate change on agricultural production and food security in Nigeria.

Recommendations for Food Security and Sustainability

Because of the envisaged impacts of climate change on man and his activities especially agriculture and environment, appropriate response strategies to tackle this problem climate change in Nigeria, have been advanced mostly in the form of mitigation, adaptation and in-depth research into new varieties that will adapt to new climate (Ayoade, 2010).

Mitigation strategies*:* - These are those measures taken to deal with the causes of climate change, since the causes of climate change are known and have been hinged on emissions of greenhouse gases through various human activities.

***Adaptation mechanisms:* -** These are the measures taken by man, to adjust to climate change and cope with the effects of the new situation. These measures will reduce or moderate the unpleasant consequences of climate change as well as take advantage of the opportunities the new climate offers.

In-depth research: - These are in the form of investment into agricultural research, which will develop crop varieties that are resistant to extreme weather conditions, less sensitive to climate variability and climate change. These research findings must be culturally acceptable, economically affordable, environmentally suitable, available and accessible and must be an improvement on people indigenous knowledge and practices. All of these mechanisms are listed below:

- Factors leading to climate change should be controlled (Bello, 2010).
- There must be population control mechanism especially in SSA.
- All tiers of government need to be involved with laws and policies to discourage deforestation (NISER, 2008) while afforestation and re-afforestation should be included in the process of rural development and urbanization.
- All countries should reduce their emissions in compliance with the Kyoto protocol, industrialized countries that have not signed the Kyoto protocol should be committed to do so without further delay (Ologunorisa, 2010). Efforts should be made by UN to capture those countries whose emissions have not been captured by the Kyoto protocol and they should immediately be made to abide by the treaty. While the Kyoto protocol that was supposed to end in 2012 should be extended by some years to give room for this capturing.
- Agricultural extension services should be strengthened to ensure that climate forecast information gets across to farmers at the appropriate time and places.
- New genes, new crops and animals improved cropping and rearing systems should be developed and disseminated to farmers for adoption, because farmers will need to replace their traditional varieties (Watson, 2010). This will provide those more adapted to the new climatic realities (Lane and Jarvis, 2007).
- Farmers' perception and attitude to climate change should be investigated into, since farmers poor agricultural practices constitute a major threat to sustainable agricultural production and food security. Farmers should be educated and motivated to use the plant environment in a more sustainable way.

- Small-holders farmers' indigenous methods of adapting and mitigating the impacts of climate change in the past, must be investigated and improved upon to meet the current and future level of climate change.
- global demand for food is expected to increase by 50 percent by 2030 (World Bank, 2008). There should be increase food production above the rate of population growth. These are needed urgently to meet the demand of a world population expected to reach 9 billion by 2050.
- There must be avoidance of bush burning and all forms of burning, while other means of recycling waste other than burning should be designed to reduce the emission of heat into the atmosphere. Meaning that there must be efficient production and utilization of energy and shift to clean renewable energy (Ayoade, 2010). International co-operation in development of low carbon technology transfer so that all countries can benefit is necessary.
- Poverty alleviation strategies must be strengthened to enable farmers adapt or mitigate the impacts of climate change.
- Green house funding to assist developing countries adapt to the reality of climate change must be a priority. The development of a global carbon market and other mechanisms to fund mitigation is imperative, and developed countries must shoulder these responsibilities taking on deep and binding targets.

Conclusion

The role played by climate in human existence and affairs cannot be overemphasized. This is because man is on this planet earth as a result of its conducive climate and an atmosphere that can sustain life. Man should therefore be concerned with what happens to the earth's climates, because man's existence depends on it. For instance this most topical and global climates issue "climate change" is a global disaster, more deadly than HIV/AIDS and a major global threat to food security in many regions especially the developing-tropical world which are largely dependent on rain-fed and labour-intensive agricultural production and are said to be more vulnerable to the negative impacts of climate change. There is therefore the need for all and sundry to pull resources together to mitigate and or adapt to climate change, because of its long-run effects on food production, supply, stability in supply and access, which may result into food insecurity and malnutrition in these areas.

To ensure the continued existence of man, a suitable environment for him and his activities, since climate change affects the social and economic structure and framework and by implication survival and basis of human existence, all the recommendations made above should be adhere to religiously and tenacious too.

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Extension Capabilities and Climate Change Protocol in the Lagos Agricultural Innovation System, Nigeria

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Abstract

Agricultural extension services are means of improving the agricultural output of farmers. Thus, several interventions through research and development and policy formulation and implementation have produce series of innovations for farmers. Personal interviews and one-on-one discussions among extension experts in Lagos provided data for analysis in this study. Simple random sampling techniques was used to obtained data for analysis from the subject, percentage and mean score were used for analysis of data. Results show that respondents were very aware of consistent change in natural environment (M=3.65) while group discussion and participatory approach with clients is one of the capabilities of extension in diffusing innovation. The study recommends the creation of emergency climate management unit within the extension agencies of agriculture ministry, re-orientation and re-training of extension experts to possess new trends and capacity on climate change and the use of extension experts in diffusing timely innovation and best agricultural practices to reduce the effect of climate change on farm output, and establishment of effective network of information to and fro government, participating agencies and users of innovation system on climate change.

***Key words**: Intervention, Agricultural Extension Experts, Climate change, Protocol, Capability, Agricultural Innovation System.*

Introduction

Climate change and climate policy have generated a strong discourse among different groups internationally. Series of tools and instruments have been designed to foster and guide adaptation to climate change, such as; the NAPA (National Adaptation Programmes of Action), policy briefing organized by BBC World Service Trust, (2009) on public understanding of climate change in Africa, Agenda 21 of Rio declaration, (1992), Intergovernmental Panel on Climate Change (IPCC), 2001. Currently, there is widespread consensus in the scientific community and even among politicians that climate change is happening and that the impacts are already with us. Climate change is often used to describe any kind of change in climate that may be natural or human- induced (Ekpoh and Ekpoh, 2011). Climate change therefore, refers to any change in climate overtime, whether due to natural variability or as a result of human activity. It can also be seen as change in climate which is attributed directly or indirectly to human activities that alter the composition of the global atmosphere and which are in addition to natural variability observed over comparable time periods. Ministry of Environment of the Federal Republic of Nigeria, MOE FRN, (2003) exposed that climate change has become a global issue

in recent times manifesting in variations of different climate parameters including cloud cover, precipitation, temperature ranges, sea levels and vapor pressure.

Climate change according to (Ekpoh and Ekpoh, 2011) is any long-term change in the patterns of average weather of a specific region or the earth as a whole. It is an abnormal variation in the earth's climate that usually occurs over durations ranging from decades to millions of years. Evidence shows that global mean temperature increased by 0.6^0C during the 20th century, with the six hottest years occurring between 1997 and 2007. This warming of the world's climate has been linked to higher concentrations of carbon dioxide and other greenhouse gases (GHGs) in the atmosphere, which are dominantly of anthropogenic origin such as fossil fuel combustion, land use and deforestation. Climate change phenomenon has serious harmful consequences for the earth in the form of significant variations in regional climates, recurrent droughts, excessive heat waves, windstorms, killer floods, and so on.

There are noticeable consequences of climate change in Nigeria such as intense thunderstorms, widespread floods and incessant droughts. Odey (2009) states that climate change impacts pose great dangers with consequences such as desertification, sea level rise, flooding, water salination, among others. These impacts could manifest in food security challenges, damage to infrastructure and social dislocation. Also, climate variability and change have a direct, often adverse, influence on the quantity and quality of agricultural production. The climate of an area is highly correlated to the vegetation and by extension the type of crop that can be cultivated. Temperature, rainfall, humidity, sunshine (day length) are the important climatic elements that influence cropping production. The overall predictability of these climatic elements is imperative for the day-to-day and medium term planning of farm operations (Sowunmi and Akintola 2010).

Climate change will affect every citizen, environment and natural resources, and thus practically every aspect of lives, our economy, and our urban and sub-urban development patterns (Ekpoh and Ekpoh, 2011). Ozor and Nnaji (2011) emphasize that agriculture is the main culprit of climate change producing significant effects through the production and release of GHGs. Clearing of forests for agricultural production replaces forests with crops thereby reducing the rate at which carbon sequestration (trapping and absorbing carbon (IV) oxide gas) occurs. There is no doubt therefore that the earth is getting warmer and human beings are mainly to be blamed (Spore, 2008). With reference to sub-Saharan Africa, there is growing interest on the likely impacts of climate change on agriculture, economic growth and sustainable development. BBC World Service Trust, (2009) revealed that African citizens are least responsible for generating the greenhouse gases that are causing the global climate to change. Yet they are already suffering, and will continue to suffer, some of the most devastating consequences of climate change.

Incidences of climate change include changes in soil moisture, soil quality, crop resilience, timing/length of growing seasons, yield of crops and animals, atmospheric temperatures, weed insurgence, flooding, unprecedented droughts, sea level rises and many more. More than 70% of those living in African, Caribbean and Pacific (ACP) countries work in the agricultural sector and climate change for these people are not a theoretic discussion; it is the difference between life and death (Spore 2008). There are projections of increases in rainfall in the humid

regions of southern Nigeria, which are accompanied by increases in cloudiness and rainfall intensity particularly during severe storms. Similarly, the savannah areas of northern Nigeria were projected to experience less rainfall, which coupled with temperature increases, reduces soil moisture availability. Changes in climate are severely affecting agricultural production in many African countries. Increased temperatures and accompanying decrease in water availability reduce the length of growing seasons and yield potential and hence the areas suitable for agriculture, further adversely affecting food security over the continent

Consequently, to sustain agricultural sector; a catalyst to human existence in terms of the provision of food, fiber, fuel and income, strategies of change need to be urgently initiated to cope with the changing climate. An intervention of agricultural extension experts (AEEs) is required in initiating this change. The action of AEEs is important because adaptations to climate change impacts require changes in knowledge, attitudes, resilience capacities, and skills of the people and agricultural extension can bring this change. Agricultural extension was once known as the application of scientific research and new knowledge to agricultural practices through farmer education. The field of extension gives a wide scope of communication and learning activities to improved farm-families. Thus, agricultural extension according to (Leeuwis, 2006) is a series of embedded communicative interventions that are meant, among other things, to develop and/or induce innovations which supposedly help to resolve problematic situations. It has been observed that agricultural extension is involved in public information and education programmes that could assist farmers in mitigating the effects of climate change (MOE FRN, 2003). According to them, such involvements include awareness creation and knowledge brokerage on the issues of climate change; building resilience capacities among vulnerable individuals, communities and regions; encouragement of wide participation of all stakeholders in addressing climate change issues; and developing appropriate frameworks for coping to climate change effects.

It is important therefore to find out the capabilities of extension agents on climate change and it effects on agricultural productivity? What are the limiting factors of climate change in the study area? Are the AEEs aware of these factors and if, what are there efforts in diffusing innovation for improved agricultural production? What is the understanding of AEEs on adaptive measures in reducing the effect of climate change in the study area? And what are the possible issues for improved innovation system on climate change in the area?

Purpose of study

The main focus of the study was to describe the actions of AEEs on climate change trends in agricultural productivity of Lagos State. Specifically, the objectives were to:

(i) Describe the limiting factors (variables) affecting climate change in the study area.

(ii) Note the awareness of AEEs on climate change issues and their capabilities in innovation diffusion.

(iii) Identify adaptive measures adopted by AEEs in reducing the effect of climate change and;

(iv) Ascertain possible issues for improved innovation system on climate change.

Methodology

Lagos State of Nigeria was used as setting for this study. The climate of Lagos is affected by ocean and atmospheric interactions both within and outside its environment, in which the Inter-Tropical Convergence Zone (ITCZ) plays a controlling factor. Maximum temperatures recorded during the dry season are high and range from 28–33^{0}C when the region is dominated by the dry northeast trade winds. Minimum temperature of about 24–26^{0}C is experienced during the wet season of May to September. The mean annual temperature is about 28^{0}C and the maximum and minimum temperature is 33^{0}C and 26^{0}C respectively. High to very high monthly rainfall is also experienced between May and November, although significant variations in monthly rainfall peak values are experienced. Minimum monthly rainfall of less than 50 mm is experienced between December and March. Occasionally, extreme precipitation events are experienced in June. Lagos has a tropical savanna climate (Köppen climate classification Aw, 2012) that is similar to that of the rest of southern Nigeria. The state has twenty local government areas (LGAs) and thirty seven local development areas (LCDA); the agricultural extension services are divided into three zones namely: Eastern Zone, Far Eastern Zone and Western Zone.

Agricultural extension experts (AEEs) made up the population for the study. Simple random sampling technique was used to select respondents, though; the entire population was intended to be surveyed due to small number of extension workers in each zone. Two zones; eastern and far eastern zones were randomly selected. Eastern zone is made up of four blocks; Odogunyan, Igbogbo, Ikorodu and Imota. Far eastern zone comprises of the following blocks; Agbowa, Itoikin, Eredo, Epe-West and Ibeju-Lekki/Ajah/Lagos-Island. Out of the entire population of agricultural extension officers in these zones, fifteen officers were randomly selected from each zone given total of thirty extension officers that make up for the study sample size. Data for the study were collected through a structured questionnaire that was validated by experts in agricultural extension. A pilot test was also conducted as part of the research instrument validation and to test for reliability (r=0.893).

The questionnaire had five sections. Section A ascertained the demographic features of the respondents, while, section B described the variables determining the outcome of climate change in the study area (objective 1). A four-point Likert scale of 'strongly agree, agree, disagree and strongly disagree', with nominal values 4, 3, 2 and 1, respectively was used to describe the variables of climate change in the study area. Relevant information on variables that determine the outcome of climate change on agriculture was obtained from literature, observations and discussion from extension experts. The respondents' average score were obtained for each response option, such that items with M ≥ 3.50 were regarded as variables/parameters and incidence of climate change in the study area. Section C dealt with the awareness of AEEs on incidences of climate change and their capability in innovation diffusion (objective 2). The study therefore, determined the quantitative level of awareness of respondents to incidence of climate change, such that response with M ≥ 3.00 was regarded as incidences of climate change that AEEs were aware of and any response that have M ≥ 3.00 were their capability in diffusing innovation about incidences of climate change. Section D rates the understanding of AEEs on adaptive measure to climate change (objective 3). Measuring scale with mean statistics (M ≥ 2.50) of respondent was seen as understanding of AEEs on adaptive measures in reducing the effect of climate change; these scales were obtained from relevant literature, extension experts and personal interview with AEEs in the study area. A four point Likert scale of ≤30%, ≤50%, ≥70% and ≥100% with nominal values 1, 2, 3 and 4, respectively was used to obtain the quantitative measure of the rate of AEEs understanding of climate change adaptive measure. Section E sought to confirm the intervention of AEEs on climate change and

possible issues for improved innovation system (objective 4). These interventions were obtained from literatures and interview of top extension officers. A four point Likert scale of ≤30%, ≤50%, ≥70% and ≥100% with nominal values 1, 2, 3 and 4, respectively was used to obtain the assessment of extension practitioners on their interventions on climate change and possible issues for improved system of innovation. However, respondents' mean scores were obtained for each response option such that scales with mean statistics (M ≥ 3.00) and (M ≥ 2.50) were regarded as interventions of AEEs on climate change and possible issues for improved innovation system respectively. Objectives 1 – 4 were analyzed using mean scores and standard deviations.

Result and Discussion

Description of Variables/Parameters of Climate Change

Table 1 below shows that cloud cover, precipitation, temperature ranges, vapor pressure were climate change variables that are prominent in the study area as indicated with the mean scores of respondents (M = 3.60). This response was furthered affirmed by the subjects of this study that the above variables were evidence in both eastern and far eastern zones of the state (M = 3.55). Thus, group discussion with some extension officers at eastern zone exposed variance in relative humidity and timely wind speed as some of the parameters of climate change. The changes in climate as agreed by respondents affect different sectors of the economy as agriculture is most prominent. These changes were caused by increased industrialization that brought about large quantities of greenhouse gases (GHGs) into the atmosphere. Data in Table 1 shows the level of responses of respondents to parameters of climate change in the study area. With existence of changes in the climate, respondents agreed that (M = 3.60), these parameters causes changes in soil moisture, soil quality, increase length of growing seasons in the study area. The changes in climate also caused weed insurgence, flooding, unprecedented droughts and extreme reduction in soil moisture as evidence in both eastern and far eastern zones of the state.

TABLE 1: Descriptive statistics of parameters of climate change (n = 30)

S/N	Scales	Sum	Mean	Std. Deviation
1.	Changes affect sectors like agric, health, water, etc.	74	3.70*	0.657
2.	Changes in soil moisture, soil quality, length of growing seasons. Weed insurgence, flooding, unprecedented droughts, are incidence of climate change	72	3.60*	0.598
3.	Cloud cover, precipitation, temperature ranges, vapor pressure are climate change variables found in the state.	72	3.60*	0.598
4.	Increased industrialization has led to the introduction of large quantities of greenhouse gases (GHGs) into the atmosphere.	71	3.55*	0.825
5.	The variables above are evidence in eastern and far eastern zones of the state.	71	3.55*	0.759

6.	Human activity is the major cause of climate change.	53	3.15	0.745

**Cut off point = 3.50*

Data in the table above shows that the standard deviations for all the scales highlighted were less than 1.00. This depicts that respondent's individual scores as regards variables determining the outcome of climate change did not differ much from their mean scores. Changes in soil moisture and soil quality could be attributed to unpleasant and unstable rainfall and temperature. The early part of year, 2012 was characterized with heavy temperature, which brought about unprecedented droughts. The eastern and far eastern zones as at February, 2012 were having an average temperature of 32^0C (day time) and 26^0C (night) and sometime, the temperature could be as high as 38^0C. Daily average relative humidity is around 80%, sunrise as early as 7; 01AM and set around 6.57PM. Top soils were becoming friable and grasses were becoming dry.

The Awareness of AEEs on Incidences of Climate Change and Their Capability in Innovation Diffusion

The awareness level of AEEs on incidences of climate change was high as respondents surveyed were very aware of the consistent change in the natural environment (M = 3.65), they were aware of deforestation for settlement, charcoal production and building materials (timber) (M = 3.55), frequent heavy winds, rainstorm, etc, (M = 3.50) and existence of increase in artificial water, such as dams, water reservoir, shallow wells to aid agricultural production (M = 3.40). This is in consonance with report of Leiserowitz (2006) that since the year 2000, numerous public opinion polls demonstrate that large majorities of Americans are aware of global warming. Data in Table 2 shows that AEEs were aware of the fact that these incidences of climate change make farming costly and discourage new farmers' entry (M = 3.35), incidences as well, causes urban migration leaving few people in farming activities (M = 3.30) and these menace decrease forage production and as such decrease livestock production (M = 3.25). Grasslands that are needed by livestock for grazing had turned to dry lands. Focus group discussion (FGD) with extension officers in the study area further revealed that AEEs were aware of climate change; as there were prolonged droughts, changed of raining seasons - their were variance of short rains and untimely rains, high temperature levels, and hence, these changes were attributed to changes in soil moisture, soil quality, changes in growing season and unprecedented droughts that were visible in the first quarter of 2012. Issues on climate change required more competence and determined personnel who will be able to employed research and development into spread of farming practices that would be less of climate risk. A mean score of 3.50 shows that respondents strongly agreed that AEEs must be equipped with variable weather conditions of their stations, so that; they can be seen as expert, relevant and valid extension officers and strongly agreed that implementations of ideas given by AEE on climate change to farmers make him relevant, valid and respected extension personnel in his station respectively. Consequent on these issues, AEEs affirmed that group discussion/orientation on adverse impacts of climate change on crop failures and livestock deaths and how it could be reduce can decrease rural-urban migration of household heads (M = 3.45) and extension message on adaptation to climate change could be compressed into extension advice on maintaining crop and livestock production and reduction of climate risks (M = 3.45) were some of the capabilities on innovation diffusion about climate change. If

farmers therefore, are participants in building innovation on farming practices and climate change; they would as well aid the diffusion of such ideas that improve farming.

TABLE 2: Awareness of AEEs on incidences of climate change (n = 30)

S/N	Scales	Sum	Mean	S.D.
1.	As AEEs, I am aware of the consistent change in the natural environment	73	3.55*	0.587
2.	I am aware of deforestation for settlement, charcoal production, building materials (timber), etc.	71	3.55*	0.510
3.	There is frequent heavy winds, rainstorms, etc,	70	3.50*	0.513
4.	There is awareness and existence of increase in artificial water, such as, dams, water reservoir/receptacle, shallow wells, etc, to aid agricultural productivity.	68	3.40*	0.503
5.	Incidences of climate change make farming costly and discourage new farmers' entry.	57	3.35*	0.587
6.	This incidence as well, causes urban migration in search of jobs, leaving few people in agricultural production.	55	3.30*	0.571
7.	These changes have affected agricultural productivity through crop failures, poor pasture cultivation and increase food shortages.	55	3.30*	0.733
8.	The decrease in animal forage has led to decrease in livestock production and mortality has increased during droughts.	55	3.25*	0.785
9.	There are evidence and reports of decrease in natural water with water levels going down in rivers and some rivers have become seasonal.	59	2.95	0.585
10.	These changes can be attributed to depletion of forests as farmers clear more forests for farming.	58	2.90	0.912

**Cut off point = 3.00*

Adaptive Measures Adopted by AEEs in Reducing the Effect of Climate Change

The adaptive measures that AEEs understood in reducing the effect of climate change in the study area are presented in Table 3. These include; conservation agriculture, planting of drought resistant cultivars, improve sanitation, post harvest management, Afforestation, planting of early maturing crops, diversification of farming and proper utilization of available fodder-zero grazing contributes to soil conservation. If some of these adaptive measures are employed appropriately at the required farming operations, it will thus, improve food security.

TABLE 3: Understanding of adaptive measure of climate change (n = 30)

S/N	Scales	Sum	Mean	S. D.
1.	Conservation agriculture - ensure moisture retention, Takes care of the little resources, especially water for the crop	58	2.90*	0.641
2.	Drought resistant cultivars - farmers plant early maturing crops and drought Resistant	56	2.80*	0.634
3.	Improve sanitation - farmers are more involved in production.	54	2.70*	0.801
4.	Post harvest management – To keep harvests free from disease and pests, keep harvests to last longer for use later during dry spells	53	2.65*	0.813
5.	Early warning systems - planning with the coming rains or drought; Monitoring weather trends to keep farmers informed of what to expect for easy planning and take necessary measures	53	2.55*	0.745
6.	Afforestation - help in enhancing rainfall- increase in rainfall amounts and temperature regulation and attract rainfall	50	2.50*	0.888
7.	New crop varieties - farmers plant early maturing crops	50	2.50*	0,751
8.	Enterprise choice - diversification of farming, incorporate other crops like cassava, which are less water-demanding	50	2.50*	0.588
9.	Zero grazing - proper utilization of available fodder; contributes to soil Conservation	50	2.50*	0.889

*Cut off point = 2.50**

Possible Issues for Improved Innovation System on Climate Change

Table 4 data shows the assessment of interventions of AEEs on climate change and issues for innovation system. The respondents affirmed that, organization of seminars, conferences, field days and workshops and use of farmer to farmer extension strategy are some of the actions on maximizing mass adoption of innovations on climate change (M = 3.20). Participatory planning; that is, use of groups to achieve wide scale adoption of innovations and implementation of agricultural extension projects (M = 3.15), the use of method and result demonstration by AEEs on climate change (M = 3.10), encouragement of extension service providers to broaden their extension contents and knowledge to cover the entire value chain, particularly on pre and post farming activities (M = 3.05) and the use of print media; posters, leaflets, etc were some of the interventions of AEEs on climate change as revealed by the respondents. The extension officers surveyed further affirmed to formulation of mechanism to strengthen partnerships, collaboration and networking to improve inter-sectoral planning and linkage with other stakeholder in agricultural innovation system (M = 2.85). Also, provision of flexible extension services that is demand-supply driven towards a subject of concern (M = 2.80), privatization of extension services (M = 2.60) and transformation of approaches like training and visit approach into "focal area approach" (M = 2.75) are possible issues for improved innovation system on climate change.

The study finds out the capabilities of extension workers on climate change trends in Lagos State agricultural innovation system, Nigeria. Specifically it examined parameters, awareness of AEEs, there capabilities and adaptive measures in reducing the effect of climate change and possible trends for improved innovation system. Results show precipitation, temperature ranges, and variance in relative humidity and timely wind speed as significant variables of climate change, while respondents were highly aware of the consistent changing in the natural environment (prolonged droughts and change of raining season). Thus, group discussion and timely orientation on adverse impact of climate change on crop failures and livestock mortality is one of the feasible capabilities on spread of innovation about climate change. The adaptive measures identified by the respondents which will improve food security include conservation agriculture, planting of drought resistant cultivars; improve sanitation, post harvest management, Afforestation, planting of early maturing crops, diversification of farming, while participatory planning; use of farmers group will aid wide scale adoption of innovation and implementation of extension projects.

It is therefore recommended that extension services delivery should intensify on the rising challenges of climate change by creating an emergency climate management unit in agriculture ministry of each state, re-orientation and re-training of extension experts to possess new trends and capacity on climate change. These will create a network of concern on climate change with the farmers and the extension service. Also, there is need for use of extension experts in diffusing timely innovation and best agricultural practices to reduce the effect of climate change on farm output and incorporation of extension clients (farmers) in building innovation for improved farming operations. Involving farmers in building innovation program will aid prompt adoption and implementation for corresponding agricultural productivity. And also, establishment of effective network of information system to and fro government, participating agencies and users of innovation system on climate change.

TABLE 4: Interventions of AEEs on climate change and possible issues for improved innovation system (n = 30)

S/N	Scales	Sum	Mean	S. D.
1.	Organization of seminars, conferences, field days and workshops and use of farmer to farmer extension strategy are some of the actions on maximizing mass adoption of innovations through group approaches	64	3.20*	0.523
2.	Participatory planning; use of groups to achieve wide scale adoption of innovations and implementation of agricultural extension projects.	63	3.15*	0.587
3.	The use of method and result demonstration can stimulate the role of AEEs on climate change	62	3.10*	0.447
4.	Encourage extension service providers to broaden their extension contents and knowledge to cover the entire value chain, particularly on pre and post farming activities.	61	3.05*	0.394
5.	Print media; posters, leaflets, etc can stimulate the role of AEEs on climate change.	60	3.00*	0.459
6.	Formulation of a mechanism to strengthen partnerships, collaboration and networking to improve inter-sectoral planning and linkage with other stakeholder in agricultural innovation system.	57	2.85*	0.587
7.	The provision for flexible extension services that is demand-supply driven towards a subject of concern	56	2.80*	0,410
8.	Transformation of approaches like training and visit approach into “focal area approach”	55	2.75*	0.550
9.	Liberalization, privatization of extension services and demand driven extension services can improved innovation system on climate change	52	2.60*	0.593
10.	Establishment of an independent regulatory body to oversee the regulation of extension service provision.	45	2.30	0.571

Cut off point = 3.00 (interventions of AEEs) and 2.50* (issues for improved innovation system)*

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Pictorial and Verbal Communication as a Method for Communicating Climate Change Mitigation/ Adaptation among Small – holder Rubber Farmers of Edo State, Nigeria

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Abstract

The study examined pictorial and verbal communication as a method for communicating climate change mitigation / adaptation among small - holder rubber farmers in Edo State. Three Local Government Areas (Ikpoba – Okha, Ovias South West and Uhunmwode) were purposively selected because of their involvement in rubber production. Structured questionnaire was administered to a total of 95 rubber farmers using proportionate and random sampling techniques. Data collected were analyzed using descriptive statistics. The results indicated that the respondents were mostly within the age bracket of 51 – 60 years and married with long years of accumulated experience. Based on their accumulated experience in rubber farming, they noticed the effects of climate change but had no good understanding and knowledge about it. Pictorial forms of communication were not adequately used in the study areas. Majority (91.58%) of respondents like to learn using pictures because it enhances quick understanding; it is more convincing with easy assimilation and clarity of ideas especially innovations with multiple steps, among others. It is, therefore, recommended that efforts should be made towards presenting climate change effects and its mitigation in pictorial forms since the respondents seemed to understand verbal communication better when supported with pictures.

Keywords: Pictorial, verbal, communication, strategy, climate change, mitigation

Introduction

The main purpose of agricultural extension is to help farmers and rural families to improve their living conditions. The extension workers' job, therefore, is to impart knowledge in the use of appropriate technology that will help rural families run their farms more efficiently and, thereby, improve their living conditions (Okoye, 2008). It has been reported that many farming communities were encouraged to adopt improved technologies, but the response was poor (Adekoya and Tologbonse, 2005). This can be attributed to the method of teaching used and the understanding level of the target audience. The nature of the channel or medium through which a message is transmitted contributes to the success of communication.

In ensuring that the target audience properly understands the message of extension, many teaching methods have been adopted. According to Adekoya and Tologbonse (2005), the most important elements in communication process are the message and the intended audience. Once the message is not accepted and

utilized, all other efforts are rendered fruitless. Agricultural messages are crucial in attaining food security.

One of the sectors most sensitive to global warming is agriculture (Zoellick, 2009). Agricultural productivity, in general, could decline between 10 to 25 per cent by 2080 in Nigeria. For some parts of the country, the decline in yield in rain fed agriculture could be as much as 50 percent (Ozor *et al.*, 2010). Such trends clearly threaten the achievement of the Millennium Development Goals (MDGs). Rural households engaged in subsistence and smallholder farmers are most vulnerable to the impacts of climate change on agriculture. They may be affected in the following ways: increased likelihood of crop failure; increase in pests and diseases, mortality of livestock, and/or forced sales of livestock at disadvantageous prices; increased livelihood insecurity, resulting in assets sale, indebtedness, out-migration and dependency on food aid; and downward spiral in human development indicators, such as health and education. Such impacts will further aggravate the stresses already associated with subsistence production, such as isolated location, small farm size, informal land tenure, low levels of technology and narrow employment options, in addition to unpredictable and uneven exposure to world markets that smallholder farmers are particularly risk-prone in the face of climate change (Adejuwon, 2006; Oladipo, 2010) .

Natural rubber (*Hevea brasiliensis*) is grown between longitudes 15^0N and 10^0S where the climax vegetation is humid with temperatures ranging from 23 to 45^0C and a well- distributed rainfall of 1800 mm to 2000 mm on a well - drained soil (Aigbekaen *et al.,* 2000). Anything above or short of these is a problem that can cause planted rubber (budded stumps) not to germinate (dormant, dried up), and eaten up by pests and diseases (eg termite and white root-rot). Temperature has a great role to play in the flow of latex during tapping of mature rubber plants. According to Giroh *et al.* (2010), the survival rate of planted rubber (budded stumps) in southern Nigeria is very low because of pests and diseases attacks, variation in rainfall pattern and high temperature. Climate change is already having negative effects on natural rubber production. Consequently, there is a need to derive a strategy for farmers to be able to cope with the effects of climate change.

It is against this background that this study focuses on the pictorial and verbal communication as a strategy to climate change mitigation/adaptation by small-holder natural rubber farmers in Edo State. The specific objectives were to: determine socio – economic characteristics of respondents; assess farmers' awareness of climate change and methods of communication; determine the forms of pictorial communication available and the levels of usage among respondents, evaluate the understanding of respondents when taught using verbal communication as supported with pictures and ascertain respondents level of importance attached to the use of pictures in learning.

Methodology

Study Area, Sample Size and Data Analysis

The study was conducted in Edo State of Nigeria. Edo State lies between longitude 05^0 04' North and 06^0 43" East and latitude 05^0 44' North and 07^0 34" East. It is bounded in the North by Kogi State, on the South by Delta State on the West by Ondo State and on the East part by Kogi State and Anambra State. It has ultisol soil

with pH range of 4.5 to 5.5 favourable for the production of natural rubber (Emokaro and Erhabor, 2006; Ike, 2010). Three Local Government Areas (Ikpoba – Okha, Ovia South West and Uhunmwode) were purposively selected because of their involvement in rubber production. A structured questionnaire was administered to a total of 100 rubber farmers selected, using proportionate and random sampling techniques out of which 95 respondents provided the desired information which was analyzed using descriptive statistics.

Results and Discussion

Many of respondents (54.74%) involved in rubber farming are within the age brackets of 51 – 60 years, implying that the middle-age rubber farmers were still active in seeking information about climate change effects and its mitigation. The labour output of the older farmers was low due to their declining productivity. This result agrees with the view of Otene *et al.* (2011) who noted that rubber farmers consisted of both the middle-age and the old. All the rubber farmers (100%) were male and majority of them (94.74%) are married. Farm size distribution of respondents revealed that rubber production in the study area is predominantly small – scale, mainly because majority 91.58% of respondents cultivated between 1-4 hectares, which is still within the range of small – scale production. Majority (73.68%) had a family size of between 9 – 12. The large family size could be a valuable source of labour for rubber production and other agricultural and non-agricultural activities. Most (86.31%) of respondents had 7 – 18 years of experience in rubber farming. Evidence from Giroh *et al.* (2010) shows that most rubber farmers have perfected their production methods with years of farming experience. This is why they noticed the effects of climate change on their own, which may facilitate adaptation strategy to climate change.

TABLE 1: Respondents' distribution based on socio- economic characteristics
(N= 95)

Variable	Frequency	Percentage
Age (years)		
30 - 40	6	6.32
41 –50	19	20.00
51 - 60	52	54.74
61 – 70	18	18.95
Sex		
Male	95	100.00
Female	-	-
Marital Status		
Married	90	94.74
Widower	2	2.11
Divorce	3	3.16
Family size (person)		
1 - 4	2	2.11
5 – 8	19	20.00
9 – 12	74	77.99
Education		
Primary	70	73.68
Secondary	17	17.89
OND	6	6.32
HND/B.Sc	2	2.11
Experience (years)		
1 - 6	3	3.16
7 –12	35	36.84
13 – 18	47	49.47
19 – 24	8	8.42
25 & above	3	3.16
Farm size (hectares)		
1 -2	53	55.79
3 – 4	34	35.79
5 – 6	6	6.32
7 - 8	2	2.11

Source: Field survey, 2011

Table 2 shows that 52.63% of respondents are aware of the effects of climate change but no good knowledge/ understanding of it (78.95%), this may be as a result of their long and accumulated experience they had in rubber farming. Amu (2011) noted that low public awareness of the risk/effects of climate change in Nigeria among the small-scale farmers.

TABLE 2: Distribution of respondents based on awareness of climate change and methods of communication

Variable	Frequency	Percentage
Aware of Climate Change		
Yes	50	52.63
No	45	47.37
Deep Knowledge of Climate Change		
Yes	5	5.26
No	75	78.95
Not Sure	15	15.79
Methods of Communication		
Verbal	87	91.58
Verbal plus Picture	8	8.42

Source: Field survey, 2011

TABLE 3: Distribution based on forms of pictorial communication available and their level of usage

Variable	Not Available Frequency	Percentage	Available and used Frequency	Percentage	Available and Not Used Frequency	Percentage
Pictures	16	16.84	10	10.53	23	24.21
Leaflets	7	7.37	5	5.26	8	8.42
Slides	21	21.05	4	4.21	1	1.05
Drawings	6	6.32	9	9.47	16	16.84
Posters	7	7.37	63	66.32	29	30.53
Maps	3	3.16	2	2.11	15	15.79
Projector/Flipbooks	35	36.84	2	2.11	3	3.16

Source: Field Survey, 2011

The result in table 3 above indicated that posters which accounted for 66.32% are the most available and used forms of pictures. Other forms of pictures were scarce and inadequately used especially projector (36.84%). Pictures are not adequately used by the extension agents which can help the respondents to learn faster the effects of climate change. The implication of this is that respondents may likely not have good knowledge about the effects of climate change. This is similar to the findings of Hoffman (2000) who reported that verbal communications are mostly used in interpersonal communication.

TABLE 4: Distribution of respondents on their level of understanding when taught with verbal communication only to when taught with verbal plus pictorial communication

Variable	Frequency	Percentage
Verbal Only		
Low	33	34.74
Very Low	60	63.16
High	2	2.11
Very High	-	-
Verbal plus Pictures		
Low	1	1.05
Very Low	-	-
High	36	37.89
Very High	58	61.05

Source: Field survey, 2011

Table 4 revealed that 63.16% of respondents indicated that their level of understanding when taught verbally only was very low, while (61.05%, 37.89%) showed that their level of understanding when taught verbally plus pictures was quite high. Hoffman (2000) reported that, pictures are known to highly facilitate comprehension (learning) but these have not been sufficiently used especially in the area of climate change awareness and mitigation.

TABLE 5: Distribution of respondents on their level of importance attached to the use of pictures in learning

Variable	Frequency	Percentage
Taught/Learning Using Pictures		
Yes	87	91.58
No	8	8.42
Importance attached		
Low	-	-
Very Low	1	1.05
High	56	58.95
Very High	38	40.00

Source: Field survey, 2011

Distribution of respondents based on level of importance attached to the use of pictures for learning. From table 5 above, shows that majority (91.58%) of respondents like been taught using pictures. The use of pictures enhance quick understanding, it is more convincing with easy assimilation of matter discussed. It gives clarity of ideas especially innovations with multiple steps of process, complementing pictures with verbal communication aid retention. The result also indicated that (58.95%) of farmers attached great importance to the use of pictures in learning, hence increase the rate of adoption since farmers adopt what they understood better. Pictures are more real and clearly represent a true of an object. This agrees with the findings of Okoye (2008) who reported that learning is made easier when ideas are expressed in pictures.

Conclusion

The study examined pictorial communication as a strategy to climate change mitigation/adaptation among small – holder rubber farmers of Edo State. Though based on the long year accumulated experience of respondents, they noticed the effects of climate change but no good understanding and knowledge about the subject matter. Majority of respondents were not taught using any forms of pictorial communication, they indicated low understanding when taught with verbal communication only. Learning with the aid of pictures was preferred by the respondents for more understanding and clarity.

Recommendations

Based on the findings from the study, it is therefore recommended that:

- Efforts should be made towards presenting climate change effects and its mitigation in pictorial forms since respondents seemed to understand pictures as supported by verbal communication;

- Climate change effects and its mitigation should be communicated to respondents using any forms of pictorial communication for better understanding, especially the less educated ones;

- Pictures should be use to aid verbal communication in creating awareness on the effects of climate change and its mitigation;

- Pictures should be simple and easy to study in a steps by steps process for quick assimilation of the effects of climate change and its mitigation and

- More attention should be paid to pictorial communication.

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Effects of Climate Change on Food Security of Rural Livestock Farmers in Oyo State, Nigeria

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Abstract

Food insecurity has been a problem of many households in developing countries, especially in Africa. However, one of the contributing factors to this is climate change, affecting many aspects of livestock production. The study assessed the effects of climate change on the food security status of rural livestock farmers in Oyo state. A multistage sampling technique was used to select a total of 153 livestock farmers in Oyo North senatorial district of the state. Descriptive and inferential statistics (Chi-Square and PPMC) were used to for data analysis The study showed that 19.6%, 17.6% and 13.4% of the respondents belonged to the age categories of 56-60, 46-50 and 36-40 years, respectively. Majority also raised goats (91.8%), Poultry (89.2%) and sheep (87.1%), and kept between one and ten sheep (67.3%) and goats (62.8%). Majority (67.3%) had 1-10 years of experience in livestock production. Majority (68.0% and 62.8%, respectively) also identified high cost of feed stuffs for feeding of animals and scarcity of water for the animals due to prolonged drought over the years as major constraints to production of livestock. More than half (56.7%) of the respondents had unfavourable perception of the effects of climate change on their level of food security, as 54.9% of them were food insecure. At 5% level of significance, respondent's perception of the effects of climate change on level of food security (r =-0.393) and constraints (r = 0.322) to livestock production were both significantly related to their food security status. Therefore, livestock farmers in Oyo state have low food security status. Hence, adaptation strategies should be developed and adapted for livestock farmers with a view to increasing their production level and translate into an improved food security of the rural livestock farmers.

Key words: climate change effects, Climate Change, Food Security, Rural Livestock, Farmers.

Introduction--

Agriculture is the basic activity by which humans live and survive on the earth. Assessing the impacts of climate change on agriculture is synonymous to assessing the food security status of farmers. In both developed and developing countries of the world, the influence of climate on crops and livestock persists despite agricultural technologies such as irrigation, improved plant and animal hybrids and the growing use of chemical fertilizers. The continued dependence of agricultural production on light, heat, water and other climatic factors, the dependence of much of the world's population on agricultural activities, and the significant magnitude and rapid rates of possible climate changes all combine to create the need for a comprehensive consideration of the potential impacts of climate on global agriculture.

Studies show that biological productivity in Nigeria will decrease in the event of global warming (Adejuwon and Adesina, 1994). Already Nigeria has experienced definite shift in the long term rainfall mean towards more arid conditions, warm sunshine regimes to hot conditions. These conditions have adverse agricultural implications (Ikeme, 2007). It is believed that livestock production systems could be at risk.

Increased demand for land and the enhanced degradation due to climate extremes and other hazards have added to the challenges in livestock production. Climate change is likely to have far greater effects on the small farmers compared to the larger commercial operations. Small farmers often rely on streams for their water supply and do not have the means to set up adequate water storage facilities. Hence, when the streams dry up, the farmers would find it hard to cope. Incidence of diseases is also reported to be on the increase especially intestinal problems which are believed to be associated with pasture feed.

It is predicted that increased carbon dioxide concentrations in the atmosphere and warmer temperatures will be conducive to rapid growth of green matter rather than crops and this might affect seasonal food security (NACCC, 2007). Rapid growth could reduce the nutritional value of pastures which could in turn result in fewer animals supported per unit area of pasture land and this could have a detrimental effect on beef production for local consumption. Similar problems (worm and infections) have been encountered by piggery farmers. Hot temperatures could result in the relocation of stocks to cooler climates (an adaptation measure) and this could entail significant costs to the farmers especially given the poor state of most of Nigerian roads. Local farmers with knowledge of which breeds or varieties can best adapt to changing conditions can provide invaluable input to any effort aimed at mitigating the negative impacts of climate change to the livestock industry. Small scale livestock farmers will be mostly affected by increased temperatures and drought as these could cause soil compaction and dry up the streams on which farmers depend for their primary source of water.

Food security depends on availability of food, access to food, and utilization of food (FAO, 2000). Food availability refers to the existence of food stocks for consumption. Household food access is the ability to acquire sufficient quality and quantities of food to meet all household members' nutritional requirements. Access to food is determined by physical and financial resources, as well as by social and political factors. Utilization of food depends on how food is used, whether food has sufficient nutrients, and a balanced diet can be maintained. It is these three facets of the food system that all need to be met in order for food security to be realized. Climate change is a major threat to food security in many regions of the developing world, which are largely dependent on rainfed, labour-intensive and extensive systems of livestock production (Parry *et al*, 1999, 2004; Döös and Shaw, 1999; IPCC, 2001a).

Livestock production is one of the numerous livelihood diversification strategies through which rural households fight food insecurity. Unfortunately, this aspect of livelihood diversification strategy is under serious threat due to climate change (Akwaja, 2006). Although there are studies on the impact of climate on food production, there is limited understanding of how climate change currently impacts

food systems and associated livelihoods (Downing, 2002; Ziervogel and Calder, 2003). The situation grows worse since not much has been done on the impacts of climate change on livestock production and food security status of the livestock farmers. Therefore, there is the need to determine the effects of climate change on the food security status of rural livestock producers in Oyo state, Nigeria.

The study identified the socio-economic characteristics of rural livestock producers in Oyo State, determined their perceptions of climate change effects on livestock production and food security, assessed the climate related constraints to livestock production, as well as determined the food security status of rural livestock producers in the study area. The study also hypothesised that significant relationship existed between respondents' selected socio-economic characteristics, perception of climate change effects on household livestock production and food security, climate related constraints to livestock production and their food security status.

Methodology

The study was carried out in Oyo State, Nigeria. The State is located in the South Western part of Nigeria. Oyo State is made up of 33 local government areas and a land area of about 37,753 square kilometers, population of 578,983. It lies between latitude $7^0 2$ and $9^0 1$ north and longitude $2^0 4$ and $4^0 3$ east.

The study area, made up of 3 senatorial districts out of which one (oyo North senatorial district) was purposively selected since it is predominantly rural. In this senatorial district, 3 local government areas (LGAs) were randomly selected and they included Iwajowa, Kajola and Iseyin LGAs. In each of the three LGAs 51 rural livestock farmers were selected, making a total of 153 livestock farmers. The data for the study comprised of primary data and it was collected using interview schedule. An interview schedule made up of different questions was developed for collecting information from the respondents' socio-economic information, perceived effects of climate change on household food security, climate-related constraints to livestock production. The data were subjected to statistical analysis using frequency counts and percentages. Pearson Product Moment Correlation (PPMC) and Chi-square were used to determine the relationship between respondents' socio-economic characteristics, perception and constraints and household food security.

Measurement of variable

1. Climate-related-Constraint to livestock farmers' production: Respondents were asked to indicate the climate-related constraints to livestock enterprises as well the degree of severity of the constraints on a three point scale as very severe (3), severe (2), Not severe (1) and Not a constraints (0). The level of constraints faced is determined by summing the scores for each item. The maximum score obtainable was 30 (15 items), and the minimum 0.

2. Perception of livestock farmers on contribution of livestock production to their household food security: Respondents were asked to respond to the perception statements so as to access their perception on effects of climate change on livestock production. A total of 16 positively and negatively worded items were used. Respondents indicated whether they strongly agreed, agreed, were undecided, disagreed or strongly disagreed with each of the items. Scores of 5, 4, 3, 2 and 1 respectively were assigned respectively for positive statements and reversed for negative statements. Respondents' scores for each of these statements were

summed to form overall scores for perception. A mean score was obtained to categorize respondents into having unfavourable (≥ mean) and favourable perception (< mean).

3. Household food security status of livestock producers: This was measured using the Food and Nutrition Technical Assistance Scale (2005). The respondents were asked about what happened in the last 30 days in their households categories of never (3), rarely (once or twice = 2), sometimes (3-10 times = 1), or often (more than 10 times = 0) in the past 30 days. Respondents scores for household food security was obtained and using the mean score, respondents were either food insecure (≥ mean) or food secure (< mean). The total score obtainable was 18, while the minimum is 0.

Results and Discussion

1. Socio-economic characteristics of respondents:

The result of the analysis shows that more than half (51.6%) of the respondents fall within the age 36 – 55 years of age. This implies that respondents are mainly young adults who are very agile. The result also shows that majority of the households of livestock farmers in the study area were male headed (76.1%). This implies those males are predominantly household heads in the rural areas of Oyo state. The study goes further to show that there were more married (66.0%) than their single, widowed and divorce counterparts. This implies that respondents have opportunities to additional hand for farm labour for livestock production activities. Majority of the respondents have low educational status, going by 45.8% and 26.1% who had non-formal and primary education respectively. This scenario may limit farmers to low level of exposure to information on effects of climate change on food security status. The study also shows that respondents have an average household size of 7 members, as 42.5% and 44.4% respectively had 6-10 and 1-5 members respectively. This number could provide farmers with opportunities of farm labour, as they attempt adaptive measures against climate change. This could help increase level of livestock production and household food security, consequently. Respondents raised different types of livestock a means of livelihood, but at varying proportion. The result indicates that 81.6%, 70.6%% and 53.5% raised poultry, goat and sheep respectively. This implies that small ruminants and fowls are the most important livestock raised in rural areas in the study area.

TABLE 1: Distribution of respondents based on selected socio-economic characteristic

Variables	Frequency	Percentage	Mean
Age:			
≤ 25	5	3.3	48.34
26-35	19	12.4	
36-45	36	23.5	
46-55	43	28.1	
56-65	30	19.6	
65 and above	20	13.1	
Sex			
Male	116	76.1	
Female	37	23.9	
Marital status			
Married	101	66.0	
Single	30	19.6	
Divorced	16	10.5	
Widowed	6	3.9	
Educational Education			
No Formal Education	70	45.8	
Primary	40	26.1	
Secondary	27	17.5	
Tertiary	16	10.5	
Household size			
1-5	68	44.4	7
6-10	65	42.5	
11-15	18	11.7	
16-20	2	1.3	
Household income (In Naira)			
< 10,000	73	47.7	45, 068.00
10, 000 – 24, 000	29	19.0	
25, 000 – 39, 000	15	9.5	
40, 000 – 54, 000	18	11.8	
55, 000 and above	18	12.1	

Source: Field survey, 2011

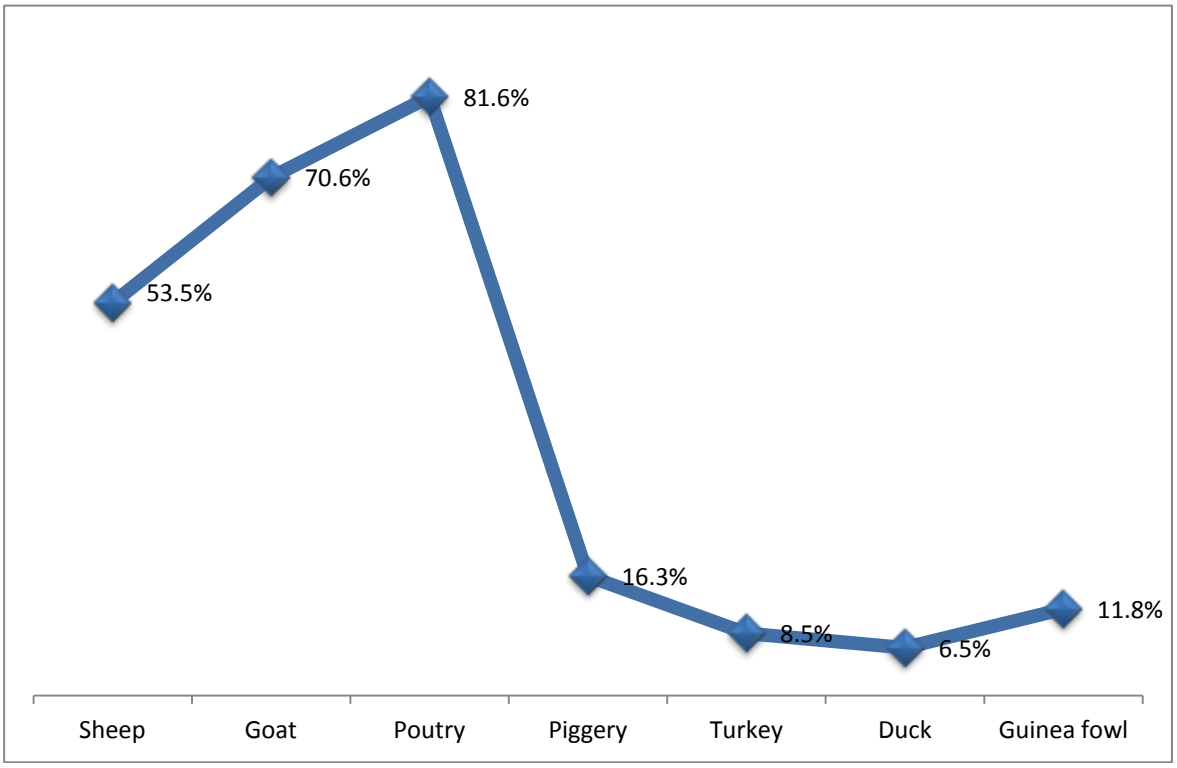


Figure 1: Livetock raised by rural livestock farmers in Oyo State
Source: Field survey, 2011

2. Climate related constraints to livestock production

The result of the findings shows that farmers were faced with different dimensions of constraints to livestock production as a result of climate change. Majority (66.0%, 60.0% and 60.0%) of the respondents opined the following constraints as very severe: reduced availability of drinkable water for the livestock, prevalence of pests and increased stress on the livestock. Also, more than half of the respondents opined that disease attack (59.5%), frequent dehydration of livestock (58.8%), increase stress on attendants (56.9%) and harsh weather conditions of the respondents were very sever constraints. The implication is that the climate related constraints to livestock production in the study area are very severe.

The weighted mean value of each constraint further shows that all the climate-related constraints to livestock production were severe (mean is approximately 2), except lack of drinkable water, which was a very sever constraint (mean is approximately 3). This corroborates with Muliagatele (2007) that Climate change is likely to have far greater effects on the small livestock farmers compared to the larger commercial operators.

TABLE 2: Climate related constraints to livestock production in the study area

Constraints	Very severe	Severe	Not severe	Not a constraint	Mean
Prevalence of pests	78(60.0)	32(20.9)	12(7.8)	31(20.3)	2.03
Increased disease attack	91(59.5)	36(23.5)	12(7.8)	14(9.2)	2.33
Lack of drinkable water	101(66.0)	23(15.0)	10(6.5)	19(12.4)	2.48
Frequent dehydration of livestock	90(58.8)	35(22.9)	20(13.1)	8(5.2)	2.35
Emaciation of the animals	67(43.8)	60(39.2)	21(13.7)	5(3.3)	2.26
Increased frequency of disease attack	69(45.1)	56(36.6)	23(15.0)	5(3.3)	2.24
Reduced immunity	76(49.7)	56(36.6)	18(11.8)	3(2.0)	2.34
Reduced quality of feed	67(43.8)	35((22.9)	21(13.7)	30(19.6)	1.91
Reduced quantity of feed	85(55.6)	35(22.9)	20(13.1)	13(8.5)	2.25
Increased stress on the animals	78(60.0)	56(36.6)	23(15.0)	3(2.0)	2.41
Increased flood	76(49.7)	56(36.6)	15(9.8)	6(3.9)	2.32
Stunted growth	70(45.8)	38(24.8)	25(16.3)	20(13.1)	2.03
High cost of feed stuffs	50(32.7)	70(49.7)	17(11.1)	16(10.5)	2.01
Increased stress on attendants	87(56.9)	42(27.5)	12(7.8)	12(7.8)	2.33
Harsh weather condition	88(57.5)	45(29.4)	16(10.5)	4(2.6)	2.41

Source: Field survey, 2011

3. Perceived effects of climate change on livestock production

The result of the finding as shown in table 3 shows that majority (54.9%) agreed that stunted growth of livestock in recent times might be as a result of climate change; and this might affect their food security. Also, 43.8% and 43.1% respectively of them agreed that Livestock production among small scale producers in the rural area is becoming stressful due to the frequent extremes of weather in recent times and that Climate change exposes livestock to dangers associated with weather extremes. However, 56.2% disagreed that neither has the climate nor livestock production changed; climate change is a product of scientific lies. This implies that respondents have unfavourable perception of climate change effects on livestock production in the study area.

The result however further shows that majority (64.1%) of the respondents had unfavourable perception of climate change on the food security of households of livestock producers in the study area (fig. 2)

TABLE 4: perception of climate change effects on livestock production

Perception statements	SA	A	U	D	SD
Continuous rise in temperature of the recent times has negatively affected household livestock production and food security in this area	41(26.7)	43(28.1)	19(12.4)	80(26.1)	20(6.5)
Yearly rains can no longer guarantee water availability for improved livestock production and food security	31(20.3)	31(20.3)	24(15.6)	110(35.9)	12(7.8)
Stunted growth of livestock might be as a result of climate change; and this affects production and food security	25(16.3)	89(54.9)	36(11.8)	12(7.8)	14(9.1)
Climate change has nothing to do with livestock production and household food security	12(7.8)	34(22.2)	40(13.1)	104(34.0)	70(22.9)
Climate change will rather help improve livestock production and increase food security status of livestock farmers in this area	10(6.5)	27(17.6)	17(11.1)	122(39.9)	38(24.8)
Harsh weather conditions that is common today improves livestock production in rural areas	14(9.1)	37(24.2)	17(11.1)	60(39.2)	25(16.3)
Incidences of prolonged droughts during the dry season due to climate change does nothing bad to livestock production and household food security of the farmers	19(6.5)	33(21.5)	30(19.6)	53(34.6)	27(17.6)
Interest in livestock production in rural areas is dwindling due to climate change	41(26.8)	42(27.5)	20(13.1)	36(23.5)	28(9.1)
Climate change leads to larger numbers and sizes of livestock.	5(3.3)	12(7.8)	27(17.6)	61(39.9)	48(31.4)
Occurrence of flood in the recent days has not been in the interest of household livestock production and food security	45(29.4)	44(28.8)	20(13.1)	35(22.9)	9(5.9)
Climate change will continue to reduce the quality of livestock produced	22(14.4)	29(18.9)	35(22.9)	48(31.4)	19(12.4)
Access to usable water for livestock farming activities is gradually decreasing and this is due to the ever rising annual temperature	43(28.1)	42(27.5)	19(12.4)	10(6.5)	39(25.5)
Climate change only has effects on crop production and not on livestock production.	12(7.8)	31(20.3)	24(15.6)	31(20.3)	55(35.9)
Neither has the climate nor livestock production changed; climate change is a product of scientific lies.	14(9.1)	13(8.5)	30(9.8)	86(56.5)	25(16.3)
Livestock production among small scale producers in the rural area is becoming stressful due to the frequent extremes of weather	35(22.9)	67(43.8)	20(13.1)	20(12.7)	11(7.2)
Climate change exposes livestock to dangers associated with weather extremes	39(25.5)	66(43.1)	16(10.8)	23(15.0)	9(6.2)

Source: Field survey, 2011

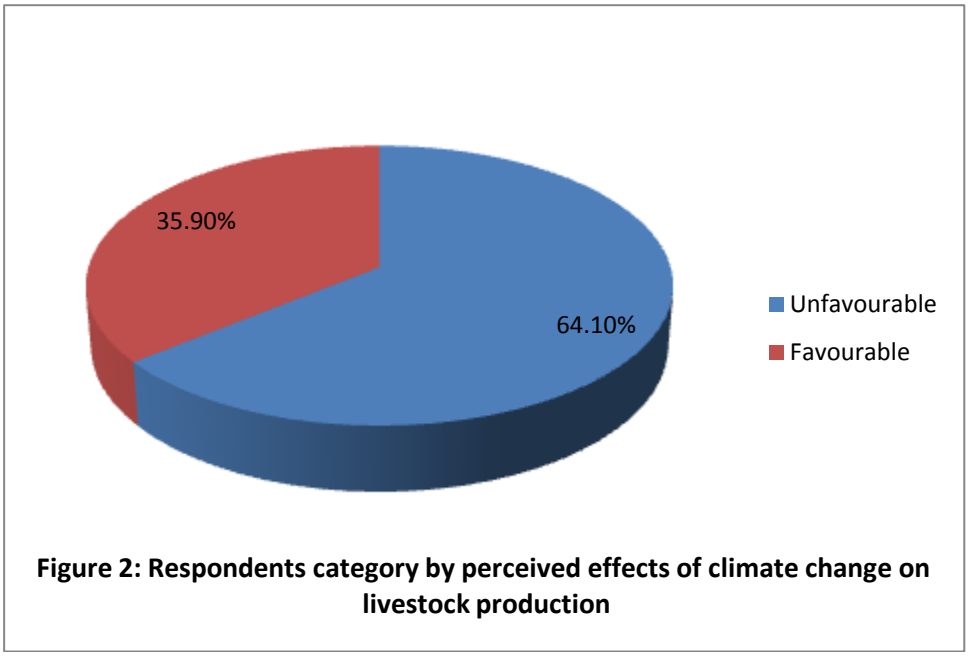


Figure 2: Respondents category by perceived effects of climate change on livestock production

Food security status of rural household farmers

Food and Nutrition technical assistance scale (2005) containing 9 questions were used to determine the food security status of the household. The mean score of each household was determined and used to categorise the respondents into food secure and food insecure households. The result of the finding showed that 62.1% of the households were food insecure, implying that only 37.9% of the rural livestock farming households in Oyo State were food secured.

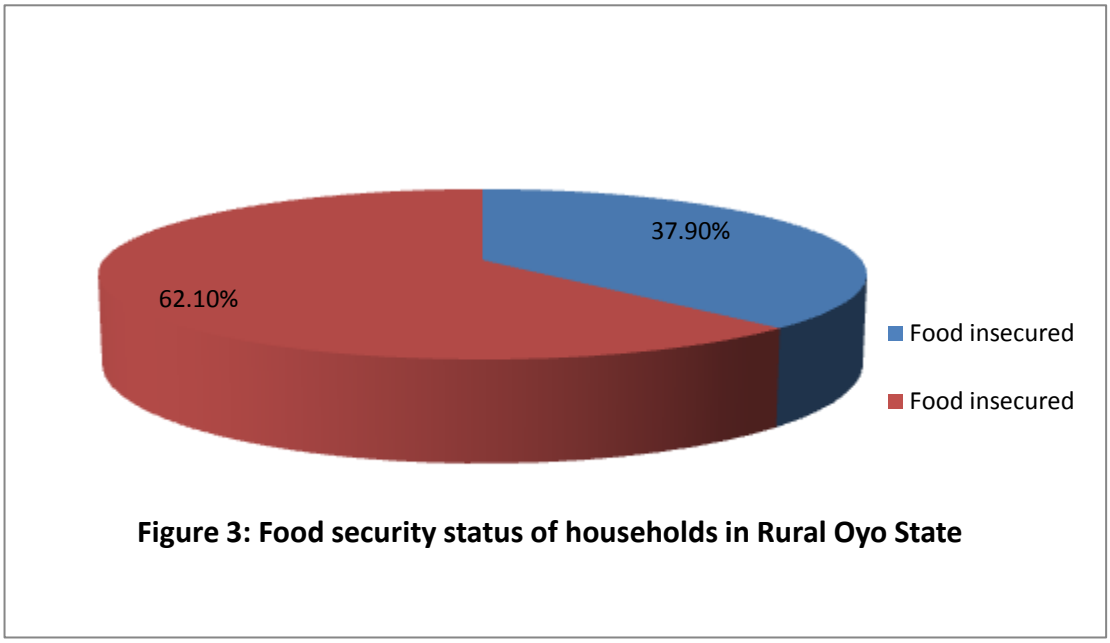


Figure 3: Food security status of households in Rural Oyo State

Source: Field survey, 2011

Test of hypotheses

1. Relationship between socioeconomic characteristics of respondents and food security status

The result of the analysis based on chi-square test of relationship shows that at 5% level of significance, respondents' sex and income from livestock production each had a significant relationship with their level of food security. However, none of marital status, religion and age of respondent showed a significant relationship with their household food security status.

TABLE 4: Chi-square table showing relationship between selected socio-economic characteristics and food security status

Variables	Df	Chi-square value	p-value	Decision on significance
Sex	1	14.310	0.038	S
Marital status	3	5.464	0.141	NS
Income	3	34.077	0.000	S
Religion	2	1.541	0.463	NS
Age	4	0.884	0.927	NS

Source: Field survey, 2011

2. Relationship between perceived effects of climate change to livestock production, constraints to livestock production and household food security status

The result of the findings shows that at 5% level of significance, perception showed a significant but negative relationship (r = -0.253) with respondents household food security. This implies that rural livestock farmers in Oyo unfavourably perceived climate change effects on their food security status. However, constraints showed a positive and significant relationship (r = 0.322) with household food security of the respondents, implying that the higher the extent of climate related constraints, the lower the food security status of the livestock keeping households.

TABLE 5: PPMC table showing relationship between perception and climate related constraints

Variable	r-value	p-value	Decision
Perception	0.393	0.000	Reject Ho
Constraints	-0.322	0.000	Reject Ho

Source: Field survey, 2011

Conclusion and recommendations

The following conclusions are hereby drawn on the basis of the objective and hypothesis of the study.

- Livestock farmers in the rural area of Oyo State are predominantly matured adults, male; having a medium sized family size. Poultry (fowls), goat and sheep are the most commonly raised livestock.

- Livestock farmers perceived that climate change is a threat to livestock production and household food security in the rural area.

- Respondents are being faced with different climate-related constraints to livestock production and many of which were severe.

- Livestock farmers in rural areas of Oyo state are food insecure.
  And based on these conclusions, the following recommendations are being made.

- Efforts by the government at increasing protein intake in the rural area should be directed towards helping rural livestock farmers overcome many of their challenges posed by the climate change.
- Various adaptation strategies that help reduce the effects of climate change on livestock production should be developed and adapted for livestock farmers with a view to increasing their production level and translate into an improved food security of the rural livestock farmers should be developed by the animal scientists.

- Improved breeds of livestocks with abilities to withstand extremes of weather associated with climate change should be developed and made available to the rural livestock farmers

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Integration of Indigenous Knowledge System into Climate Change Adaptation Strategies in Sub-Saharan Africa

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Abstract

Indigenous knowledge systems (IKS) is widely recognized for being cost effective, resilient and most sustainable in tackling complex societal issues such as climate change and environmental challenges. Unfortunately, these knowledge systems are not usually incorporated by development practitioners and governments in developing effective solutions to such challenges. This paper emphasizes the benefits of integrating innovative IKS into climate change adaptation strategies in sub-Saharan Africa. It further identifies useful IKS already being practised across selected countries in sub-Saharan Africa with the proposition for integrating such measures into various regional, national and local governments' climate change adaptation strategies. The paper concludes that both innovative IKS and improved technologies from elsewhere need to be integrated and adapted in a systematic manner in order to provide the most efficient and effective climate change adaptation strategy for countries in sub Saharan Africa. This of course will require requisite policies and institutions to be able to accomplish the desired objectives.

Key words: Integration, Innovative, Indigenous Knowledge System, Climate Change Adaptation, Strategies, sub-Saharan Africa

Introduction

The IPCC Third Assessment Report 2001 concludes that current knowledge on adaptation to climate change and adaptive capacity is limited and emphasized the need for further research on timely, progressive and viable adaptation options. Most countries in sub-Saharan Africa (SSA) region are heavily dependent on climate-sensitive sectors (agriculture, fisheries, tourism etc) and are therefore more vulnerable to climate change than other regions (Ludi, 2009). Climate modeling scenarios for SSA predict warmer temperatures, drier soils, rising sea levels, increased desertification, higher frequency of floods and droughts and consequent shifting patterns of resource availability (IPCC, 2007).

According to the Institute for Global Environmental Strategies (2004) one of the promising methods to design socially benign and culturally appropriate adaptation policies is to document and understand local adaptation strategies for climate change. This is because indigenous societies accumulated valuable knowledge that helps in understanding human-environment relationships for optimum utilization of resources and to regulate human environmental impacts (Kempton, 2001). Several studies (Umunakwe, 2011; Ozor et al. 2010) have confirmed the use of local knowledge such as the use of resistant crop varieties and livestock breeds, changes

in harvesting and planting dates, increased weeding, migration, rain water harvesting and diversification of enterprises to adapt to climate change in SSA.

A workshop conducted in 2005 on “community level adaptation to climate change” in Bangladesh has stressed the importance of incorporating indigenous knowledge systems into climate change adaptation projects in developing countries (Hossain, 2005). While the importance of IKS has been recognized in the design and implementation of sustainable development, little has been done to integrate them into formal climate change mitigation and adaptation projects in SSA (Nyong et al., 2008). Rather, focus has remained on the introduction of western/modern adaptation strategies most of which do not suit the African situation. This as a consequence has led to the loss of useful indigenous adaptation strategies.

Integrating IKS into formal climate change projects and policies will lead to the development of effective mitigation and adaptation strategies that are cost-effective, participatory and sustainable (Robinson and Herbert, 2001). However, the integration should not be done at the expense of western adaptation strategies rather than compete, they should complement each other to produce better results. Agrawal (1995) argues that there is a need to move beyond the dichotomy of indigenous versus scientific knowledge and work towards building bridges across the indigenous and scientific knowledge divide. This requires parity and integration between traditional and scientific knowledge systems, demanding a mutual understanding of the cultural, material and epistemological basis of each.

This paper explores some of the effective indigenous climate change adaptation measures used in sub-Saharan Africa. It further develops a framework for their integration into climate change adaptation strategies and advocates for the combination of the two knowledge systems (IKS and western).

Concept of climate change

Global climate change is possibly the greatest environmental challenge facing the planet earth in this 21st century. The IPCC Fourth Assessment Report published in the early 2007 asserts that global climate change is already happening. Observations already confirm changes in the Earth’s climate and show increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global sea level (IPCC, 2007). There is however a scientific consensus that global land and sea temperature are warming and will continue to warm whether emissions increase or decrease in the next two decades. Apart from the average weather, many other features of the earth’s environment have been changing rapidly during the past few centuries owing in large part to technological advancement and rapid population growth. Examples include loss of soil quality, erosion and desertification (Intergovernmental Working Group on Climate Change, IWGCC, 2008).

The term climate change has been defined as any change in climate over time, whether due to natural variability or as a result of human activity (IPCC, 2007). It has also been defined as the change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural variability observed over comparable time periods (UNFCCC, 1994).

The earth’s atmosphere is central to the phenomenon of climate change. The atmosphere is mainly composed of two gases, Nitrogen and Oxygen (together

comprising 98% of the atmosphere). Argon, neon, helium, water vapour, carbon dioxide, ozone, methane and nitrous oxide are other components. However, water vapour, carbon dioxide, ozone and nitrous oxide are referred to as greenhouse gases (GHGs) and are central to the earth's natural temperature control system (SACAU, 2008).

The main cause of climate change is anthropogenic activities. Such activities like the burning of fossil fuels, deforestation and animal agriculture release GHGs into the atmosphere which raise the already existing concentration thereby resulting to global warming (i.e. abnormal increase in the earth's surface temperature) (IPCC, 2007). Global warming will then induce climate change (SACAU, 2008). However, Anyadike (2008) posited that other factors such as volcanic eruption can cause climate change. But this was more during the pre-industrial era (US EPA, 2009).

Impacts of climate change

Climate change will affect every region in the world. However, developing countries are considered most vulnerable largely because of their often limited capacity to adapt (Nyong et al. 2007). According to Ozor (2008) the impacts of climate change in the SSA region border mainly on agriculture and natural resource availability especially water.

Climate change is projected to affect crop yield directly because of alterations in temperature and rainfall patterns, and indirectly through changes in soil quality, pest and disease attacks (Explore, 2005). In the tropics, some of the crops are near their maximum temperature tolerance and where dryland, non-irrigated agriculture dominates, yields are likely to decrease with even a small increase in atmospheric temperature (CGIAR, 2005). Similarly, water stress is projected to increase significantly in those areas that are already relatively dry (e.g. SSA). Excessive water withdrawals can increase the likelihood and impact of drought (Bates et al. 2008) causing crop and livestock losses which can lead to food insecurity (Pavel, 2003). Water shortages can contribute to the spread of diseases because people lack water basic for hygiene (UNEP, 2003).

Furthermore, climate change overburdens states and regions that are already fragile and conflict-prone. Reduction in resources like arable lands and fresh water has been observed in SSA. Water shortage in particular has the potential to cause civil unrest, leading to significant economic losses (Besada and Sekwambo, 2009). The drying up of streams and rivers in many parts of SE Nigeria has triggered conflicts among many communities in addition to man-hour losses.

Concept of indigenous knowledge systems

Indigenous knowledge is variously referred to as folk knowledge, traditional knowledge, local knowledge, traditional environmental knowledge, indigenous traditional knowledge, indigenous agricultural knowledge or rural people's knowledge. It is based on experience, often tested over centuries of use and entails many insights, perceptions and intuitions relating to local culture and environment (IGES, 2004).

IKS refers to the content or substance of knowledge resulting from intellectual activity in a traditional context, including the know-how, skills, innovations, practices and learning that form part of traditional knowledge systems and knowledge embodying traditional lifestyles of indigenous and local communities, or contained in

codified knowledge systems passed between generations. It is not limited to any specific technical field and may include agricultural, environmental, food preparation and medicinal knowledge as they are perceived as the basis for local-level decision making (ICIPGRTKF, 2011).

According to Barasa (n.d) IKS are locally bound, indigenous to a specific area; culture and context specific; orally transmitted and generally not documented; dynamic and adaptive; holistic in nature and; closely related to survival and subsistence of people worldwide.

Indigenous knowledge system and climate change adaptation in sub-Saharan Africa

To local people, knowledge is only of importance if it is necessary for their survival and for coping with their daily problems (IGES, 2004). According to Agwu, Amadu, Morlai, Wollor and Cegbe (2011) farmers need to innovate continuously if they are to cope, compete and survive. They further maintained that farmers tend to know more than scientists when it comes to the characteristics and dynamics of the environment in which they farm.

Several studies have acknowledged that African farmers have and are still responding to climate change using IKS (Umunakwe, 2011; Agwu et al. 2011; Speranza, 2010; Nyong et al. 2007). However, Speranza (2010) argued that most of the adaptations are at the farm level (smallholders) including both on-farm and off-farm activities. Some of the innovative adaptation strategies include the following:

Crop production

These include crop diversification, crop combination, use of cover crops, mulching and crop residue, use of improved crop varieties, use of pest/disease resistant crop varieties, use of drought resistant crop varieties, change of planting dates (early or late planting), irrigation, planting along the river banks, fallows, use of organic manures, migration, increased weeding, change of harvesting dates, making ridges in steep slopes, intercropping, mixed cropping, and contour planting, conservation tillage, agroforestry practices and pitting etc.

Shemdoe et al. (2008) reported that some farmers in Tanzania use traditional terraces (matuta) and mulching from crop residues left from preceding season to conserve soil moisture and to increase soil water availability to plants hence improving crop production. Also, a study carried out by Adebayo et al. (2011) revealed that many farmers in Nigeria are coping with climate change through the use of high resistant crop varieties, mulching and planting date adjustment.

Livestock production

Rural livestock producers have a degree of adaptive capacity and have only survived or emerged as livestock keepers due to this capacity (WISP, 2010). Some of the measures used include changing herd composition, reducing herd number, diversification of livestock types, breeding locally adapted livestock species, resource management practices, feed production technologies, pastoral livestock mobility, settlement around water points and livestock insurance etc.

Because of the problems of water, pasture, and recurrent droughts, pastoralists are increasingly replacing cattle with sheep, goats and camels depending on the prevailing season. This practice is common in Niger, Kenya and Ethiopia

(GebreMichael et al. 2010). It is reported that farmers also diversify their herd composition (combinations of goat, sheep, camel, donkey and cattle) (Behnke et al. 1993). This is seen as adaptation to diverse ecology in which vegetation can be highly varied in both space and time (WISP, 2010). Pastoralists are also observed to move from one place to another (transhumance movement) which allows herds to access seasonally available resources (e.g. wet season pastures or dry season forests) and evade seasonal stresses (such as parasites) (WISP, 2010).

Water management

While water is available (rainfall, flowing streams and rivers) during the rainy season, it becomes scarce during the dry season. However, in dry regions of SSA people have evolved certain indigenous measures to cope. In Kenya, Tanzania, Ethiopia and Namibia, people dig holes in the sand beds of streams and rivers to fetch water. However this traditional practice has been enhanced by the construction of dams (Speranza, 2010). Micro catchment techniques (contour bunds) are another method used to harvest water. An example is the *trus cultivation* i.e. a traditional water conserving method of cultivation used on clay soils that harvests surface run-off by constructing low-earth bunds called *trus* (Osman-Elasha, 2006). Also, farmers in Tanzania use pitting as a traditional system of sowing to collect runoff at hill sides and valley bottoms during the early growing stages of crops (Habitu and Mahoo, 1999).

Integrating IKS into climate change adaptation strategies

The integration of IKS into climate change adaptation strategies should be guided by the following principles; bottom-up participatory approach, establishment of partnership and collaborative processes, win-win situations, demand-driven, sustainability dimension, periodic assessment, outreach strategies and technology transfer and capacity building and public awareness (Institute for Global and Environmental Strategies, IGES, 2004).

Reasons for integrating IKS into climate change adaptation strategies

1. IKS is a powerful asset and social capital: This means that the people depend on it for their socio-economic and cultural developments. As an asset, the people utilize IKS in every sphere of their livelihoods including agriculture, health, construction, entertainment, wars, peace, etc. IKS therefore forms part and parcel of the people and enriches their culture and social capital.
2. It has site specificity and dynamic nature: This means that IKS is location specific and what works for the people in one location may not work for the people in another location. It also has the tendency to grow among the people as the generations modify its use and applications (dynamic).
3. It has a tight linkage of knowledge and social responsibility: IKS is strongly linked with societal values and responsibility. IKS effectively supports the society that produces the knowledge hence it can be sustained for generations by such society.
4. It facilitates understanding and effective communication and increase the rate of dissemination and utilization of climate change adaptation: Because IKS evolves from a common people, it is easier to be understood and communicated from one person or generation to another. This enhances the diffusion and dissemination of such knowledge. In the same vein, if the people

evolves an adaptation strategy for climate change using their indigenous knowledge, it tends diffuse more easily and faster within the same social system.

5. IKS provides mechanism for participatory approaches: Because no single person claims ownership of an IKS but the community or the social system, it tends to be participatory in its application and use. Every member of such a social system thus has the chance of contribute to its efficacy and application with the overall goal of ensuring the functionality and sustainability of such an indigenous knowledge. Unfortunately this makes it difficult for patenting of IK and restricts intellectual property rights.
6. It is multi-level and multi-sector oriented: This means that all categories of stakeholders across sectors within a social group or community can have access to IKS. It is not restrictive as access and benefit sharing for all members of the social group is equal.

Stages of integrating IKS

According to Srinivasan (2001) the stages in integrating IKS into climate change adaptation strategy include:

(a) Documentation of identified IKS

(b) Awareness of particular IKS

(c) Perception of the practice as a solution to improve climate change adaptation

(d) Motivation to enhance adaptation using IKS

(e) Experimentation with IKS practice to improve climate change adaptation

(f) Evaluation of both indigenous and introduced (modern) strategies

(g) Utilization of the most suitable approaches

(h) Dissemination and popularization

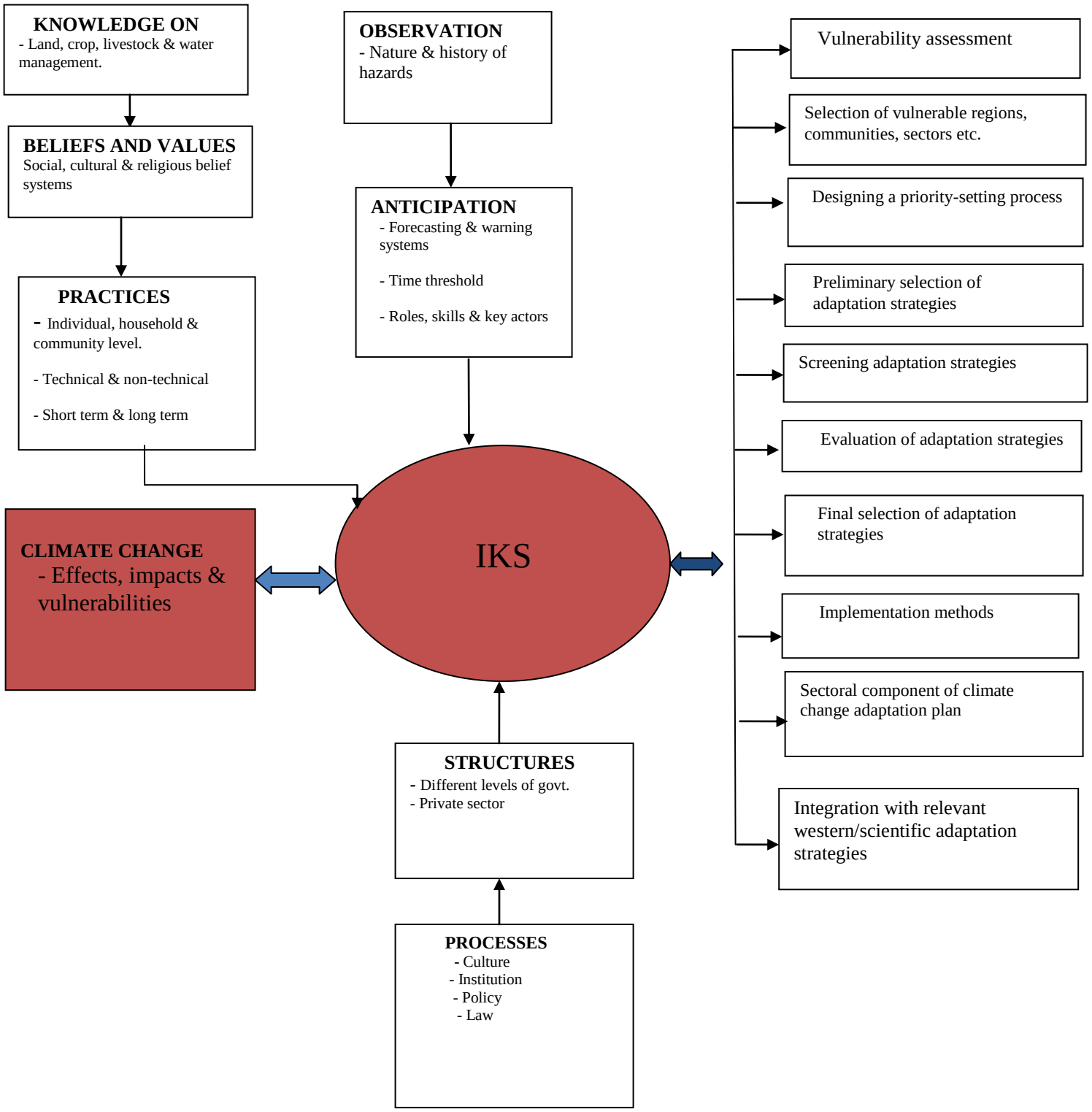


Fig 1.Framework for integrating IKS into climate change adaptation strategies in SSA

Challenges of integrating IKS

Knowledge either indigenous or scientific is influenced by power and human relationships including social, political, technical and economic elements. However, such factors as marginalization, exploitation, powerlessness, cultural imperialism, violence and denial of existing knowledge placed upon its bearers and the often hidden nature constitute challenges to the integration of IKS into formal projects (Law, 1994). Rist and Dahdouh-Guebas (2006) added that these factors contribute to the suppression of IKS in a society where the scientific culture is dominant. Again, the open access nature of IKS makes it difficult for persons/ people involved to patent its products, processes or genetic resources.

Conclusion and Recommendations

The overall goal of integrating IKS into climate change adaptation strategies is to promote sustainable development through the reduction of vulnerability and facilitating the inherent coping strategies of local people. It is however, important to note that while climate change is a global phenomenon its adaptation is largely location-specific. This means that an adaptation strategy applicable to a specific region may not be applicable to another. As location-specific issues require location-specific knowledge, there is the need to promote the use of IKS (bottom-up strategies) in climate change adaptation strategies since they are likely to be more successful than imposed (top-down) strategies. IKS has the advantages of being developed, experimented and improved upon, properly understood, cost-effective, resilient and adopted by the people in a particular region. Its use therefore will engender collaboration and participation among the local people.

As long as sub-Saharan African region is concerned optimal integration of IKS into climate change adaptation strategies will result in the development of more culturally appropriate, integrated and holistic adaptation options. This will however require the promotion of researches and formulation of sustainable policies on adaptation which will recognize the importance of IKS and fully integrate them.

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Climate Change: Threats to Human Health, Agriculture and Food Supply

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Abstract

The article examined threats of climate change to human health, agriculture and food supply. Climate change is inevitable and its impacts could be detrimental or beneficial to natural human systems and among the most frequently cited human systems likely to be affected by climate change is Agriculture. Resources continue to deplete for the majority of people that have their livelihood depended on nature. Climate change occurs due to increasing accumulations of green house gases that have caused the earth's surface temperature to rise perceptibly. Other causes include bush burning, improper waste management, construction activities, emissions from mechanical generators in water supplies, burning of fossil fuels among others. These have therefore affected human health directly because the changing weather patterns encourage the production of disease vectors and parasites like those causing malaria. Also to be affected are water availability, air quality, food quality and quantity, ecosystems among others and all these affect people's health. Also is the prevalence of diseases transmitted between humans and animals. Children are most vulnerable to climate change as food shortage causes malnutrition in them and make them vulnerable to other diseases. Then, among the threats of climate change to Agriculture include loss of Agricultural output, disruption of water supplies to cities and Agriculture, loss of species and forest areas, disruption of weather patterns and extreme of weather to crop plant and livestock, erosion which leads to loss of soil fertility, prevalence of pests and diseases etc. However, among those that could combat or mitigate climate change are; regular monitoring of air, water, land and vegetation, collection of scientific data on the weather elements, avoidance of gas flaring, integrated waste management and renewable energy options, sustainable forest management like forest regeneration, reducing emissions of greenhouse gases etc. Ultimately, it is noted that climate change arising from the greenhouse effect of heat trapping gases is a global problem and all nations are involved in both its causes and consequences. For this reason, if care is not taken in developing nations, emission will grow considerably in coming decades.

Introduction

Climate change is inevitable and its impacts can be detrimental or beneficial to natural human systems. Among the most frequently cited human systems likely to be affected by climate change is Agriculture. Agriculture is dependent on weather and climate and is especially vulnerable to climate variability and extreme climate events (Aina and Oyedele, 2006). Then climate change has continued to be a major global issue and it may not be off the front burner for a long time to come. The simple reason for this is that climate generally has an overall influence on all environmental elements including the domineering Homosapiens. It is therefore certain that climate change would continue to present a challenge to future livelihood strategies (Bohle *et al……,* 1994). Climate change can't be ignored in Nigeria, disaster looms because resources continue to deplete for the majority of people that have their livelihood depended on nature. Hence, climate change according to Adejuwon and Ogunkoya (2006) simply refers to a change of climate attributed directly or indirectly to human activity which alters the composition of the global atmosphere in addition to natural climate variability observed over comparable time periods. According to Harris (2002), global climate change refers to global warming. A basic warming effect will produce complex effect on climate patterns with warming in some areas, cooling in others and increased climatic variability. Also, increasing accumulations of green house gases have caused the Earth's surface temperature to rise perceptibly. Some warming may be a natural trend while human caused impact on the atmosphere has contributed substantially to the observed warming over the last 50 years. Temperature had reached levels unprecedented in the past thousand years. The steady rise in earth's average temperature has many significant effects on climate. For instance, one effect of climate change is likely to be a rise in sea level as polar ice caps and glacier melt. This will have serious effects on islands and low lying coastal areas. Rising sea levels may cause serious damages. The only way to stop this would be to prevent climate change itself. Meanwhile, attribution of climate change to natural forcing and human activities has been addressed by inter- governmental panel on climate change (IPCC) working Group 1 in climate change 2001 which is the most recent assessment of research on the topic of climate change. The working Group 1 Report concludes that globally averaged surface air temperature is projected to warm1.4 to 5.8^0C by the year 2100 relative to 1990 and globally averaged sea level is projected to rise 0.09 to 0.88m by the year 2100. The projections also indicate that the warming would vary by region and would be accompanied by increases and decreases in precipitation.

Global warming: is the increase in average global temperature as a result of emissions from human activities.

Green house gases: these are gases such as carbon dioxide and methane whose atmosphere concentrations influence global climate by trapping solar radiation

Green house effect: this is the effect of certain gases in the earth's atmosphere trapping solar radiation, resulting in an increase in global temperatures and other climatic changes.

Causes of climate change

Climate change occurs due to natural variability or as a result of human activities, and all nations are involved in both its causes and consequences. In Nigeria

especially, among the causes of climate change include poor agricultural practices characterizes by annual bush burning as a result of shifting cultivation, unplanned urban and infrastructural development, improper waste management as evidenced in the discharge of industrial effluents into open and natural water bodies as well as numerous open dumpsite which emit gases into the atmosphere in the process of waste decomposition, construction activities, emission from mechanical generators to power almost all factories and homes, wanton destruction of natural forests to produce cooking charcoal for domestic heating and cooking, continued and unguided deforestation, burning of fossil fuels like; coal, oil and natural gas, methane and nitrous oxide emissions from agriculture and industry, gas flaring by the oil producing industries, etc.

Health impact of climate change on man

Going by Joto-afrika (2010), much of the evidence of the health impacts of climate change has focused on malaria but the impacts are much wider than that. Most of the other impacts on man include high temperature which is projected to increase by 0.2 – 0.5^0C per decade, severe droughts, and adverse changes in the rainfall patterns of the country. For instance, in the southwest Nigeria, the onset of rainy season is being delayed till around May/June while in the northern part of the country rain started much earlier than expected thus catching the people unaware and leading to greater flooding. All these may affect human health directly because the changing weather patterns encourage the production of disease vectors and parasites such as those causing malaria. Also to be affected are water availability, air quality, food quality and quantity, ecosystems e.t.c and all these affect people's health.

Then, climate change may increase the prevalence of diseases transmitted between humans and animal. Children are most vulnerable to climate change as food shortage cause malnutrition in them and make them vulnerable to other diseases. The communities living in areas prone to flooding are often displaced forcing them to move to temporary accommodation without basic facilities which eventually make them more vulnerable to water-borne diseases. More so, rising temperatures can extend the habitats of the mosquitoes that carry the malaria parasite which results into malaria transmission. Also, floods and higher rainfall create new or larger mosquito breeding sites. Ultimately, there may be health damage and death from heat waves and spread of tropical diseases.

Threats of climate change to agriculture

Among the threats of climate change to agriculture include the following:

- Long – term climate variability which influences sowing dates, crop duration, management practices and crop yield (Fakorede, 1985; Lansigan *et al.,* 2000).

- Global warming is predicted to lead to thermal expansion of sea water, along with partial melting of land – based glaciers and sea – ice, resulting in a rise of sea level and such a rise could pose a threat to agriculture in low – lying coastal areas (IPCC 2001).

- Reduced agricultural output due to drought

- Disruption of water supplies to cities and agriculture. Water demand by and water supply to crop plants will be modified to the detriment of crop yield as global warming progresses.

- Land area loss, including beaches and wetlands, to sea – level rise.

- Loss of species and forest area.

- Disruption of weather patterns, with increased frequently of hurricanes and other extreme weather events.

- Positive feedback effects, such as increased carbon dioxide which speed up global warming.

- Erosion problem and loss of soil fertility

- Generally, pests and diseases vectors do better when the temperature is high under conditions of optimum water supply. Therefore global warming is likely to extend the range of distribution of certain pests and disease of crops polewards.

However, IPCC (2001) offers the view that the response of crop yields to climate change will vary widely depending on the species, cultivar, soil conditions and other location factors.

Combating/mitigating climate change

- Climate change sensitization programs like school environmental clubs, youth organizations and other sectors of the society.

- Regular monitoring of air, water, land and vegetation.

- Collection of scientific data on the weather elements could act as a disaster warning guide.

- Avoidance of gas flaring through the harnessing of the gas flared into further domestic use.

- Integrated waste management which comes from the recycling of the bio-degradable and non-biodegradable waste materials. For instance, agricultural wastes could be turned to organic fertilizers while metals could be crushed and recycled.

- Promotion of renewable energy options for industrial and domestic uses.

- Sustainable forest management practices like forestry regeneration, avoidance of indiscriminate deforestation can help mitigate climate change and assist forest – dependent communities to adapt to its impacts.

- Ecological control and integrated coastal zone management.

- Effective transportation system.

- Construction of dikes and seawalls to protect against rising sea levels and extreme weather events such as floods and hurricanes.

- Shifting cultivation patterns in agriculture to adapt to changed weather conditions in different areas.

- Reducing emissions of greenhouse gases, either by reducing the level of emissions – related economic activities or by shifting to more energy efficient technologies that allow the same level of economic activity at a lower level of carborndioxide emissions.

Conclusion

It is noted that climate change arising from the greenhouse effect of heat trapping gasses is a global problem. All nations are involved in both its causes and consequences. Current developed nations are the largest greenhouse gas emitters. If care is not taken in developing nations, emission will grow considerably in coming decades. Sincerely, climate change poses some threats which are yet to be accurately measured to agriculture and food supply. So also, it poses threats to human health in the society. To agriculture, major effect could be loss of agricultural output due to drought hence food security will no longer be guaranteed. To the man, there may be health damage and deaths form heat waves and spread of tropical diseases.

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Impact of Climate Change on Agricultural Practices in Taraba State, Nigeria: The Role of Agricultural Extension

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Abstract

The article examines how changes in climate affect agriculture and the role of extension workers/programmes in life long environmental education enhancement. The influence of climate change on agricultural activities/practices can't be underscored in the sense that its devastating effect is felt all over the world. From the study, 66% of the respondents sourced their agricultural information from radio, 30% through viewing on television and only 4% obtained their agricultural information from the GSM/internet/e-mail services.it is hope that service providers can be utilized in the future to send weather forecast signals through SMS from the extension personnel to farmers in order to improve ICTs utilization in the area. The study recommended that, there should be wide range of publicity to create awareness at all levels through national orientation, the use of ICTs, mass media, TV, radio and Newspapers. Also extension workers should be trained and provided with ICTs facilities for efficient coverage.

Keywords: *climate change, impact, agricultural extension, ICT, information, technology.*

Introduction

Various authors explained the meaning of the concept climate change in multifaceted ways and meanings. According to Ezeji (2011), climate is the average condition of an area or location over a specified period of time. If refers to the regular pattern of weather conditions of a particular area. The climate of any zone is determined by rainfall, temperature, light, wind, and humidity. Climate change therefore is a change in the statistical properties of the climate system when considered over a long period of time. Climate change is attributable to the natural climate cycle and human activities and has severely and adversely impacted on agricultural productivity in Africa (Nigeria). Available evidence shows that climate change is global likewise its impacts, but the greater adverse effects will be observed and felt mostly by developing countries like Nigeria due to their low level of management strategies (Amusa & Enete ,2012). They further opined that climate change is one of the most serious environmental threats facing mankind worldwide. It affects agriculture in many ways including its direct impact on food production and sufficiency. Climate change which is attributable to the natural climate cycle and human activities has adversely affected agricultural productivity in Africa.

Objectives of the Study

The general objective of this study was to make a survey on the level of the use of information and communication technology (ICTs) facilities by extension agents in combating climate change in Taraba State. The specific objectives were to:

(i) Identifies the causes of climate change through agricultural practices in Ardo Kola and Jalingo local government areas.

(ii) Access the impact of climate change on agriculture in Taraba State.

(iii) Identify the role of agricultural extension in managing climate change.

Research Methodology

The Study Area

The study was conducted in Ardo Kola and Jalingo local government areas of Taraba State with Jalingo being the state capital. The State is located on latitude 6^0 .30' and 9^0.36' North and Longitude 9^0.10' and $11^0$50' East. Tropical climate is prevalent in state. Dry season is from November to March and rainy season is from April to October. Average rainfall is 1.350mm. Temperature varies from place to place with an average of 350 depending on the season. Vegetation ranges from forest and tall grasses in the Southern parts and short grasses in Northern parts.

Sampling Procedure/Technique

The study was carried out principally in Ardo-Kola and Jalingo local Government among farmer's co-operatives. Five (5) farmers co-operatives were randomly selected which served as bases for the respondents. One thousand (1000) respondents, five hundred (500) each purposively selected in each of the two local government areas. The respondents were both crop producers and livestock readers.

Causes of Climate Change through Agricultural Practices in Nigeria

The use of natural resources in the developing countries contributes to some extent, to climate change despite the fact that developed countries through industrial activities contributed more than 95% to greenhouse emission which is the chief causes of global warming. In Nigeria it also contributes to climate change in the following ways:

Deforestation through fuel wood harvesting, lumbering, housing etc. which increase carbon dioxide in the atmosphere and increase in desert encroachment. Agricultural activities such as the use of fertilizers and pesticides which release nitrous oxides into the atmosphere. Land degradation due to soil erosion, over cultivation, overgrazing, bush, burning etc. Use of fossil fuels (Petroleum products).The rearing of ruminant animals which emit methane gas into the atmosphere (Adebayo 2010).Other causes include irrigation, mulching and the use of agro-chemicals.

Impacts of Climate Change on Agriculture in Nigeria

According to Adebayo (2010) global warming may lead to increase in food production in some places such as southern Canada which may benefit from more rainfall and longer growing season. In sub-Sahara Africa, less rain and higher temperature will shorten the growing season and reduce crop yields. The incidence of dry spell in July and August is increasing in Yola for the past two decades.

Likewise there has been persistence of late onset and early cessation of rain in northern Nigeria in the last three (3) decades (Sawa and Adebayo, 2010).

Ecosystems could also be affected by a change in temperature. It has been predicted that an increase in temperature would affect species composition. Scientists believe that up to two thirds of the world's forest would undergo major changes. Deserts would become hotter, and desertification would extend and become harder to reverse.

Natural disasters such as flood, hurricane, and heat waves are the fallout of global warming and they are claiming many lives in different parts of the world. Drought stricken areas of the world have doubled between 1970 and early 2005 (Adebayo 2011).

The impact of climate change on agriculture in Nigeria is an adverse one. Droughts, floods and storms affect agriculture in the north, middle belt and in the southern part of the country negatively. Changes in rainfall that is late arrival, early departure and low amount of rainfall results in poor harvest of crops which consequently affect the income of the people and the nation in general. Drought affects the volume of water in the rivers and lakes, used for irrigation and fishing activities. According to the Federal Government of Nigeria (FGN 2008) in past thirty years, over ninety percent (90%) of the Lake Chad water has been lost to drought. This has affected the farming and fishing activities on the lake (Sokiyo and Ochoyi, 2011).

In the southern part of Nigeria, the impact of climate change on Agriculture is seen on the effects of gully erosion on land use. A large portion of arable land is lost due to gully erosion in Enugu, Ebonyi and Kogi States. Sometimes, effects of the erosion are in form of leaching, where agricultural lands are devastated leaving the lands to be unproductive, resulting in poor harvest. It is on record that years of drought in Nigeria are years of invasion of locusts and pests on tender farm crops with the attendant hunger on the citizen. Floods destroy farm crops close to river banks resulting in poor harvests and the destruction of bridges, blocks road to markets and farms. Since 70 percent of Nigerians depend on agriculture, any decrease in agricultural production is dangerous not only on an individual but on other sectors of development (FGN, 2008).

In some places, floods/drought could become more frequent and more severe, local changes in temperature, precipitation and soil moisture could severely influence many things important to human life and all life around us, including natural ecosystems, agriculture and food supplies, human health, forestry, water resources, energy and transportation (Apagu, etal 2011).

The accumulation of greenhouse gases in the atmosphere is growing faster than predicted. It is clear that the impacts of ICTs on climate change need to be understood. It has a critical role to play, with other sectors, in designing and deploying the solutions needed to create a low-carbon society. The real opportunity is for ICT to enable efficiency and emission reductions across the economy in such areas as logistics, buildings, power grid and motor systems. Aside from emissions associated with agriculture and deforestation, the largest contribution to man-made greenhouse gas emission comes from power generation and the fuel used for transportation. ICT can help to improve energy efficiency in power transmission and distribution, in buildings and factories and in the delivery of goods.

Ayodele and Yunusa (2011) enumerated the impacts of climate changes on agricultural practices as follows:

(i) Reduction in crop yields due to unfavorable weather conditions like high temperature, decreased in water availability and emergence of new pests.

(ii) Reduction in livestock production due to low quantity of fodders, heat stress, increasing disease and disease-spreading pests.

(iii) The fish stocks at the coastal areas are gradually diminishing due to drying up of lakes/lagoons.

(iv) Displacement of farmers due to storm surge, flood, erosion and other hazards as a result of rise in sea level.

(v) Global warming causes an increase in rainfall in some areas, followed by increase of atmospheric humidity and high temperature which favour pathogens, crop pests, disease vectors and weeds.

(vi) Desertification is one of the world's most serious environmental problems. It is caused by a combination of natural (mainly climate change) and human factors such as over-grazing, over-farming, population pressure, unsustainable water use systems and deforestation.

(vii) Loss of biodiversity due to climate variability and climate change. According to the United Nations assessment, 20-30% of Earth's planet and animals face extinction if the world warms by between 1.5 and 2.5^{o}C (IPCC, 2007).

(viii) Extreme weather such as thunderstorms, heavy wind, floods and devastating farm lands can lead to crop failure.

(ix) It is estimated that by 2010, Nigeria and other West African countries would have agricultural losses of up to 4% GDP due to climate change. Parts of the country that experienced soil degradation and operate rain-fed agriculture could have decline in agricultural yield up to 50% between 2000 to 2020 due to increasing impact of climate change (IPCC, 2007).

(x) Direct impacts include health problems such as malaria, cholera, typhoid, fever cerebra-spinal meningitis (CMS) are aggravated due to extreme climate conditions such as flooding, poor drainage, heat and drought. All these in turn affect the effectiveness and productivity of Nigeria's labour force, particularly farmers (IPCC 2007).

Role of Agricultural Extension in Managing Climate Change

Ogunbameru, etal (2008) explain the concept of agricultural extension to be a service which assists farm people and adults, through educational procedures in improving farming methods and techniques, increasing production efficiency and income and bettering their results of living and lifting the social and educational standards of rural life. According to Van den Ben and Hawkins (1998) agricultural extension involves the conscious use of communication of information to help the farmers to form found opinion and make a good farm decision. They suggested however, that agricultural extension is not always concerned with decision making. It should create awareness of problems and clarify goals and means available to

them. Agricultural Advisory Services (AAS) as coined by (www.cta.int) are therefore crucial to improve output and processing opportunities. But for extension programme to have any real value, it needs to be demand-driven and involve local farmers in defining and providing advice and assistance to farmers including climate change education and information which impact on agricultural productivity/output.

Managing Climate Change: The Agricultural Extension Way

Some climate changes are sudden and require quick and immediate intervention to curtail the adverse impact of the climate variables; flooding, extreme changes in temperatures, strong winds, spread/outbreak of pests and diseases etc. These require fresh and immediate information to be communicated to beneficiaries/farmers through the educational programmes or extension education in little or no time. Extension services rollout in Information and Communication Technologies (ICTs) can be helpful in Nigeria in particular. Due to urgency of climate variables that impacted on agricultural output, the use of ICTs to combat the challenges of climate change becomes more imperative and necessary.

Ani (2007) expressed that, the used of ICTs in agricultural extension delivery programmes has always been stress. Experience has shown that most contact extension agents have used all sorts of traditional ICTs including radio, video and television presently, both the extension service and other service providers and their clients are experimenting with newer digital opportunities that can be effectively used to exchange, process, manage and communicate information. The digital camera with video capabilities is becoming very popular for the fact that a “picture” displayed by an extension agent at an agricultural extension programmes is worth a thousand words and will enable even those constrained by low level of education to communicate. In the same vein most international radio and state radio stations have scored high in acceptability, popularity and listenership because of their special interest and focus in broadcasting to local farmers in local languages. Access to radio is extensive compared to any other ICT with 4 in 10 persons living in rural area possessing radio (Oroyot, 2003 in Ani, 2007).

Baba (2011) in a study on mass media accessibility in Jalingo L.G.A of Taraba State revealed that the majority of the respondents relied on radio and television as their major sources of agricultural information. The use of Global System of Mobile (GSM) or email and Internet are still at the rudimentary and infancy stage in informing agricultural information, especially as it affects variability on weather elements. This is shown in the Table 1:

TABLE I: Mass Media Accessibility

Types of Mass Media	**Media Number of Respondents**	**Percentage**
Radio	660	66
Television	300	30
GSM/Internet/e-mail	040	04
Total	**1,000**	**100**

Source: Field survey, (2011)

This finding agrees with Bzugu (2008) who stated that radio is one of the fastest, simplest, most powerful, and in most cases the only effective way of communicating

with the majority of people living in the rural areas. From Table I 66% of the respondents sourced their agricultural information from radio, 30% through viewing on television and only 4% obtained their agricultural information from the GSM/ Internet/e-mail services. These they do through small massage service (SMS) and email to the extension agents, who in turn relay that to research institutes via the state headquarters of the agency for extension programme.

With the improvement on "service providers" in Nigeria, improvement can be made to send weather forecast through SMS to the farmers through their extension personnel. Farmers get the message as ICTs technology are proving popular with farmers in Jamaica. Innovative extension services are enabling them to prepare, for bad/good weather improve techniques and tap into new markets. They are also helping to give agriculture a whole new image (www.cta.int) Nigerian agricultural extension program can borrow a "leaf" to combat the impact of climate change/variables through the use of available ICTs.

Conclusion

Sudden and long term climate variables impact on agricultural productivity and output. These climatic factors are flooding, excessive temperatures, outbreak of diseases and pests, strong winds etc, impacted on agricultural practices and output. To manage effectively these climate challenges influencing production require the provision of information and communication to the farmers, who constituted about 70% of the rural population. The means to that therefore is to use revolution ailing technologies. Inform action and communication technologies (ICTs) to educate and inform the teeming farming population in Nigeria through internet, Short Message Service (SMS), electronic-mail (e-mail) using the Global System of Mobile (GSM) about the weather/climate variables impacting on agricultural production by means of agricultural extension delivery services.

Recommendations

In view of the impact of global Climate Change on agriculture, the following recommendations will help in combating the menace:

1. There should be a wide range of publicity to create public awareness at all levels. This should be through national orientation agencies, ICTs, mass Media, TV, radio and newspapers.

2. Adequate knowledge through proper education needs to be given to schools on coping with environmental hazards caused by climate change.

3. Practices such as indiscriminate bush burning, overgrazing, total tillage, deforestation etc. should be discouraged.

4. Extension workers should be trained and provided with ICTs facilities for efficient coverage if ICTs is to be used.

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Adaptive Measures to Climate Change Adopted by Farmers for Sustainable Maize Production in Giwa Local Government, Kaduna State

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Abstract

The study was carried out to ascertain adaptive measures used by maize farmers in Giwa Local Government to mitigate the effects of climate change. Farmers were interviewed using structured questionnaire. A total of 631 maize farmers with farm size not less than 5 hectares constituted the sample frame, of which 20% (126) were interviewed. Descriptive statistics and correlation procedures were used to analyse data. About 45% of the respondents were aged 36-45years; 40% of the respondents cultivated between 5-10 hectares of farmland while 22% of the respondents cultivated between 11-15 hectares of farmland, and 56% of the respondents claimed that their productivity had reduced over the years possibly due to climatic parameters variability. Increased disease and pest infestation, lateness of rainfall, rapid weed growth rate flooding and high wind speed were some of the constraints observed by farmers. Most of the farmers resorted to the use of selective herbicides, change in cropping pattern, and change in farm management practices (mixed cropping, drainage and irrigation systems) as adaptation to the constraints observed. Climate change parameters affected the yield of maize negatively. Most of the measures adopted by the farmers were not effective in combating effect of climate change on maize production in the study area. Research institutions should look into development of effective means of combating the effect of climate change on maize production. Farmers should be encouraged on tree plantation in their farms to combat the carnage caused by of high speed winds.

Keywords: Adaptive measures, maize production, climate change.

Introduction

Agriculture is the main stay of Nigeria economy. It involves small scale farmers scattered over wide expanse of land area, with small holding ranging from 0.5-3.0 hectares per farm land. It is characterized by rudimentary farm systems, low capitalization and low yield per hectare (Kolawale and Ojo, 2007). The roles of agriculture remain significant in the Nigerian economy despite the strategic importance of the oil sector.

Rising income of much of the developing countries and the consequent growth in meat and poultry consumption have resulted in a rapid increase in the demand for maize as livestock feeds (IFRI, 2000). Maize (*Zea mays*) is a major staple cereal crop of great importance in many countries of Sub-Saharan Africa (SSA). Maize has been in the diet of Nigerians for centuries. It is third most important cereal crop after sorghum and millet. Similarly, Porter (2006) stated that maize consumption was formerly considered a poor man's food, but

recent consumption patterns indicate maize as a major staple food in almost every household in Nigeria, especially by low and middle income groups. As a cash crop, it has been used to substitute for imported grains, flour, Kuskus, baby foods, confectionaries and livestock feeds. This trend is particularly evident in East and Southeast Asia, where maize requirements are projected to rise from 150 million tons in 1995 to 280million in 2020. IITA (2007) asserted that land area under maize has increased from 653,000 ha in 1984 to its present level of 5 million ha. Production has also increased from 1 million to 7 million tons during the same period. Average yield of 1.4-1.5 ton/ha being obtained is low compared to other places. Every attempt to boost its production will enhance food security, serve as import substitution and earn foreign exchange for the country through export to food deficit countries. Analyses of the increased production from 1984 have shown that the increase was due more to increase in land under cultivation rather than intensive cultivation. A number of factors could have been responsible for the low productivity. These include little or no use of improved seeds, herbicides and fertilisers, increased levels of biotic and abiotic constrains and above all climate change parameters. These parameters are associated to change in rainfall pattern leading to erratic and unreliable rainfall and in some cases resulting in drought. Furthermore, the little or no use of fertilizers and organic manure has resulted in soils becoming poorer with an opportunistic expansion in striga infestation problems (IITA, 2007).

The savannah zone (Guinea, Sudan and Sahel savannah) is located on the northern part of the Nigeria. This region is characterized by short wet season and long dry season, high annual temperature on the range of 28-32^{0}C, few scattered trees and grasses, gentle slope and large farm holdings. Maize, sorghum, millet, wheat, rice, cowpea, pepper, tomatoes, onion are the major crops grown (Sowunmi and Akintola, 2009). The limiting factor to sustainable crop production in this region is water. This is because of short wet season that often commences in June and ends in September. Climate change elongates scarcity of essentials, especially, cereals, root crops like yam, cassava, potatoes and others. Available evidence shows that climate change is global, likewise its impacts; but the most adverse effects will be felt mainly by developing countries, especially those in Africa, due to their low level of coping capabilities (Nwafor 2007; Jagtap 2007). Nigeria is one of these developing countries (Odjugo, 2010). It is based on this that adaptation to climate change is the adjustment in natural or human systems in response to actual or expected climatic stimuli of the effects, which moderates harm or exploits beneficial opportunities (IPCC, 2007).

Maize is the most important food crop in Nigeria but the ability to have its production on a large scale for both local consumption and export is becoming risky due to unpredictable climatic parameters. This study was therefore aimed at evaluating the adaptive measure to climate change by farmers of Giwa Local Government, Kaduna State for sustainable maize production.

Methodology

General Description of the Study Area

The study was conducted at Giwa Local Government Area (Giwa LGA) of Kaduna State, Nigeria. Kaduna State occupies almost the entire central portion of the Northern part of Nigeria. The study area is known to have a tropical Guinea Savannah vegetation with very short rainy season which is experienced between the months of May through October and long dry season which is experienced between the months of November through April.

The population of Giwa Local Government is 286,427 (NPC, 2006). Giwa LGA has about 11 wards that constitute the local government. Some of the crops grown in the area include millet, maize, sorghum, groundnut, cowpea, vegetables tomatoes, pepper and sugar cane. A total number of 631 farmers constituted the sample frame (Table 1). Twenty percent of recognized maize farmers in each ward were randomly interviewed using structured questionnaire. The total number of maize farmers interviewed added up to 126 (Table 1).

TABLE 1: Distribution of maize farmers in wards of Giwa Local Government

Wards	Major Maize farmers	20% of sample size required
Giwa Central	72	14
Gangara	69	14
Shika:	66	13
Yakawada:	75	15
Panhauya:	25	5
Danmahawayi:	51	10
Kadagi	76	15
Galadimawa	60	12
Kakangi	45	9
Kudadan	24	5
Idasu	68	14
TOTAL	631	126

Measurement of variables

Where y_1 is the dependent variables which are the adaptive measures in offsetting the effect of climate change parameters on maize production. The dependent variables were defined as 1 for irrigation, 2 for drainage system, 3 for use of selective herbicides, 4 for change in cropping pattern, 5 for pest/disease management. This is to ascertain the level of adaptive measures to mitigate effects of climate parameters or not as at the time of the study. The independent variables are the socio-economic characteristics of maize farmers. Such as:
x_1=gender
X_2=educational status
X_3=occupation
X_4=farming experience
X_5=source of credit

Results and Discussion

Socio-economic characteristics of respondents

Table 2 shows the socio-economic characteristics of maize farmers in Giwa Local Government of Kaduna State. About 70% of the respondents were between the ages of 26-45years. This is an advantage for increased utilization of adaptive measures by these virile individuals who still have the strength and zeal to participate in farming for food sustenance. Most of the respondents (87%) were males. The result shows that 30% of the respondents had no formal education;

however 42% of the them were literates in their differentials while 29% had Quranic education. Obinne (1991) stated that low level of education among the respondents would likely make them more irresponsive to many agricultural policies.

Majority of the respondents (73%) were basically farmers (primary occupation) while 27% engaged in farming as secondary occupation in support of their major profession as civil servants, traders and artisans. About 90% of the respondents had been in farming for more than 10 years. Long farming experience is an advantage for increase in farm productivity since it encourages rapid application of acquired accumulated knowledge to better ways of coping with climate challenges. Majority (98%) of the respondents financed their farming enterprise through their personal savings. The results further stated that 8% also obtained loan from banks. It can be deduced that respondents generate their income for purchase of farm input, leasing of land and labour from their personal savings which comes from storage of their produce.

Observable climate parameters militating against maize production

Table 3 shows the observable climate parameters militating against maize production in Giwa Local Government Area of Kaduna State. About 80% of the respondents stated that rain that were accompanied by high speed wind affected the productivity of their cultivated maize. The table further shows that maize production of 53% of the respondents was disturbed by early stoppage of rainfall. This was reported to have made the maize premature and contributes to a low yield. About 50% of the respondents narrated that pest/disease infestation influenced their maize production. About 40% of the respondents' maize production were influenced by early rainfall, 30% of the respondents also stated that their maize production were negatively influenced by flood while 17% and 20% asserted that their maize production was influenced by high temperature and late rainfall. The observable effect of climate change in this study on maize production was in agreement with the report of Agboola and Ojeleye (2007) who stated that decline in crop yield and food crop production may be due to reduction in rainfall and relative humidity, and increase in temperature. Molua and Lambi (2006) also stated that adverse climate effects can influence farming outputs at any stage from cultivation through to the final harvest.

Impacts of climate change on maize productivity

Table 4 revealed that 56% of the respondents had decreased yield from 2007-2011. About 37% of maize crops had stunted growth for the same period. About 44% of the respondents narrated their ordeal that intensive rainfall washed away some crops at every fertilizer application. This agrees with the findings of Moula (2008) who reported that performance of agricultural yield depends largely on the non-destructive rainfall and the timely and adequate provision and application of agricultural inputs.

Adaptive measures adopted to mitigate the effects of climatic change on maize production

Table 5 shows the adaptive measures adopted by respondents to mitigate the effects of climate change on maize production. These mitigating factors included the use of selective herbicides (83%) to combat rapid weed growth as a result of intensive rainfall, use of pest/disease management to cope with infestations (50%) and change in cropping pattern (40%). About 30% and 6% of the respondents further stated that they adopted drainage and irrigation systems, respectively to mitigate the effect of climate change on maize production.

TABLE 2: Socio-economic characteristics of respondents

Variables	Frequency	Percentage	Mean
Age (Years)			
15-25	6	5	38.97
26-35	35	28	
36-45	57	45	
45 and above	28	22	
Gender			
Male	110	87	
Female	16	13	
Education status			
No formal education	38	30	
Primary school	16	13	
Secondary school	28	16	
Tertiary school	16	13	
Qur'anic school	36	29	
Farming experience (years)			
1-5	2	2	16.66
6-10	14	11	
11-15	35	28	
16-20	36	29	
21 and above	36	29	
Sources of credit			
Banks	22	8	
Contributions	5	4	
Friends/relatives	38	30	
Personal savings	124	98	

TABLE 3: Observable climate parameters militating against maize production

Climate parameters	Frequency	Percentages
Inconsistent rainfall	32	25
Intensive rainfall	94	75
Flooding	38	30
High temperature	21	17
Rain with high speed wind	99	79
Increased pest/disease infestation	61	48
Late arrival of rainfall	25	20
Early arrival of rainfall	51	41
Early and sudden stoppage of rainfall	73	53

TABLE 4: General effect of climate change on maize yield

Effect	Frequency	Percentages
Decreased maize yield	70	56
Stunted growth	47	37
Reduced effect of fertilizer/organic manure used	56	44
Increased flooding	67	53

Table 5: Adaptive measures adopted to mitigate effects of climate change

Adaptive methods	Frequency	Percentages
Irrigation	8	6
Driange system	34	27
Use of selective herbicides	105	83
Change in cropping pattern	50	40
Pest/disease management	65	52

Conclusion and recommendation

The maize farmers of Giwa Local Government had experienced some setbacks in maize production. Most of the measures adopted by the farmers were not effective in combating effect of climate change on maize production in the study area. Government agencies (research institutions and Federal Ministry of Agriculture) that are responsible for development of innovations in agricultural activities should look into development of effective means of combating the effect of climate change on maize production. This paper also recommends improved tree plantation by farmers within their farms to combat the carnage of high speed winds.

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Mitigating the Impacts of Climate Change through Checkmating the Existence of Hazardous Waste in Ibadan, Nigeria

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Abstract

This paper aims to promote the mitigation of climate change impacts through efficient and affordable hazardous waste management technologies in Ibadan, Nigeria. It provides information on the locations, types and sources of hazardous wastes generated in the area and use of the information to choose appropriate technologies that will be used in achieving environmentally sound management of the domestic, agricultural or industrial wastes. It is recommended that waste reduction, reuse, recycling and composting technologies be encouraged. Government at all levels should work in collaboration with the NGOs, community-based organizations, women, youth and public interest group programmes, and with local municipal authorities to mobilize community support for waste reuse and recycling using focused community-level campaigns. Also, these technologies should be publicized through workshops, local meetings, and mass media for the benefit of the specific community and the country as a whole.

Keywords: hazardous waste, climate change, waste reduction, re-use and recycling.

Introduction

Waste is generated universally and is a direct consequence of human activities. Waste is defined as any unwanted materials intentionally thrown away for disposal. However, certain wastes may eventually become resources valuable to others, once they are removed from the stream of waste. Solid waste streams should be characterized by their sources, type of waste produced, as well as generation rate and composition (Gumbo, 1996; Famuyigbo, 1998).

Several classifications of wastes have been proposed. Waste can be classified in terms of state; solid, liquid, or gaseous states. There are eight major classifications of solid waste generation based on the origin and risk to human and environmental health. They are; residential, industrial, commercial, institutional, constructional and demolition, municipal services, process and agriculture (Hoornweg, 1999). According to Oyedele (2009), solid wastes can be classified in terms of their degradation into biodegradable and non-biodegradable wastes; or into types as agricultural wastes, auto wastes, construction, demolition works, municipal solid wastes generated in streets, parks, beaches and households, mineral activities, radioactive wastes, e-wastes (from electrical materials and electronics) and sewage residue. Solid wastes can also be grouped as organic and inorganic wastes. In the rural areas, agricultural wastes formed over 80 per cent of their wastes hence management of wastes are usually not a problem.

Vitus (2010) maintains that Nigeria generates high amount of waste daily, adding that most of the urban cities in Nigeria such as Lagos, Ibadan, Kano, Kaduna, and Aba among others generate 50,000 metric tons of waste daily. This can be attributed to the fact established by Hoornweg (1999) that generally the greater the economic prosperity and the higher percentage of urban population, the greater the amount of solid waste generated. Gaseous waste is normally vented to the atmosphere, either with or without treatment depending on composition and the specific regulations of the country involved. Liquid wastes are commonly discharged into sewers or rivers, which in many countries is subject to legislation governing treatment before discharge (Waqar, 2009).

Onibokun and Kumuyi (1999) observe that because of lack of institutionalized waste-disposal facilities or the inability or unwillingness of people to use them, people employ a variety of other methods to dispose of their waste, with severe repercussions on the environment. The illegal dumping of refuse in open spaces, along the roads or open drainages blocks drains and sewer holes, disrupts business in commercial areas, reduces road space, and constitutes traffic congestion. In addition, as solid-waste services are unable to cope with the volume of refuse, it is usually burned in households, zones, depots, and disposal sites, which causes air and general environmental pollution (Gumbo, 1996; Famuyigbo, 1998).

Waste management, climate change and agriculture are interrelated processes that take place on a global scale. There is need to understand what the potential climate change impacts may be on waste management in order to begin the process of identifying what changes may be needed in waste management operations, regulations, strategy, planning and policy. In an effort to establish the relationship between climate change and agriculture, McCarthy (2001) concluded that climate change is a serious international environmental concern that needs researching on. He further stated that in international scientific circles, a consensus is growing that the buildup of carbon dioxide ($C0_2$) and other green house gases (GHGs) in the atmosphere would lead to major environmental changes such as (1) rising sea levels that may flood coastal and river delta communities; (2) shrinking mountain glaciers and reduced snow cover that may diminish fresh water resources; (3) the spread of infectious diseases and increased heat-related mortality; (4) possible loss in biological diversity and other impacts on ecosystems; and (5) agricultural shifts such as impacts on crop yields and productivity.

Global warming is projected to have significant impacts on conditions affecting agriculture, including temperature, precipitation and glacial run-off. Rising carbon dioxide levels would have effects, both detrimental and beneficial, on crop yields. The overall effect of climate change on agriculture will depend on the balance of these effects. Assessment of the effects of global climate changes on agriculture might help to properly anticipate and adapt farming to maximize agricultural production (Wikipedia, 2012).

One of the major problems impeding achieving environmentally sound management of hazardous waste (domestic, agricultural or industrial) is that there are no efficient and affordable technologies that can be adhered to. The technologies like rotary kiln, chemical disinfection etc, are efficient but they have not yielded the needed result. The reason is that they are not affordable. The affordable ones like brick or

drum incinerator, waste burning and others result to massive emission of black smoke and repulsive odours that eventually have negative effects on the climate. It is therefore necessary to have knowledge about sources of waste generated, method of disposal, locations and type in an area in order to design and operate appropriate solid waste management systems. This paper aims at promoting efficient and affordable technologies to manage the existence of hazardous waste in Ibadan, Nigeria. It further gives the suggestions on ways to prevent the effects of climate change and handle the problems of waste management efficiently at the lowest possible cost.

Objectives

The objectives of the paper are to:

(i) review the method of disposing waste in Ibadan metropolis.

(ii) recommend the appropriate technologies for waste disposal within the city.

Methodology

Secondary method of data collection was utilized for the study to get information on the locations, types, method and sources of wastes generate in Ibadan metropolis.

Findings

The result of the findings based on the published data used, reveals that there is no proper management of wastes in Ibadan City (See Table 1). Ibekwe et al (2010) revealed that food remnants, plastics and metals constitute the largest proportion of solid waste generated in the study area. Burning of refuse when dry and disposing the ashes in drainage channels or open spaces is the method of disposing refuse in the city. This is in line with NISER (1988) study which reveals that burning refuse and disposing of the ashes in drainage channels were the method for disposal of refuse used by 26.8% of surveyed inhabitants of Ibadan.

Some parks and markets in the city seize the opportunity of the State monthly environmental sanitation to clean up the environment, but this is not enough to sanitize those areas properly. Iwo Road Motor Park is being cleaned up twice in a day which is a commendable effort, provided that it is sustained for a long period of time.

TABLE 1: Environmental Conditions of three (3) Motor Parks in Ibadan Metropolis

Features	Akinyele Motor Park	Iwo Road Motor Park	New Garage Motor Park
Nature of waste generated	Packaging: including plastic and nylon sachets, wrappers, food scrap from fruits and leftovers, rags, phone recharge cards, metal scrap, cans.	Packaging: including plastic and nylon sachets, wrappers, food remnants and metal scrap.	Packaging: including plastic and nylon sachets, wrappers, food scrap from fruits and leftovers, phone recharge cards and metal scrap.
Cleaning frequency	2 times/week	2 times every day – at 7 am before start of the work and 6 pm at the close of the day.	Once in a month (last Saturday from 6am-9am) and occasionally on Thursdays.
Method of waste disposal	Open refuse dump behind the park; partly thrown into a nearby stream; when dry, the refuse is burnt openly.	All the refuse is put in bags and stored at the temporary dump site; each bag is contracted out to a private sector agent at a cost of N30. The LGA finally disposes off at their designated dumpsite on a regular basis; the system works well.	Open dumping in one corner of the market and burning; there are 'pay and use' toilets for faecal and urine disposal.
Environmental upkeep	Ground littered with refuse; human faeces and urine also found.	The environment is relatively better; the rear side of public toilet is being used for dumping refuse;	Relatively good; private managers take care of 'pay and use' toilets.
Activities	Trading, food vending, minor repairs of vehicles, kiosks, vulcanizing, mechanic workshops, barbing saloons.	Trading, food vending, minor repairs of vehicles, kiosks, vulcanizing, mechanic workshops, barbing saloons.	Trading, food vending, minor repairs of vehicles, kiosks, vulcanizing, mechanic workshops; barbing saloons, an adjoining market which also contributes to the waste in the motor park.

Responsibility of cleaning	Individual workers, operators and owners of kiosks.	All Union workers, operators and owners of kiosks; penalties apply for non-compliance.	Drivers, Motor Mechanics, Food vendors and hawkers including passengers within the vicinity are all expected to participate.

Source: Ibekwe et al, 2010.
Note: LGA, local government authority; GRA, government-reserved area.

With the result above, it is cleared that there is indiscriminate dumping of refuse around Ibadan City. This may have great impact on the climate. Therefore, urgent measures need to be put in place to address this ugly situation.

Measures for Mitigation of Climate Change Effects

Measures which are useful for mitigation of climatic change effect should align with waste prevention and management hierarchy, from most favoured option to the least favoured one, as indicated in Figure 1. The primary goal of waste minimization plan is to eliminate or reduce the generation of waste at the source which is also supported by Dow Jones (2008). Once source reduction options have been considered, reuse, recycling and disposal should be taken as secondary waste minimization techniques in that order.

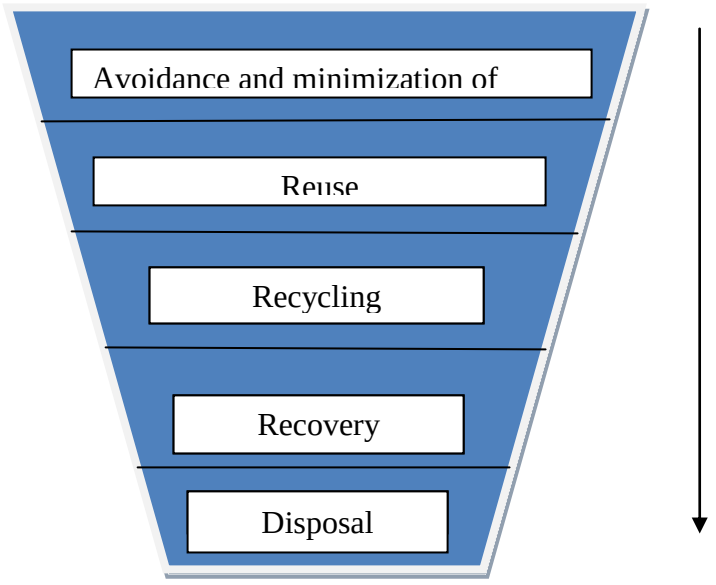


Figure 1: Waste Management Hierarchy

Waste minimization

Dow Jones (2008) defined waste minimization as the reduction, to extent feasible, of hazardous waste that is generated or subsequently treated, stored, or disposed of. The main objective in implementing waste minimization plan is to discover viable ways to eliminate or reduce the generation of waste at the beginning of a process. According to Environmental Health & Safety (2010) the most desirable method of waste minimization is source reduction.

Source reduction: This is any activity that reduces or eliminates the generation of hazardous waste at the source. It involves changing a process and using good operating practices to minimize the generation of wastes from their sources. CalRecycle (2011) highlighted processes that should be followed to see if source reduction option exists for a waste stream as:

- Change in raw materials, material handling and inventory practices;
- Operational Improvement -- improved plant management and practices that reduce, avoid or eliminate the generation of waste;
- Production Process Change -- change in a process, method or technique that reduces, avoids or eliminates the generation of waste;
- Product Reformation -- changes in design, composition or specifications of products to reduce, avoid or eliminate the generation of waste;
- Waste Segregation;
- Administrative steps to reduce waste generation including but not limited to:
    - A team of employees who work in the areas that generate the waste are given the opportunity to put their knowledge towards source reduction.
    - Employee Training.
    - Corporate and Management Commitment.

This is the best way of reducing the generation of waste and EPA (2012) also encourages practices that reduce the amount of waste needing to be disposed of, such as waste prevention. Waste prevention, is designing products to reduce the amount of waste that will later need to be thrown away and also to make the resulting waste less toxic. Waste minimization options that appear most practical must undergo a technical and economic evaluation. Each option should be evaluated using the following criteria:

- Regulatory compliance
- Workplace safety
- Liability Issues
- Reduction potential
- Implementation difficulty
- Cycle time
- Cost of implementation

Those options that involve operational, procedural or material changes not requiring equipment installation are implemented as soon as production and material scheduling permit without an extensive feasibility study. Options involving equipment modifications or the purchase of new equipment require additional planning design, funds allocation and construction similar to other capital improvement projects. Options that require capital expense but whose benefits could be substantial must go through a comprehensive cost analysis. When performing a cost analysis of a source reduction or waste minimization option, the difference between estimated operating costs of the proposed source reduction or waste minimization option and the current cost of the existing system must be considered. EPA concluded that the following are possible costs and savings that are considered in this analysis:

- Environmental permitting because the initial permitting costs can be a significant contributor to the capital cost of implementing an option. Options that do not require environmental permitting can have a significant cost benefit over other options that do;
- Employee training;
- Fees for off-site treatment, storage, transportation and disposal;
- On-site treatment, storage and handling costs;
- Reporting and record keeping costs for the previous two items;
- Employee health and safety, including protective equipment.

Each implemented source reduction and waste minimization option should be monitored in order to ascertain its effectiveness. The performance evaluation should be measured against reduction in waste management costs and raw materials, as well as responses to other less quantifiable benefits, such as corporate image, environmental liability and employee morale.

Waste minimization or reduction is also the first thing that CalRecycle (2011) considered in its waste management hierarchy. Waste reduce, reuse and recycle--actually express the order of importance of these ideas:

- Reduce needless consumption and the generation of waste.
- Reuse any item that can be reused or give it to a person or charity that can reuse it.
- Recycle whatever discards remain if you can and only dispose what you must.

Waste Reuse and Recycling

The terms reuse and recycle have specific meanings, but they are often confused, switched, and misused.

Waste reuse is the use of a material for different purpose and usually as an alternative to throwing it out while waste recycling is the practice of recovering used materials from the waste stream and then incorporating those same materials into the manufacturing process (CalRecycle, 2011).

Recycling consists of processing used or abandoned materials for use in creating new products (Waqar, 2012) or returning a waste material to another process as a raw material (CalRecycle 2011). It involves the recovery of useful materials, such as paper, glass, plastic, and metals, from the trash to make new products, reducing the amount of new raw materials needed. The concept of "cycle" in the term "recycle" should be noted. For there to be a complete cycle, the things you send to be recycled must come back to you. HubPages (2012) made it known that recycling also includes composting.

Composting involves collecting organic waste, such as food scraps and yard trimmings, and storing it under conditions designed to help it break down naturally. This resulting compost can then be used as a natural fertilizer. It is an organic matter that has been decomposed and recycled as a fertilizer and soil amendment. Compost can be rich in nutrients (See Figure 2). It is used in gardens, landscaping,

horticulture, and agriculture. The compost itself is beneficial for the land in many ways, including as a soil conditioner, a fertilizer, addition of vital humus or humic acids, and as a natural pesticide for soil. In ecosystems, compost is useful for erosion control, land and stream reclamation, wetland construction, and as landfill cover (Wikipedia, 2012).



Figure 2: Showing compost prepared through organic waste materials

Recycling method was created to address issues of acid rain and green house gases effects created from incineration or landfill technologies forms of waste management. Recycling has a positive impact on the environment and also helps to reduce the amount of waste needed for disposal by making a portion of it available for reuse (Waqar 2012).

EPA (2012) maintains that many industrial hazardous wastes can be recycled safely and effectively. Hazardous waste is recycled if it is used, reused, or reclaimed. Furthermore hazardous waste regulation makes an important distinction between materials that are used or reused without reclamation and those that must be reclaimed before reuse. Tetra Pac (2009) concluded that recycling depends on consumer action, private sector/industry capability and governments enabling recycling. Only a concerted effort will deliver sustainable and timely results.

The recycling process includes three steps: collecting and processing, manufacturing, and buying recycled products. Collecting recyclables varies from community to community, but there are four primary methods: curbside, drop-off centers, buy-back centers, and deposit/refund programs. The key to recycling is the individual. Recycling is a choice. Once cleaned and separated, the recyclables are ready to undergo the second part of the recycling loop. More of today's products are being manufactured with total or partial recycled content. Common household items that contain recycled materials include newspapers and paper towels, aluminum, plastic, and glass soft drink containers, steel cans, and plastic laundry detergent bottles. Recycled materials also are used in innovative applications such as recovered glass in roadway asphalt (glassphalt) or recovered plastic in carpeting, park benches, and pedestrian bridges.

Recovery

This is energy recovery from waste. It is the conversions of non-recyclable waste materials into useable heat, electricity, or fuel as some States across the Country have embarked on the project.

Disposal

This is the least preferred system in waste management and it involves disposing wastes that cannot be furthered process.

Conclusions

Waste should not be completely regarded as waste; instead it should be seen as a way of creating wealth. It is therefore imperative that high level communication process be mounted by the Oyo State government and local government areas where the affected motor parks are located to expedite the inculcation of more environmental friendly behavior by the motor park users including travelers. This step should be the prerequisite to a solid process for the adoption of modern waste management.

People are ready to pay for waste services if they are efficient and affordable, and good mechanism is put in place.

Minimization of waste is a pre-requisite for the effective reuse and recycling of waste. Recycling of solid wastes is although labour intensive, yet it needs to be actively promoted. Waste that is properly managed will ensure clean and safe environment.

Recommendations

Government agencies at all levels should educate society as well as enforcing laws to govern the disposal of waste so that the negative effects that the current wastes management have on the environment is reduced. Also, local municipal authorities in collaboration with NGOs, community-based organizations, women, youth and public interest groups, should mobilize community support for waste minimization, reuse and recycling.

Improved efficient local technologies should be made available by the production engineering in both public and private sectors. Those technologies should be easily turned waste into fertilizer, biogas production and other useful materials from worthless value.

These technologies should be publicized through workshops, local meetings, and mass media for the benefit of the specific community and the country as a whole.

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Review of Socio-Economic Impact of Climate Change on Agriculture and Adaptation Strategies in the Africa Sub-Region

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Abstract
Climate change is the permanent departure of climatic patterns from mean values of observed climate indices over a long period of time. African countries are particularly susceptible to climate change due to the desertification process, declining run-off from water catchments, declining soil fertility, dependency on subsistence agriculture, the prevalence of Acquired Immune Deficiency Syndrome (AIDS) and vector-borne diseases, inadequate government mechanisms and rapid population growth. Observable effects of climate change include flooding, drought, change in frequency and distribution of rainfall, drying-up of rivers, melting of glaciers, receding of water bodies, landslides and cyclones. These impacts will continue to be felt unless adaptation strategies including diversification of livelihood activities, institutional architecture, adjustment in farming operations, income generation projects, sale of labour and non-farm livelihood incomes are employed and sustained to mitigate its adverse consequences.

Key words: Climate change, agriculture, adaptation strategies

Introduction

Climate change has been defined as a long-term change in the statistical distribution of weather patterns over periods of time that range from decades to millions of years. It may be a change in the average weather conditions or a change in the distribution of weather events with respect to an average such as greater or fewer extreme weather events. Climate change may be limited to a specific region, or may occur across the whole earth (Adejuwon, 2004). It also refers to the variation in the global or regional climates over time and describes changes in the variability or average state of the atmosphere over time scales ranging from a decade to millions of years (Adejuwon, 2004).

It has also been defined by Intergovernmental Panel on Climate Change (IPCC) (2007) as a change in the state of the climate identifiable by changes in the mean and or the variability of its properties and that persists for an extended period typically decades or longer. Okali (2004) defines climate change as the average weather together with the variability from the average; it is the synthesis of the weather in a given place over a period of at least 30 years. He listed the main elements of weather to include temperature, rainfall, dew, humidity, wind, sunshine, mist, haze and cloud. It is the permanent departure of climatic patterns from mean values of observed climate indices (Obioh, 2002).

The recent increase in atmospheric temperature, change in rainfall pattern, rise in sea level, violent storms and flooding are all evidences of global change in climate system. Studies by Adger *et al., (*2007); Haile (2005) and Huq *et al., (*2004) have indicated strong impacts of climate change on the African continent, particularly in the drier regions. The likely impacts would pose more challenges on ecosystem services, agricultural production and livelihoods (Obadiah, 2010). These African regions were characterized by limited resilience, high vulnerability, economic poverty, food production at a subsistence level and a low and highly variable natural production potential (Eboh, 2009).

African countries are particularly susceptible to climate change due to the desertification process, declining run-off from water catchments, declining soil fertility, dependency on subsistence agriculture, the prevalence of Acquired Immune Deficiency Syndrome (AIDS) and vector-borne diseases, inadequate government mechanisms and rapid population growth (Anyadike, 2009). Countries in sub-Saharan Africa are likely to suffer the most devastating impacts of climate change because of their geographical location, low incomes, low technological and institutional capacity to adapt to rapid changes in the environment, as well as their greater reliance on climate-sensitive renewable natural resource sectors such as water and agriculture (Eboh, 2009).

Climate change has been increasingly recognized as one among many processes that influence vulnerability (O'Brien and Leichenko, 2000). Liverman (1994) emphasized that the most vulnerable people may not be in the most vulnerable places – poor people can live in productive biophysical environments and be vulnerable, and wealthy people can live in fragile physical environments and live relatively well.

There are different causes of climate change including certain astronomical variables such as precision of the *equinoxes* or *solstices* and the eccentricity of the orbit; anthropogenic (human-induced) variables such as burning of fossil fuels which produce carbon emissions. The major cause of climate change therefore, is the increasing concentration of carbon IV oxide (CO_2) and other greenhouse gases in the atmosphere introduced primarily through human activities (IPCC, 2007). The carbon so produced combines with methane produced by ruminant animals, insects and rice paddies during anaerobic fermentation and nitrous oxide from the intensive use of agrochemicals to produce a greenhouse effect over the surface of earth there by steadily increasing the global temperatures (Obadiah, 2010).

Climate change can be considered a spatially differentiated process. Although many areas could experience temperature increases on the order of 1.5-4.5^{0}C, some areas may actually cool under 'global warming' conditions (Houghton *et al*., 1996). Patterns and amounts of precipitation are also likely to change, and it is projected that rainfall will increase in some areas and decrease in others (Houghton *et al.*, 1996).

Available evidences show that climate change will be global, likewise its impacts, but the biting effects will be felt more by the developing countries, especially those in Africa due to their low level of coping capabilities. It was on this premise that this study took an overview of relevant literature on climate change with particular reference to its socioeconomic effects on the landscape in the sub-region and the adaptation strategies to mitigate the adverse consequences.

Methodology

This work is essentially an attempt to review literature on the socio-economic effects of climate change and adaptation strategies. The data and literature utilized are solely from secondary sources which include journal articles, textbooks, the United Nation's publications, the internet, e.t.c.

Socio-economic Effects of Climate Change

The main drivers of agricultural responses to climate change are biophysical effects and socioeconomic factors. Crop production is affected biophysically by meteorological variables, including rising temperatures, changing precipitation regimes and increased atmospheric carbon dioxide levels. Biophysical effects of climate change on agricultural production will be positive in some agricultural systems and regions and negative in others and these effects will vary through time. Socioeconomic factors influence responses to changes in crop productivity, with price changes and shifts in comparative advantage (Parry *et al.,* 2003).
Numerous country studies have been conducted to identify how climate change might play out in particular regions or sectors within the context of existing environmental and socioeconomic conditions (Smith *et al.,* 1998; O'Brien and Leichenko, 2000). The objective of these impact assessments according to O'Brien and Leichenko (2000) is to measure the positive and negative consequences of short or long term climate change and to evaluate different adaptation strategies that could be taken in response to the impact. Obadiah (2010) shared a similar view that many integrated assessments of climate change seek to determine whether the net impact of climate change is positive or negative for a given sector such as energy, agriculture or forestry. Within the assessment framework lies the goal of identifying climate sensitivities and vulnerabilities with an emphasis on regions, sectors, ecosystems and social groups within each country that are likely to be most affected by climate change (Parry and Carter, 1998).

Observable and potential effects of climate change in Africa include flooding, drought, change in the frequency and distribution of rainfall, drying-up of rivers, melting of glaciers, receding of water bodies, landslides, and cyclones among others (Urama and Ozor, 2010).

Flood is the most prevalent disaster in North Africa, the second most common in East, South and Central Africa, and the third most common in West Africa (AWDR) (2006). About 14 countries, namely, Burkina Faso, Chad, Ethiopia, Ghana, Kenya, Liberia, Mali, Niger, Nigeria, Senegal, Sudan, Togo, Uganda, and Rwanda, are the worst hit by flood in the African continent. Scores of people have died and hundreds of thousands have been displaced by the floods that have submerged much of the continent's most productive farmland, hence necessitating urgent food, shelter and medicare. In the same vein, episodes of flood accounted for 26 per cent of total disaster occurrences in Africa during 1971-2001 (Vordzorgbe, 2003) with devastating effects. Table 1 shows recorded flood incidents in West and Central Africa within the past decade displaying the number of affected population, families and deaths.

Droughts on the other hand have both direct and indirect consequences for human livelihoods (Pavel, 2003). A direct consequence is crop loss, which can cause

starvation if alternative food sources are not available. Indirectly, water shortages contribute to the spread of disease, because, people lack water for basic hygiene (Urama and Ozor, 2010). Hydro-meteorological disasters such as floods and droughts have major effects on food supplies, health, economic and environmental losses, and social upheaval (Pavel, 2003).

TABLE 1: Flood impact profile in some countries in West and Central Africa in 2010

Country	Number of affected population	Number of families	Number of deaths
Burkina Faso	105,481	13,193	16
The Gambia	3,506	447	8
Ghana	33,602	1,416	36
Guinea Bissau	56,792	7,099	2
Liberia	15,486	1,344	7
Niger	198,742	29,252	3
Sierra Leone	234	39	19
Cameroon	3	560	13
CentralAfrica Republic	1,585	1,235	3
Sudan	10,000	3,775	50
Chad	9,091	1,800	25

Source: United Nations Office for the Coordination of Humanitarian Affairs (OCHA) (2010)

Thus, climate change impacts are complex, they can be both direct and indirect, and they can be a serious threat to achieving poverty reduction and sustainable development (Urama and Ozor, 2010). According to German Advisory Council on Global Change, (WBGU) (2008), climate change can affect many important sectors of the economy by influencing the supply of and demand for goods and services. Empirical evidence shows that there will be changes in the supply and demand of food commodities as a result of low yields resulting mainly from drought and flooding events. The changes will also affect the profitability of farming and the affordability of food.

The effects of climate change are certain to displace some populations, with a significant increase in the number of environmental migrants over the coming decades. For example, between 1970 and 2004 about 14 per cent and 22 per cent of the populations in East and West Africa, respectively, were affected by the multiple effects of drought, extreme temperature, floods, slides, wave/surges, and wind storms (Raleigh, *et al*, 2007). There is also a growing consensus that anthropogenic greenhouse gas emissions have contributed to a change in the climate and that such trends will continue into the future unless dramatic mitigation measures are adopted (Houghton *et al.,* 1996). IFPRI (2011) has estimated that by 2050, the effects of climate change on agriculture will add 25 million children to the total of those suffering from malnutrition.

Adaptation Strategies

There would continue to be a rise in the level of CO_2 since the major emitters of green house gas have failed to curb emissions; even with the European Union's goals and policies of 20% reduction of the green house gas emissions by the year 2020. Climate change would therefore continue to occur along with its impacts on humanity. Adaptation, perhaps, seems to be the major option because, it has been shown to be successful and sustainable when linked to effective governance system. According to Adger *et al.,* (2003) adaptation at a minimal level as a natural response to extreme climatic and weather events has been observed throughout human history as a coping strategy based on structural and other socio-economic factors.

Some attempts have been made to study adaptation methods in the rainforest zones of Africa (NMSA, 2001; Nhemachena and Hassan, 2007; Nwajiuba *et al*., 2008; Deressa *et al.*, 2008; Yesuf *et al.,* 2008; Gbetibouo, 2009; Onyeneke and Madukwe, 2010). Except the studies of Deressa *et al*. (2008) and Yesuf *et al.* (2008) in Ethiopia, Nhemachena and Hassan, (2007) in South Africa, and Gbetibouo (2009) in the Limpopo Basin of South Africa; no other study has identified the determinants of each of the adaptation methods to climate change thereby creating a vacuum.
A range of factors including wealth, technology, education, information, skills, infrastructure, access to resources, various psychological factors and management capabilities can modify adaptive capacity (Block and Webb, 2001). Of the emerging range of adaptation practices, the diversification of livelihood activities, institutional architecture (including rules and norms of governance), adjustments in farming operations, income generation projects, sale of labour (e.g., migrating to earn an income) and the move towards non-farm livelihood incomes represent key adaptation options (Bryceson, 2004). Reducing risks with regard to possible future events will depend on the building of stronger livelihoods to ensure resilience to future shocks. Also important is the role of migration as an adaptive measure, particularly as a response to droughts and floods. Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States further suggested some other adaptation strategies including resilience to droughts supported by improvements in existing rain-fed farming systems, improved early warning systems which might reduce vulnerability to future risks associated with climate change. Others include: biotechnology research, especially in Africa, which could potentially lead to drought-and-pest-resistant and tolerant crops, national grain reserves, grain futures market, weather insurance, food price subsidies, cash transfers and school feeding schemes.

However, African and Asian regions should focus on increasing their adaptive capacities to climate variability and climate change over the long term. Ad hoc responses (e.g., short-term responses, uncoordinated processes and isolated projects) are only one type of solution. Other solutions could include mainstreaming adaptation into national development processes (Huq and Reid, 2004).

In a workshop in Nigeria on National Science-Policy and Climate Change organized by West African Research and Innovation Management Association (WARIMA) and START International Secretariat (2010), the following recommendations on climate

change adaptation/mitigation strategies were made: (i) There should be a national depository for climate and allied data which can be easily accessed by researchers and development agencies, (ii) The Federal Government of Nigeria (FGN) should ensure increased capacity in the areas of information technology and modelling in all the segments of the economy to keep vulnerability at a minimum and build resilience in Local, State, and National levels, (iii) There should be improved surveillance for emerging and re-emerging epidemic prone diseases, strengthening of primary health care system in line with MDG on health, (iv) Suitable adaption and mitigation measures should be site specific as to respond to anticipated changes in rainfall and temperature in Nigeria. For instance, Nigeria should take advantage of predicted increase in precipitation in the South to increase food production in the country. Similarly, efficient water management systems are advocated for the Northern drier parts of Nigeria, (v) Nigeria should pursue the international programme of housing for all as well as adequate provision of basic social amenities, so as to reduce the spread of communicable diseases and improve standard of living, (vi) There should be establishment of Coastal zone management commission by FGN to address problems within the coastal zone, (vii) Federal Ministry of Petroleum Resources should ensure that pipelines be made of alloys of higher tensile strength and hardness, and ensure strict adherence by the Oil companies, (viii) There should be implementation of existing forestry policy and laws to take care of deforestation, (ix) Appropriate adaptation strategies to conserve freshwater bodies across the country should be put in place, (x) The federal government should abide by her commitment to stop gas flaring by the end of year 2010. The government should also put in place an enabling environment for the private sector to be involved in implementing mitigation of GHGs from the energy sector, (xi) Women should be empowered and be involved in decision making with respect to climate change issues, (xii) Concerted effort should be made by government, NGOs, CBOs, FBOs and the private sector to bring proper awareness and education on environmental management to the general public and (xiii) There needs to be proper integration of research findings with policy formulation and implementation.

Research on climate change adaptation has advanced from a “top-down” approach to a “bottom-up” approach. The top-down model starts with climate change scenarios, and estimates impacts through scenario analysis, based on which possible adaptation practices are identified (Gbetibouo, 2009). The bottom-up approach, on the other hand, takes on a matrix of impact-vulnerability-adaptation perspective where adaptation strategies are considered more as a process involving the socio-economic, biophysical and policy environments, producers’ perceptions, and elements of decision-making (Bryant *et al*., 2000; Wall and Smit, 2005; Belliveau *et al*., 2006). In the top-down, scenario-based approach, adaptations are assumed and are invariably treated as primarily technical adjustments (for example, changing to different crops, adopting efficient irrigation systems, or altering production systems) to the impacts identified (Gbetibouo, 2009). Most of these adaptations represent possible or potential adaptation measures, rather than measures that have actually been adopted. Indeed, there is no evidence that these adaptation options are viable, realistic, or even probable to occur. Furthermore, they would only be possible with complete and accurate knowledge of future climatic conditions, which is why they have been aptly named “clairvoyant farmer” scenarios (Belliveau *et al*., 2006). Bottom-up studies have

shifted the focus of research from the estimation of impacts to the understanding of farm-level adaptation and decision making.

Conclusion

The paper reviewed the impacts of climate change in the African sub-region. Subsistence-oriented farmers are highly vulnerable to the impacts of climate change owing to their poor economic base and highly variable natural production potential. The dependence on subsistence agriculture by the African countries, prevalence of AIDS and vector-borne diseases, desertification, declining soil fertility, inadequate government mechanisms and rapid population growth make them particularly susceptible to the menace of climate change.

Observable effects of climate change include flooding, drought, change in frequency and distribution of rainfall, drying-up of rivers, melting of glaciers, receding of water bodies, landslides and cyclones. Floods and droughts particularly affect the supply and demand of food commodities due to low yields.

These impacts will continue to be felt by the farmers unless adaptation strategies including diversification of livelihood activities, institutional architecture, adjustment in farming operations, income generation projects, sale of labour and non-farm livelihood incomes are employed and sustained to mitigate the adverse consequences of climate change.

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Climate Change Adaptive Strategies used by Arable Crop Farmers in Umuahia North Local Government Area (LGA) of Abia State, Nigeria

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Abstract

The study was undertaken to ascertain the adaptive strategies used by arable crop farmers in Umuahia North LGA of Abia state. A semi-structured interview schedule was used to collect data from a sample of 100 respondents, randomly selected from five communities in Umuahia North LGA. Data were analyzed using percentage and mean score. The findings indicate that a great percentage (94.9%) of the respondents were aware of climate change. The effects of climate change included late rains (M=3.50), high rate of weed growth (M=3.03), decrease of soil moisture (M=3.01), decrease in the yield of crops (M=2.99), excessive soil moisture (M=2.95), shortening of crop life cycle (M=2.85), heavy winds (M=2.76), harvest losses (M=2.62), pest and disease infestation (M=2.61), among others. The adaptive strategies used by respondents in cushioning the effects of climate change included: organic manure, cover crop, mulching, zero tillage system, inorganic manure, mixed farming, listening to information, preservation of seeds and seedlings and change of planting date. The study recommends that government should provide adequate support to the farmers e.g. providing farm input subsidies. This is expected to reduce the burden of the adverse effects of climate change. Also, there is need for research institutes to work on new ways of adapting to climate change. This will complement the indigenous means of adaptation being used by farmers presently.

Keywords: Climate change, Adaptive strategies, Arable crop farmers, Umuahia North LGA, Climate change effects.

Introduction

Climate change, which is attributable to the natural climate cycle and human activities, has adversely affected agricultural production in Africa (Ziervogel, Nyong, Osman, and Cortes et al. 2006). There is evidence to show that climate change is global, similarly its impacts; but the most serious effects will be felt mainly by developing countries, especially those in Africa (which Nigeria is one), due to their low level of coping capabilities (Nwafor 2007; Jagtap, 2007). Farmers will face the prospects of tragic crop failures, reduced agricultural productivity, increased hunger, malnutrition and diseases (Zoellick, 2009). It is projected that crop yield in Africa may fall by 10-20% by 2050 or even up to 50% due to climate change (Jones and Thornton, 2003), particularly because African agriculture is predominantly rain-fed and hence fundamentally dependent on the vagaries of weather.

The agricultural sector remains the main source of livelihood for most rural communities in developing countries in general. In Nigeria, agriculture is the main source of food and employer of labour, employing about 60 -70 percent of the population. Agriculture in Nigeria

is mainly rain fed, this means that any change in climate is bound to affect productivity in particular and any other socio-economic activities in the country. The impacts could be measured in terms of effects on crop growth, availability of soil water, soil erosion, incidence of pests and diseases, sea level rises and decrease in soil fertility (Adejuwon, 2004).

Climate change has become a threatening issue not only to the sustainable development of socio – economic and agricultural activities of any nation but to the totality of human existence (Adejuwon, 2004). Climate change affects food and water resources that are critical for livelihood systems in Nigeria where much of the population especially the poor, rely on local supply systems that are sensitive to climate variation. Disruptions of existing food and water system will have devastating implications for development and livelihood and this will pose serious food security threats in Nigeria.

From the above, climate change actions regarding adaptation should be increasingly sought to address the negative effects of climate change on agricultural and socio-economic activities of the populace, especially the rural poor farmers who dominate agricultural sector in Nigeria. Adaptation has the potentials to reduce adverse impacts of climate change and to enhance beneficial impacts (www.wikipedia.com). The type of adaptation will depend on the kind of change taking place, vulnerability of the people and the natural systems to this change. Consequent upon this, this paper sought to ascertain the adaptive strategies to climate change being used by farmers in Umuahia North LGA of Abia state. In this regards, questions that guided this research were: are farmers in Umuahia North LGA aware of climate change? what are the perceived causes of the changes in climate? what are the effects of these changes on arable crop farming activities? And what are the adaptive measures used?

Purpose of the study

The general purpose of the study was to ascertain the climate change adaptive strategies used by arable crop farmers in Umuahia north LGA of Abia state. The specific objectives were to:

1. ascertain the awareness of climate change among crop farmers in the study area;
2. identify perceived causes of climate change as it relates to arable crop farming;
3. ascertain the perceived effects of climate change on arable crop farming activities; and
4. ascertain adaptive strategies adopted by the respondents in cushioning the effect of climate change on arable crop farming.

Methodology

The study covers Umuahia North LGA of Abia State. The LGA has an estimated population of 220,660 persons with a land area of 245km^2. A multistage sampling technique was used in selecting respondents for this study. In the first stage, 5 town communities namely, Umuosu, Ngboko, Umuakum and Umuochi were randomly selected from the fourteen town communities (14) in the LGA. Secondly, 4 village communities were also randomly selected from each town. This gave a total of 20 village communities. In the last stage, 5 farmers were randomly selected from each of the 20 village communities. This gave a total of 100 respondents used for the study. Data for the study were collected through the use of interview schedule.

Objective 1and 4 were realized with percentage while mean statistics was used to achieve objectives 2 and 3. To determine the awareness of climate change in the

area, respondents were asked to tick against response options of “Yes” or “No”. To identify the causes of climate change, respondents were asked to indicate their perception by ticking response options on a 4 point Likert type scale of strongly agreed (SA) = 4; agree (A) =3; and disagreed (DA) = 2 and strongly disagree (SD) = 1. These values were added to get 10, which was later divided by 4 to obtain a mean score of 2.5. This was taken as the cut-off. Variables with the mean score values equal to or above 2.5, were seen as perceived major causes.

To ascertain the perceived effects of climate change on agricultural activities, respondents were asked to indicate their perceptions on a 4- point Likert type scale of “to a very great extent”, “to a great extent”,“ to a little extent” and “to no extent”. Values assigned to these options were 4, 3, 2 and 1 respectively. These values were added to obtain 10; this was divided by 4 to obtain a mean of 2.5. Mean scores equal to or above 2.5 were regarded as climate change variables having effect on crop farming activities.

To ascertain the adaptive measures adopted by the respondents in cushioning the effects of climate change on arable crop farming, a list of possible adaptive strategies were made available to respondents and they were asked to indicate those ones they used. Any response option with frequency ≥ 50% was regarded as adaptive strategy used, while response options with frequency < 50% were ignored.

Results and Discussions

Awareness on Climate Change

Figure 1 shows that most (94.9%) of the respondents were aware of climate change, especially as regards their arable crop farming. This is in line with Oisahom’s (2009) observation that people in developing countries are aware of the changes taking place in the atmosphere and have begun to adjust through long and short term coping methods. LEISA (2008) reveals that most rural areas have always experienced climate variability and farmers have always had to cope with a degree of uncertainty in relation to the local weather.

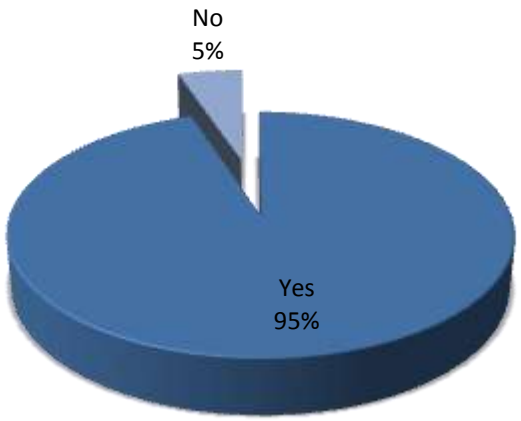


Fig. 1: Awareness of climate change

Perceived Causes of Climate Change as it relates to Arable Crop Farming

Table 1 reveals that majority of the respondents perceived the following sources as serious causes of climate change. They included the use of generator to generate

electricity (M= 3.46), burning of fossil fuels by industries (M = 3.43), burning of fossil fuel from automobiles (M = 3.26), gases released from cerement industries (M = 3.16), cutting down of trees (M = 2.78), and use of chemical in farmland (M = 2.71). This findings is line with the study of Egbule (2010) which revealed that bush burning, and excessive use of chemicals on farmlands were perceived as causes of climate change which are resultant from human activities. The implication of this finding is that human activities are to a large extent the major causes of climate change as most of their industrial or agricultural activities lead to increase concentrations of green house gases in the atmosphere.

Table 1: Respondents perceived causes of climate change as it relates to arable farming

S/N	Causes of climate change	M	SD
1.	Burning of fossil fuel by industries	3.43*	0.93
2.	Use of generators to generate electricity	3.46*	0.88
3.	Burning of charcoal during brooding of birds	1.65	0.79
4.	Burning of fire wood for cooking	1.72	0.78
5.	Bush burning	2.04	0.87
6.	Burning of fossil fuel from automobile like vehicle	3.26*	0.90
7.	High use of irrigation which change the amount of water	2.08	1.02
8.	Cutting down of trees	2.78*	0.89
9.	Over grazing of farmland by livestock	1.90	0.77
10.	Gases released from cement industries	3.16*	0.89
11.	Use of excess chemical on farm land e.g. fertilizer, herbicides	2.17*	1.07

Effect of Climate Change on Arable Crop Farming

Data on Table 2 show that late rain (M = 3.50), low rain intensity (M = 3.37), high rate of weed growth (M = 3.03) decrease of soil moisture (M = 3.01), decrease in the yield of crops (M = 2.97), and excess of soil moisture (M = 2.95) were among the major effects of climate change. Other effects include shortening of crop cycle (M = 2.85), increase salinity in the soil (M = 2.78), destruction of field crops by heavy winds (M = 2.76), loss of farmlands as a result of over flooding (M = 2.74), unfertile soil (M = 2.70), lengthening of crop life cycle (M = 2.68), loss of root and tuber (M = 2.66), increase in pest and disease infestation (M = 2.61), and change in the tastes of arable crops (M = 2.60), change in storage quality of crops (M = 2.58), and high humidity (M = 2.56).

This finding is in line with the work of Egbule and Agwu (2011), where it was found that the effects of climate change could lead to change in the taste of fruits and vegetables as well as the storage quality of crops. This also supports a Wikipedia document which reported that climate change could affect agricultural production in terms of quality and quantity of crops (http://en.wikipedia.org/wiki/Climate_change_and_agriculture). The implications of these findings are that agricultural production will suffer great losses due to the effects of climate change on production. This in effect will lead to increase in poverty of the farmers who depend mostly on income generated from the sale of their agricultural produce.

TABLE 2: Respondent's mean scores of perceived effects of climate change on arable crop farming

S/N	Effects of climate change	M	S/D
1.	Low rain intensity	3.37*	0.77
2.	Late onset of rain	3.50*	0.66
3.	Lengthening of crop cycle	2.68*	0.96
4.	Shortening of crop cycle	2.85*	1.02
5.	High rate of weed growth	3.03*	0.91
6.	Decrease of soil moistures	3.01*	1.04
7.	Excess of soil moisture	2.95*	1.02
8.	Unfertile soil	2.70*	1.05
9.	Increase salinity in the soil	2.78*	1.15
10.	Decrease in yield of crops	2.97*	1.09
11.	Destruction of field crop by heavy wind	2.76*	1.15
12.	Premature ripening of arable crop	2.43	1.21
13.	Change in the storage quality of arable crop	2.58*	1.12
14.	Change in taste of arable crop	2.60*	1.25
15.	Losses of roots and tuber under storage	2.66*	1.23
16.	Increase in pests and disease in infestation as a result of high humidity	2.61*	1.23
17.	Loss of farmland due to over flooding	2.74*	1.22

*Serious effects**

Adaptive Strategies Adopted by the Respondents in Cushioning the Effect of Climate Change on Arable Crop Farming.

Table 3 shows the adaptive strategies used by the respondents. Majority (95.9%) of the respondents conserved their soil and water, 93.9% use organic manures, 87.8% used pest and disease resistant crops, 87.8% used cover cropping, 77.6% used mulching, 77.6% also used recommended planting distance, 76.5% increased the number of weeding of farm, 75.5% reduced access to eroded areas, 73.5% used zero or minimum tillage system, 72.4% used inorganic manure, 72.4% also used mixed farming practices, 71.4% use early maturing crop varieties, 71.4% listen to information on climate change and 70.4% used proper preserved seeds and seedlings. About 69% of the respondents changed their planting date, 68.4% used chemicals like herbicide, insecticides etc, 65.3% had access to rural services, and 56.1% used crop varieties that are well acclimated with their environment.

These findings are in concordance with De Chavez and Tauli-Corpus (2008), who noted that in Africa, local farmers are already practicing zero tilling practices and mulching during cultivation and other soil management techniques. Also, IPCC (2007) observed that women now plant crops that are more resistant to droughts and pests and also select and save seeds for planting each year. This show that majority of the respondents embarked on conservation practices, which helped their soil to retain water and nutrient in order to withstand changes in climate.

TABLE 3: Distribution of respondents according to adaptive strategies used (n = 98)

S/N	Adaptive strategies	Percentage
1.	Conservation of soil and water	95.9
2.	Use of organic manure	93.3
3.	Use of inorganic manure	72.4
4.	Planting draught resistant crops	17.3
5.	Planting disease resistant crop	87.8
6.	Use of crop varieties that well acclimated	56.1
7.	Draining of wet land for crop cultivation	42.9
8.	Cover cropping	87.8
9.	Use of minimum tillage system	73.5
10.	Use of irrigation system	34.7
11.	Use of chemical such as herbicide insecticide etc	68.4
12.	Increased in the number of weeding of crop land	76.5
13.	Use of early maturing crop varieties	71.4
14.	Protection of water shed and mulching	77.6
15.	Proper preservation of seed and seedling used for planting	70.4
16.	Proper preservation of seed and seedling used for planting	34.5
17.	Proper preservation of seed and seedling used for planting	39.8
18.	Reducing access to eroded and erosion prone area	75.5
19.	Mixed farming practices	72.4
20.	Change of planting dates	69.4
21.	Use of recommended planting distance	77.4
22.	Listening to information about climate change	71.4

Conclusion

Based on the findings of the study, the following conclusions were made:

1. It was observed that, generator, gas and fossil fuel from industries, automobiles, and emission of green house gas, tree cutting and chemicals were indicated as the major causes of climate change.
2. Majority of the respondents indicated that rainfall pattern; changes in temperature were climate factors that are seriously affecting their arable crop farm, because changes in these factors give rise to other effects.
3. Majority of respondents adopted adaptive strategies like conservation practices, improved crop varieties, and use of chemicals in cushioning the effect of climate change.

Recommendations

(1) In the design or development of adaptation measures, there is need to develop specific adaptation options that best addresses vulnerable areas. This will make for better adaptation as measures that suit a particular area will be more effective instead of the more general options/measures.

(2) There is need for government to enact adaptation policies and measures that will address the issue of multiple stresses in agriculture with specific responses to crop, water stress, high rate of weed growth, crop breeding (for resistance), integrated pests management, weather forecast and climate information that could be possible solutions.

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