# Enhancing Agricultural Yields by Small-holder Farmers through Integrated Climate Change Adaptation in Sierra Leone

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AFRICAN TECHNOLOGY POLICY STUDIES NETWORK

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# Abstract

The present trend of climate change impact is especially affecting poorer communities, particularly small-holder farmers, in developing countries. While small holder farmers play an important role in spurring economic growth of a country, they lack the coping capacity to tackle the most impacting and quite expensive-to-solve climate change problems. This has high negative repercussions on developing countries like Sierra Leone.

This research was therefore conducted using multi-stage cluster sampling technique to solicit both qualitative and quantitative information from 500 farmers on climate change impacts on small-holder agriculture and the adaptive capacity of Sierra Leonean farmers to respond to such impacts. The research was carried out across the four agro-climatic regions in Sierra Leone. It was in bid to contribute to the development of robust adaptation policy that would be streamlined into national and local development programmes for enhanced agricultural productivity and socio-economic growth in Sierra Leone.

The findings revealed quite interesting, but thrilling issues that need the attention of the government and its partners. It was realized that small-holder farmers are already moving from an apriori situation to building a culture on an already observable changed climate. According to them, phenomenal changes in rainfall, temperature and cold are already taking place in an uneven and erratic manner in the past two to three years. Various indigenous predictions that no longer work well as a result of the changing climate were acknowledged by farmers. Thus they have often missed their locally predicted start-of-farming and start-of-seasons dates. This had reportedly resulted to crop failures, pest and disease proliferation and extreme hunger.

Few indigenous innovations/ emerging technologies to solve these problems were identified, but from limited locations. The capacity of small-holder farmers to adapt to climate change, it causes and impacts were also discovered to be very low. Information transfer was found to be from a single source (radio); and assistance to tackle climate-related problems were concentrated in only one region, the rainforest, but at very low rate (30%) and from only NGOs/CBOs and government institutions. The burden of climate-related diseases was also identified as an inhibiting factor responsible for low agricultural yields, food self-sufficiency and local economic growth. A simple bivariate analyses revealed that all costs on sickness is at least 30% more than returns from yields and this in combination with expenditure on farming activities can lead to a substantial decrease in

the earning power of small-holder farmers. In addition, only a few farmers,  an average proportion of 1%, agreed on year-round feeding on reserved food.

Urgent attention to these problems should not be overemphasized. The need for collaborated efforts to mobilize resources and promote research, technology and indigenous innovations in the country is paramount. Science and technology (S&T) communications strategic framework should be developed, and the capacity of small-holder farmers should be built in the area of climate change impacts and adaptation responses.

# List of Acronyms & Abbreviations

| | |
|---|---|
| ARI | Acute Respiratory Infections |
| ATPS | African Technology Policy Studies Network |
| CaCO3 | Calcium Carbonate |
| CARE | Corporation of American Relief Everywhere |
| Ch4 | Methane |
| CILSS | Interstate Committee for the Control of Drought in the Sahel |
| Co2 | Carbon Dioxide |
| DRR | Disaster Risk Reduction |
| ENSO | El Nino Southern Oscillation |
| FAO | Food and Agricultural Organisation |
| FEWS | Famine Early Warning System Network |
| FGDs | Focus Group Discussions |
| GCMs | General Computation Model |
| GDP | Gross Domestic Product |
| GEF | Global Environmental Fund |
| GHGs | Greenhouse Gases |
| GtCO2 | Giga tons of Carbon Dioxide |
| LCDF | Least Developed Countries Fund |
| LDC | Least Developed Countries |
| MAFFS | Ministry of Agriculture, Forestry and Food Security |
| NAPA | National Adaptation Programme of Action |
| NaSTEC | National Science and Technology Council |
| O3 | Ozone |
| PEMSD | Planning, Evaluation, Monitoring and Statistics Division |
| STI | Science, Technology and Innovation |
| SPSS | Statistical Package for Social Scientists |
| SRI | System of Rice Intensification |
| SSA | Sub-Sahara Africa |
| UNFCCC | United Nations Framework Convention on Climate Change |
| USAID | United States Assistance for International Development |

# 1. Introduction

The advent of climate change debates seems to put scientific research on climate change at the heart of development. There is fear of leaving a gap that will completely militate against development and increase poverty in countries, communities and among individuals that are already at the margin of survival due to climate change impacts. The fact that scientific research on climate change impacts largely concentrates on reduction of greenhouse gas emissions, and large-scale agricultural technology seem to be given high priority, could leave indigenous farmers in poverty and their knowledge underutilized for sustainable food self-sufficiency and economic growth.

## 1.1 Background

Climate change debate is not a recent phenomenon. Since the 19th century, scientists have argued on a foreseeable increase in greenhouse gas (GHG) concentration which would lead to higher mean temperature (Wiki, 2005), further creating risks and opportunities worldwide (USAID, 2007). According to the most recent climate change models, doubling of preindustrial gases is likely to create a rise in global mean temperature between 2-50C – a scale that is considered to be outside the experience of human civilization (Schellnhuber, 2006). Other scientific evidences even show that if annual GHG emissions remain at this rate, concentration will be more than three times that of the pre-industrial levels, committing the earth to 2-30C by 2100(IPPC, 2001). This according to generalized conclusion from different climatic modeling, This according to generalized conclusion from different climatic modeling could lead to increases in rainfall in higher latitudes and to reduced rainfall in the sub-tropics (Schar et al, 2004).

In particular, countries in Africa are faced with high negative impacts of climate change as a result of low adaptive capacity of their growing population. Almost all countries in Sub-Saharan Africa (SSA) lack the necessary institutional, economic and financial capacity to cope with the impacts of the changing climate, and in some cases rebuild damaged infrastructure due to climate-related natural disasters. Climate variability causes uneven disruptions that take a major toll on the economy of a country, particularly when a reasonable part of its economic activities is sensitive to weather and climate (Dieudonne 2001, Sokona and Denton 2001). The main impact of climate change will be evidenced on food security, agriculture, water resources, human health, natural resource management and biodiversity (Dieudonne, 2001). This in turn profoundly undermines economic growth and social stability in a country (Funk, 2009)- a result that militates against Africa's development. Presently the economies are gradually experiencing reduced food and financial aid at a point of rising global economic downturn- a time that help is needed most by underdeveloped nations. It is estimated that 75% of the world's population (particularly in Africa), are poor, and mostly live in rural areas where agriculture and related activities form their main source of livelihoods (Bruisma, 2003). These conditions are likely to be exacerbated with a 2-30C rise in temperature. Potentially the people most at risk from this are estimated to be between 30-200 million, particularly in Africa where: 1) the declines in yields are greatest; 2) dependence on agriculture is highest, and 3) purchasing power is limited (Warren et al, 2006). Furthermore, an estimated 70-80 million people would be exposed to malaria in Africa with 3-40C increase in temperature; and 300,000 deaths would result from climate-related problems with a 10C rise. Climate change impacts are already highly visible in Sierra Leone; but the trend and nature of such impacts, and the corresponding indigenous responses from the most affected are yet to be understood in the country- which is why this research has been undertaken.

## 1.2 Problem Statement

Sierra Leone is no exemption to the debilitating effects of climate change on developing countries across the globe. The country (like any other developing country), lacks the coping mechanisms and financial back-ups to reverse and/or adapt to the climate change and climate variability currently threatening humanity. At present Sierra Leone is experiencing de-facto climatic hazards such as floods, changed rainfall patterns, strong winds, thunderstorm and seasonal drought.

In spite of all these visible indications, there is lack of established/ adapted technology, as well as specific adaptive measures to redress the impact of climate change on agriculture, food security, human health and economic growth- a result from limited knowledge on what exists and what needs to be done by policy shapers, policy-makers and decision makers to reveal the inter-related factors responsible for climate change, climate variability and impacts felt by poorer communities and their surroundings in Sierra Leone and elsewhere. Most dispiriting is that the current climate change debate seems to focus on large-scale adaptations. In agriculture large-scale mechanized farming is given priority. Little attention is paid to small-holder farmers, who form the majority (over 70%) of the farming community. This group of the farming population has been relentlessly tilling small (less than 2 hectares) and marginal (less than 1 hectare) farms since pre-industrial age. The impact of climate change is highly felt on them and their families. It has been long established that inextricable link does exist between climate-related health risks, disaster, agricultural development and economic growth. Poor health and injury can greatly reduce the working capacity of farmers; and the present climate change dynamics is offering such possibilities to farmers in Sierra Leone.

The adaptive capacity of small-holder farmers is very low. In addition, human population increase in the Sierra Leone, which is at the rate of 1.9% per annum, and climate change impacts on agriculture, health and food security, presents serious challenges. to Sierra Leoneans themselves. This might have pushed indigenous farmers to be making countless strides to adopt /come up with local innovations/technologies that can help improve on their agricultural yields. Contrary to this, is that indigenous farmers lack the capacity of using scientific predictions, high cost technologies as well as gaining access to credits that would help reduce future climatic shocks in their farming activities.
Information on how farmers cope with the changing climate, its impacts on yields and local economic growth have limited research interest- hence little/no formalized documentations with

regards indigenous innovations/technologies to adapt to climate change impacts have been done in Sierra Leone. It is therefore important that these knowledge-based innovations/technologies be identified to give future directions on possible value addition/improvements for sustainable agricultural development and local economic growth in Sierra Leone.

## 1.3 Research Objectives

This research was undertaken to address the problems posed by climate change on agricultural production. It generally intends “promoting a comprehensive climate change adaptation policy through stakeholder participation for enhanced food production, food security and poverty reduction at local and national levels in Sierra Leone”. Specifically, the research seeks to achieve this general aim through the following objectives:

- Understanding the socio-economic status of indigenous people, their knowledge, perceptions and behavior towards climate change;
- Identify and document effective indigenous and emerging technologies and innovations for climate change adaptation in the study;
- Build the capacity of the farming communities in the study area to adapt to climate change impacts;
- Enhance behavioural changes towards climate change adaptation measures at individual and institutional levels in the study area;
- Examine the state of climate change and climate variability across agro-climatic regions in Sierra Leone.
- Build a model on how climate links health, natural disaster, to food security and the local economic growth;
- Make policy recommendations for building climate change resilience at the state and nationals in Sierra Leone;
- Build capacity in the area of climate change.

## 1.4 Rationale/Justification for undertaking the Study

Sierra Leone is presently experiencing untimely thunderstorms, destructive landslides and floods (claiming tens of lives, particularly in coastal towns and lowland farm settlements). Rainfall now takes unanticipated seasonal directions, causing farmers to miss their start-of-farming dates. In addition, the main food crops produced in the country (maize, cereal, groundnut, potato, cassava and vegetables) survive under varying climatic conditions. The present down pour of rain and duration is a course of concern for agricultural yields in Sierra Leone. A serious decline is seen in recent years. There are four agro-climatic regions in the country, but these might have been shifted considerably due to the present tangible climate change impacts. Even though climate change observations are done for several years, the need to develop an early warning system in the country is essential. In particular, Start-of-Season (SOS) and Start-of-Farming (SOF) systems must be in place to inform farmers and flood-prone coastal and lowland dwellers in the country. The need for temporary mapping of the shifted agro-climatic regions should also not be overemphasized for increased food yields, livestock production and reduced climate-related diseases in the country. The cost for high modern technological transfers on climate change adaptation is high but unavoidable, considering the cost of damage caused by climate change impacts. Studying the economics of climate change is therefore vital because modern climate change adaptation techniques remain costly and unaffordable in Sierra Leone.. However, one main asset that is often disregarded but yet highly essential to build on, is the traditional knowledge on climate change. This is a knowledge-based system comprising innovations, technologies and cultural expressions that has been in existence since pre-industrial revolution. The indigenous people have developed this system and related innovations as valuable sources of technology in response to risks and needs in a constantly changing environment. It could be cost effective therefore if this knowledge is harvested and tapped into scientific ideas for sustainable climate change adaptations in the country. Little has been known about climate change impacts on human health and the implications on food production and economic growth in countries like Sierra Leone. Infectious diseases affect a large number of people in developing countries (WHO, 2002c). Generally, poor individual health can lower work capacity and productivity (Philips and Verhasselt, 1994).

It is worth noting that Sierra Leone is entirely within the tropics and climate change is likely to be exceeding the threshold of human tolerance, and contributing to disease burden such as malaria, yellow fever, cholera and diarrhea. This in combination with injuries and other forms of disabilities have strong correlation with agricultural production, food security and economic growth. It is necessary therefore, that such study is included, to estimate the burden posed by climate-related diseases on farmers in Sierra Leone. Sierra Leone is part of the African Ministerial Conference on Environment (AMCEN), and participated at in the 2008 AMCEN Conference in Johannesburg, South Africa, where climate change adaptation was considered as the most immediate priority, considering the vulnerability of countries in the continent. Meanwhile, despite this agreement, Sierra Leone still lacks adequate information on climate change and its adaptation measures. The results from this research therefore will feed policy makers with relevant recommendations and build the capacity of individuals, institutions and local stakeholders for sustainability. It can also serve as a reference base/spring-board for future research ventures in related field in the country and other parts of the world, particular Africa, whose countries share uniformity in climate, culture and tradition.

## 1.5 Limitations

Ideally, this research was meant to be executed over a period of nine (9) months; - that is 31st December 2009 to 30th September, 2010. This time was limited to carry out the required deliverables, which included intermittent reports/evaluations and time delays in budget processing for execution of action. Hence, a slight shift to October was made to produce the final report. It is also necessary to note that one of the objectives of this research was to track climate change and variability across the agro-climatic regions in the country. However, it was observed that secondary data on key climatic parameters such as temperature and rainfall were not available in a consistent manner at the meteorological departments- making it difficult to make substantive conclusion on the state of rainfall and temperature in each of the agro-climatic regions.

## 1.6 Organisation of Report

This paper t presents results from research findings on “enhancing agricultural yields by small-holder farmers through climate change adaptation programme in Sierra Leone”. It starts with: (i) background information that gives a global view of the trend in climate change and its impacts; (ii) problems/gaps and rationale for undertaking such research; (iii) literature review that verify the problems/gaps identified (iii) research method and procedures, and (iv) research results, from which conclusions and policy recommendations were made.

# 2. LITERATURE REVIEW

## 2.1 Causes of Climate Change and Climate Variability

Over the past 150 years there has been an increase in greenhouse gas concentration (with the exception of water vapour which remains constant in the system). This increasing apparent effect is largely due to rising world population and growth in human activities such as agriculture, fossil fuel burning and several other economic activities- augmenting greenhouse gas emissions.

Scientific findings show that there is a close link between temperature change and the content of carbon dioxide in the atmosphere (Waugh, 1998). Carbon (both as an element and in its oxidised form CO2) is cycled continuously through the natural systems. Findings show the natural flows in the carbon-cycle total around 440GTCO2/yr between the land and the atmosphere and are approximately in balance. Meanwhile, due to human-induced disturbances the CO2 concentration in the atmosphere has increased by one-third since the inception of the industrial revolution.

Hence most scientists now confirm that adding greenhouse gases to the atmosphere increases the ability to trap heat and that such effect is causing what is today referred to as 'global warming'. Presently world temperature stands at a rate of 0.50C since the middle of the 19th century and latest predictions suggest that temperature could increase by between 10C and 3.50C by the year 2100 – with best guess being about 20C. Other scientific evidences even show that if annual green house gas emissions remain at the present rate, concentration would be more than three-times that of the pre-industrial levels by 2100 (IPCC, 2001).

## 2.2 How much does Agriculture and Land-use contribute to Greenhouse Gas Emissions?

It is worth nothing that half of all human-induced emissions (from land-use change, burning fossil fuels and cement production) are taken stock of carbon. This according to evidences leads to a natural response to the rising concentration of carbon in the atmosphere. A stock equivalent to just over 7,300 GtCO2 is currently stored in plants and soils – more carbon than contained in all remaining stocks, and more than double the amount current in the atmosphere.

In 2000, it was estimated that land-use change alone accounted for 18% of global green house gas emission, making it the second largest source of emissions after the power sector. Though measuring the flows of carbon dioxide emissions in the atmosphere is difficult, estimates from

Haughton (2003) indicate that in 2000, human changes to land uses led to a loss (release) of around 8 $GtCO_2$. This seems clearly small – less than 2% of the total flow to the atmosphere from the land, but can have a significant impact on the climate.

The natural processes of nitrification and de-nitrification release normal flow of Nitrous Oxide ($N_2O$), but fertilizer applications (both man-made and natural) releases its output – making such practice the largest single source (38%) of emission from agriculture. The application of the Nitrogen fertilizers is possibly the largest human-induced source of $N_2O$ emissions in developed countries; and $N_2O$ is estimated to have approximately 296 times the radioactive forcing of $CO_2$ (Sivakumar and Stefanski, 2008).

Methane ($CH_4$) is produced as a waste product of digestion by ruminants particularly the cattle, through what is referred to as enteric fermentation. In combination, cattle, buffalo, sheep, goats and camels account for the majority of $CH_4$ emissions made. This makes livestock to be the second largest source of emission (accounting for 31% of agricultural emission). $CH_4$ is also produced as a result of incomplete decomposition of organic matter.

During the growing period, any flooded rice does not decompose in the presence of oxygen (i.e. anaerobic decomposition), leading to the release of $CH_4$. Meanwhile the level of emissions depends on the specific water management practices and quantity of organic matter involved. Overall 11% of all agricultural emission comes from this practice. $CH_4$ gas emission is also possible when the manure is not stored in a sufficiently oxygenated environment, leading to anaerobic decomposition. On the other hand, nitrogen in livestock manure and urine encourages nitrification and de-nitrification, releasing, nitrous oxides. Thus, manure managements according to records (including the handling, storage and treatments of livestock waste) causes 70% of agricultural emission.

Burning of agricultural residue and open burning from forest clearing contribute to other non – $CO_2$ emissions from agriculture (accounting for 13% of emissions from the sector). Agriculture also releases $CO_2$ through soil and biomass management practices that disturb the natural carbon sink.

## 2.3 Emissions from Sierra Leone

Even though Sierra Leone is among the poorest nations, and more than 70% of its populace depends on agricultural sectors in the country, emissions seem to be minimal when rated at global level. The country served as a net sink of $CO_2$ in 1990- placing 360 $GgCO_2$ above equilibrium point with 303,058 $GgCO_2$. Meanwhile the IPCC TAR for Sierra Leone reveals that the energy industries (MCI), metal products, conversion of forest and grasslands (FGC), removals of other woody biomass (CFWB), abandonment of managed lands (AML), burning of savannahs and rice cultivation are the principal engines of emissions-contributing to the release of carbon dioxide ($CO_2$), carbon monoxide (CO), nitrogen oxides ($NO_x$) and methane ($CH_4$) as the main greenhouse (GHGs) in the country.

In 1990, 360 $GgCO_2$ and 6,108 GgCO were emitted in the atmosphere. 99% of the $CO_2$ emissions came from the energy sector, whilst manufacturing and construction industries contributed 42%. Also 82% and 18% of the CO emission came from the agricultural and land-use change/forest sectors respectively. Burning of the savannahs is also responsible for 80% of CO emissions in the country. CH4 which is more important because of its global warming potentials with an equivalent rate of 1.2 x 1015 tons CO2 equivalent (TCO2E) represents 100% of the total emissions in Sierra Leone – the bulk of which come from rice cultivation. Meanwhile, taking a reference base of CO2 concentrations of about 350 parts per million (ppm) in 1990, the MAGGICC/SCENGEN models predicted doubling of CO2 concentration levels of about 580ppm by 2025 and about 700ppm by 2100.

## 2.4 Profiling History on the Impacts of Climate Change and Variability

Several climate models predict that in the future, average rainfall patterns will look more like an El Nino. Meaning, a significant shift in weather occurs in many parts of the world, with areas that are normally wet perhaps rapidly becoming dryer. Also extreme high temperature will occur more often, increasing human mortality during the pre-monsoon months and damaging crops. Critical temperatures are likely to be exceeded more frequently and predictions show that up to a 70% reduction in crop yields resulting from such climate is likely to occur at the end of the century assuming no adaptations take place.

It is obvious that, as all regions eventually feel the impact of climate change, developing countries will see disproportionately harmful effects – with poorer communities, who are already living at or close to the margins of survival, feeling the greater part of it. A defense to this statement is that developing countries are exposed to an already fragile environment, an economic structure that is highly sensitive to an adverse and changing weather, and low income that constrain their ability to adapt.

Sach (2001) argues that poor soils, the presence of pest and parasites, high crop respiration rates due to warmer temperature, and difficulty in water availability and control explain much of the tropical disadvantage in agriculture. Meaning climate change will have a disproportionately damaging impact on developing countries, in part, at least, to their location in low latitudes, the amount of variability of rainfall they receive and the fact that they are already "too hot".

In Sierra Leone, poor people rely on forest products for their livelihoods. As stated by Vedeld et al (2004), the poor has the forest for: (a) insurance purpose when food and cash income have unexpected shortfall; (b) Gap filling in terms of regular shortfalls; (c) regular subsistence uses of fuel wood, wild meat, medicinal plants, etc; and (d) low-return cash activities which include a wide range of extractive or "soft management" activities. Due to the rapid consumption demands from such over-dependence on the fragile ecosystems, there has been a considerable decrease in the number of forest areas in Sierra Leone. This in part, at least, has led to an increase in carbon dioxide (CO2) concentration in the country- having a cyclic effect on the poor, who have high vulnerability and low adaptive capacity to climate change impacts. Projections from the Sierra Leone IPCC Third Assessment Report (TAR) even indicates doubling of the 1990 reference rate of 350ppm by 2100 (i.e 700ppm).

It is worth noting that the rate of CO2 emission has a direct relationship with temperature. Any increase in CO2 can lead to a corresponding increase in temperature (Waugh, 1998). A doubling of CO2 concentration therefore would have high impacts on agriculture in Sierra Leone. In particular, crops that have reached the threshold of temperature extreme would be greatly affected- further threatening the food security situation in the country.

Major crops grown in the country are very sensitive to climate variation and other climate-related elements. According to the IPCC Third Assessment Report (TAR) for Sierra Leone, taking a reference base of 1990, average monthly temperature falls around 28°C, with a maximum temperature of 32°C from June to October. Temperatures of about 36°C have also been recorded in March. This means that any further increase in temperature would place most of the major crops grown, at risk in Sierra Leone. Crops that are likely to be affected include: rice (with limit of 25°C), Cocoa (18°C to 21°C), Oil Palm (25°C to 28°C). Meanwhile crops such as maize, millet, and cassava (which are less of staple food in the country), may have growth potentials.

**Linking climate change impacts to food security and health is also significant to understand the implications on economic growth.**

Climate change impact on food security, health and disaster management forms a complex labyrinth of network that has strong correlation with socio-economic growth and development. For instance, it has long been acknowledged that the health status of the population of any place or country influences development. It can be a limiting factor, as generally poor individual health can lower work capacity and productivity; this impact can severely restrict the growth of economies (Philips and Verhasselt, 1994). Similarly, poor diet as a result of food shortage leads to protein and vitamin deficiency which in turn results to Kwashiorkor, Marasmus, Rickets and Berry-Berry sicknesses. On aggregate, this increases expenditure and low work capacity of poorer communities-further constraining local economic growth.

Climate change influence on food productivity is already impacting on humanity. Around 800 million people are currently at risk of hunger (approximately 12% of the world's population) (Parry et al, 2004), and malnutrition causes around 4 million deaths annually- almost half of Africa. Studies reveal that a 30C temperature increase by will put additional 250 – 550 million at risk – over half in Africa and Western Asia. However, if crop responses to $CO_2$ are stronger, the effects of warming on risk of hunger will be considerably smaller.

Also, though with limited information on climate change impacts, fisheries is another important agricultural element that needs attention. About a billion people worldwide (1/6 of the world's population) rely on fish as their primary source of animal protein. It is proven evidence that higher ocean temperatures may increase growth rates of some fish, but the disadvantage is that reduced nutrient supplies may occur due to warming which has the potential to limit growth.

## 2.5 Capacity Building on Climate Change and Impacts

Knowledge, accessibility, availability and affordability of resources are crucial to people's response to climate change. Developing countries are especially characterized by: low-income and underdeveloped financial market; poor water-related infrastructure and management; and poor public services whose availability would otherwise help them adapt.

The poor are often constrained both by low-income levels and limited access to credit, loans or insurance (in terms of accessibility and affordability). Globally, over one billion low-income people do not have access to bank account with less than 20% of people in many African countries having access compared to 90-95% of people in the developed communities. In addition, poor people are typically constrained by their lack of collateral, insufficient information to enable leaders to judge credit risk, unclear property rights, volatile income and lack of financial literacy, among other things. These constrains are likely to become increasingly worsened for poor people as wet and dry season become difficult to predict. This is often exacerbated by weak social safety nets that leave the poorest people very vulnerable to climate shocks. At national level, many low-income countries have limited financial reserves to cushion the economy against natural disasters as well as to reduce impact on agriculture. In Sierra Leone, for instance between 2004 and 2008 real GDP growth rate fell sharply by 1.3% (7.4-6.1), and revenue and grant fell by 1.6% (21.3-19.7) though investment rate increased by 4.6% and export of goods and non-factory services rose by 6%-leading to low expenditure rate and fragile fiscal balance of -2.7 in 2008. Presently the demand for investment in agriculture alone in Sierra Leone (with irrigation being a single component) is about US$1.32bn if and only if 147,300 Ha of land should be under irrigation for 618,660MT milled rice equivalent. This is exclusive of providing 1,584 tractors, 2,438 power tillers, 660 harvesters and 990 milling machines, 1,267,000 bags of fertilizer, 178,000 liters insecticides and 178,000 liters of herbicides by 2010 for mechanization. Achieving this stands a long way off without external support-considering the slow pace of economic growth and negative fiscal reserves.

Dependence on water, which is the most climate sensitive economic resource, is also high for the growth and development of developing countries. In particular, agricultural and industrial activities, the energy and transport sectors highly rely on water for increased productivity, in addition to domestic uses. Hence irrigation and effective water management would be very important in helping to reduce and manage the effects of climate change on agriculture. Studies indicate that irrigation plays an important role in improving returns from land- an increase in cropping intensity of 30% being observed with the use of irrigation (Commission for Africa, 2005).

Meanwhile, many developing countries have low investment in irrigation systems, dams and ground water. Ethiopia for example, has less than 1% of the artificial water storage capacity per capita of North America, despite having to manage for greater hydrological variability (World Bank, 2006c). Sierra Leone, on the other hand, has very high potential for irrigation-with about 241,600 Ha of irrigable land area enhanced by more than 6 river courses across the country[1]. Yet the country lacks the investment capacity to explore this opportunity. As stated by Brown and Lall (2006), Sierra Leone has only 3% (2.14/km$^3$) of seasonal storage index (SSI) and a total of 100% hard water[2]. Meaning the country has 100% storage deficit that could be tapped during the wet season.

Inadequate resources and poor governance (including corruption) on the other hand result in poor provision of public services. Early warning systems for extreme weather conditions, education programs on raising awareness on climate change, and preventive measures and control programs for disease spread by vectors or caused by poor nutrition are example of public services

[1]*The main river courses include Rokel , Great Scarcies, and Little Scarcies, Tabei, Sewa, Mano, Wanjei, Taia , Panpana ,Maboli, Mongo.*
[2]*SSI indicates the volume of water need to satisfy annual water demand base on the average seasonal rainfall cycle (calculated as the volume of water needed to transfer water from wet months to dry months "hard water" is the water storage requirements.*

that would help manage and cope with the effects of climate change, but receive weak support and attention in developing countries. Capacity building is therefore an important asset in building climate change resilience in an extremely fragile society. According to UNCED *"a fundamental goal of capacity building is to enhance the ability to evaluate and address the crucial questions related to policy choices and modes of implementation among development options, based on an understanding of environment potentials and limits and of needs perceived by the people of the country concerned"* (UNCED, 1992). Strengthening the capacity of people so that they can determine their own values and priorities, and organize themselves to act on these, is the basis of development (Eade and Williams, 1995). Also one main concern about capacity building is the relationship between social and political dynamics and can therefore be viewed in the wider social, economic, and political environment- governments, markets, and the private sector as well as CBOs, NGOs and other institutions, right down to the community, household and personal level.

Capacity building for climate change refers to the development or strengthening of personal skills, expertise, and relevant institutions and organizations to reduce greenhouse gas (GHG) emissions and/or to reduce vulnerability to climate-related impacts. Capacity building often involves the participation of multiple stakeholders, including host country governments, nongovernmental organizations (NGOs), research institutions, local communities, and international organizations.

## 2.6 Policy Responses, Farming Systems Adaptations and Technologies/ Innovations to Climate Change Resilience

Crop yields to a large extent depend on prevailing climate conditions vis-à-vis; temperature and rainfall patterns. Food production therefore, will be particularly sensitive to climate change. And it is noteworthy that agriculture currently accounts for 24% of world output, employs 22% of the global population, and occupies 40% of the land area. 75% of the poorest people in the world (the 1 billion people who live on less than $1.00 a day) live in rural areas and highly rely on agriculture for their sustenance (Bruinsma, 2003).

For the mid to high latitudes (Austria, Europe, US, Siberia and some parts of China), low levels of warming may improve the conditions for crop growth- by extending the growing season and/or opening up new areas for agriculture. However, additional warming will have extremely high negative impacts, as damaging thresholds are reached more often and water shortages limit growth in some regions like Southern Europe and western USA. Also high temperature episodes can reduce yields by up to half, if they coincide with a critical phase in the crop cycle such as flowering (Slingo et al, 2005; Caias et al 2005). The size of "carbon fertilization" effect is crucial in determining climate change impacts on agriculture. $CO_2$ is a basic building block for plant growth. As such, rising concentrations in the atmosphere may enhance the initial benefits of warming and even offset reductions in yield due to heat and water stress. Predictions for carbon fertilization effect suggest that yields of several cereals (wheat and rice in particular) will increase for 2 or $3^0$C of warming globally; however, yield would start falling as temperatures reach 3 to $4^0$C (rising temperatures may pose significant challenge for maize cultivation, which declines as temperature increases– since it has a different physiology that makes it less responsive to the direct effects of rising $CO^2$). Correspondingly, world cereal production only falls marginally (1-2%) for warming up to $4^0$C (Warren et al, 2006). Meanwhile, as a weak carbon fertilization effect is used, worldwide cereal production declines by 5% for a $2^0$C rise in temperature and 10% for a $4^0$C rise. At this limit, entire regions may be too hot and dry to grow crops.

Nonetheless, while agriculture in higher-latitude developed countries is likely to benefit from moderate warming (2-3°C), even small amounts of climate change in tropical regions will lead to decline in yields. In the tropics crops are already close to critical temperature thresholds and many countries have limited capacity to make economy-wide adjustments to farming patterns. The impacts will be strongest across Africa and Western Asia (including the Middle East), where yields of the predominantly regional crops may fall by 25-35% (weak carbon fertilization) or 15-20% (strong carbon fertilization) once a 3 or 4°C temperature threshold is reached. Also, maize- based agriculture in tropical regions, such as part of Africa and Central America, is likely to suffer substantial declines, because maize has a different physiology to most crops and is less responsive to the direct effects of rising carbon dioxide (Fischer et al 2005). Food production in Sierra Leone is seeing a steady increase after a sharp fall during the war-period. However, food insecurity is one of the problems faced by Sierra Leoneans both in terms of food access and poor quality of food intake. FAO estimate in 2002 shows that out of 580,000 MT required by the country, only 46% of cereal consumption (especially of rice, the staple food), was met by local production- with the balance of 54% coming from imports and as food aid. It is worth noting that currently agriculture's share of GDP stands at about 45%, account for over 25% of export earning and by far the largest employer (almost 75%) in Sierra Leone (Sesay, 2009). Hence, even a slight decline would have very high negative implication on development for majority of the population and other sectors of the economy. The interventions taken by countries, the international community, firms, donor agencies and individuals, to address climate change impacts on people's livelihoods, food production, health and economic growth need to be critically examined. This section therefore looks at the policy responses, farming systems adaptations, technology/innovations to climate change impacts in Sierra Leone and other parts of the world.

### 2.6.1 Policy Responses to Climate Change Resilience in Sierra Leone and other Parts of the World

The present trend of climate extremes has made governments, firms and individuals to realize that adaptation is a vital component of any policy response to climate change. Nonetheless the ability of a system or society to modify its characteristics or behaviour to cope better with changes in externalities is highly essential. According to evidences, climate change is generally detrimental to the agricultural sector, if no adaptations are done (JokoAfrika, 2009). Adaptation can be short-term or long-term and localized or widespread (IPCC, 2001).

Meanwhile global concerns in tackling climate change problems seem to concentrate largely on reduction in GHG emissions, with limited attention to addressing impacts on agricultural production and food self-sufficiency. There are however inadvertent attempts to increase food self sufficiency and improve on some other development priorities which perhaps may reduce vulnerability in terms of impact on climate change. But the policies are biased against small-holders, who are more often than not, the poor (World Bank, 1997).

### 2.6.2 Policy Responses in Favour of Climate Change Resilience for Enhanced agricultural yields in Sierra Leone

In Sierra Leone the overall policy objective for agricultural productivity is “making agriculture the engine of socio-economic and development through commercial agriculture". More specifically the policy objectives include:

i. To enhance increase in agricultural productivity through intensification,
ii. To promote diversified agricultural commercialization (extensification) through private sector promotion,
iii. To improve research and extension delivery services,
iv. To promote efficient and effective resource management system,
v. To mainstream cross-cutting themes such as gender and youth development as well as farmer's health (including HIV/AIDS) and sustainable development.

The Ministry of Agriculture and Food Security has taken tremendous strides in recent years to achieve these policy goals and objectives. The challenge is in bid to meet and surpass the government Poverty Reduction Strategy Paper (PRSP) agricultural targets. Meanwhile, targets for rice, cassava and sweet potatoes were well achieved in 2005 (see table 1), but much need to be done to meet other targets and projections considering the population growth rate of 1.9% per annum.

**Table 1: Comparing Targets and Actual Production (MT) for the First Year of PRS Implementation**

| Crop | 2005 Target | 2005 Actual | Difference | Target 2006 | Target 2007 |
|---|---|---|---|---|---|
| Rice | 540,000 | 552,000 | 12,000 | 875,000 | 1,290,000 |
| Cassava | 1,935,221 | 2,287,060 | 351,839 | 2,100,000 | 2,300,000 |
| Sweet Potato | 160,856 | 191,498 | 30,642 | 185,368 | 203,905 |
| Groundnut | 95,684 | 167,200 | 71,516 | 110,265 | 121,292 |

*Source: Ministry of Agriculture*

Recent estimates however reveal that by 2012, the Sierra Leonean population will be at 5.7 million. In order to meet the food demand for such population, it is estimated that 524,200 MT milled equivalent (120% sufficiency ratio) would be the expectation. For such projections/targets to be met, robust and appropriate science (research), technology and innovation (STIs) need to be adopted. Fortunately, the science and technology policy is already in existence in Sierra Leone; and it is designed in way that it cuts across all development priorities with the objective of spurring national development and poverty reduction. The policy goals on science and technology in Sierra Leone therefore include:

i. the development of manpower;
ii. provision of atmosphere for creation of Science and technology culture in society; (3) intensification of basic and applied research;
iii. promotion of female participation in S & T programmes;
iv. application of research findings to developmental activities in all sectors of the economy;
v. promotion of development and integration of indigenous technology into modern technology, and
vi. fostering regional and international cooperation.

Agriculture, food security and agro-allied industries form the top-most priority in the science and technology policy, suggesting that they have the potential to increase output on crop, livestock and marine resources with the emphasis on fish, and diversified food sources. The objectives gear towards the PRSP and other national targets on food self-sufficiency and food security in the country. This implies that science and technology should be applied if PRSP policy objectives are to be achieved. Specifically the S & T Policy objectives for food self-sufficiency and food security are to: (a) stimulate economic production of crops, animals and fisheries and encourage prudent intensification and diversification of products; (b) develop and promote appropriate land use practices, and (c) upgrade, popularize and rationalize production of farm tools and implements and improve local agricultural practices. These objectives need cost-effective and appropriate implementation strategies which are already outlined in the policy.

Areas such as environment, whose ignorance can militate against efforts to reduce climate change impacts, are also emphasized in the S&T policy in Sierra Leone. In particular, the policy seeks to complement national environmental policy objectives that tend to enhance environmental quality. Hence the S&T policy specifically seek to:

> Provide ways in which S&T would be applied to reduce levels of environmental degradation and pollution,
> Encourage proper environmental management in urban and rural areas,
> Encourage the use of environmental-friendly and economically viable technologies in natural resource exploitation and development,
> Monitor regularly environmental quality using recent techniques in S&T,
> Collect and make available technical scientific data for national decision-making on resource use and conservation.

**Considering the large number of indigenous farmers, who are basically poor and who live on less than US$1.00/day, by-passing the traditional technological knowledge would also undermine efforts to meet food self-sufficiency targets.** Frantic effort is seen in the S&T policy formulation, as it tends to capture indigenous technology by suggesting upgrading and modernizing such technology so that it can better serve the needs of the society. The policy aims at: (a) increasing the productivity of surviving indigenous technology through the infusion of modern scientific and technological methods; (b) increasing appeal, popularity and affordability of indigenous technologies nationwide; and (c) encouraging the development of labour and cost saving devices using local materials and internally generated indigenous knowledge. Various implementation strategies to achieve these aims and objectives have been identified:

> Supporting R&D in indigenous technological systems,
> Providing an enabling environment for the production and marketing of goods using indigenous methods,
> Providing formal and non-formal instructions in materials, methods and finishing techniques to producers,
> Fostering the integration of indigenous and modern technology in the production of drugs from medicinal plants and in the production of key chemical products such as detergents, salt, preservatives, etc.
> Undertaking R&D in indigenous technology including the study and assessment of existing systems at the highest levels possible, including industry, polytechnics and the university,

- Introducing courses at the universities, polytechnics institutions and informal education which stimulate creativity to aid production of prototypes of machinery/labour saving devices, building materials to bridge gaps,
- Introducing curricula related to indigenous technology.

### 2.6.3 Farming Systems Adaptations, Technologies/Innovations to Climate Change Resilience

Climate change is increasingly becoming a serious global problem, particularly when over 70% of the world's population relies on the agricultural sector (which is largely hit by the compounding impacts of climate change). Generally speaking, the world is making efforts to offset these impacts on food production through alternative technologies (including value addition change). Meanwhile, high illiteracy has often suppressed successes in the efforts as the World's population keeps on increasing, making Thomas Malthus' famous prediction that "the earth would not be able to support its growing population", a truism. The most widely affected are small-holder farmers. The emergence of climate change impacts makes it more difficult for them to cope. However, farmers are adapting and experimenting with their farms in order to respond to changes over which they have very little control; going on with the slogan **"you either adapt or die"**. These challenges have been complemented by various governments. That is, small- (and large-) scale farmers around the world already make countless adaptations and coming up with dynamic innovations in order to make their farms more sustainable. One instance is the micro-irrigation and water-use efficiency practices. Several micro-irrigation methods have gained considerable popularity over the last fifteen years- in particular *"drip irrigation systems"* and *"sprinklers"*- which have been adopted for efficient use of water for agricultural purpose in areas of water scarcity. That is, using less water to produce the same crop. This section therefore presents on-going adaptation practices (including technologies) and lessons learnt in selected countries around the globe.

### A. Adaptation System of Rice Intensification (SRI) and Efficient Water Use in Madagascar

SRI is a set of rice cultivation practice that aims at high productivity of the crop with very limited consumption of water. This is a practice developed and used in Madagascar- but is becoming increasing popular in many parts of the world in response to the increasing climate change impacts and climate variability. It is an innovative farm practice that ensures that rice seedlings are transplanted early- that is within a period of eight (8) days. The transplanting is done in carefully prepared squares to enhance effective weeding. The method allows for intermittent use of irrigation- in about 2-3 days intervals. Thus the roots of the rice plant under this method develop much more and faster under the SRI, as seen in conventional farming systems. Sometimes farmers inundate the paddy to control weed growth, but the philosophy of SRI is that water is too costly to just use as a herbicide. Farmers therefore use botanical herbicides in addition to manual weeding and removal of paddy plants. The lesson learn from this SRI is that water saving of more than 20% are common and yields have been observed to be usually 10-30% higher.

### B. Adaptation/technological Adoption Efforts to Combat Food Security Problems in Sierra Leone

The growing rate of the population of Sierra Leone and the challenges offered by climate-related impacts have been pushing Sierra Leoneans to find adaptation solutions to address food insufficiency problems. Food crop production in Sierra Leone is mainly rain-fed and changes in weather patterns may pose significant decline in food production. Looking at the slow pace in food production by dominant small-scale agriculture and the foreseen climate-change impacts, the government of Sierra Leone is adopting various strategies to increase yield and maintain steady increase in a sustainable manner. Identified agricultural implementation strategies have thus been grouped into short, medium and long term.

Meanwhile, whilst taking cognizance of agricultural intensification the Ministry is planning robust adoption of extensification (mechanized farming) for rice self-sufficiency as a staple for 100% of Sierra Leoneans. In order to achieve rice self-sufficiency by 2010 for instance, and assuming that 533,400 Ha (80%) of rice field area should be tilled, it has been estimated that 1,584 tractors and 2,438 power tillers would be required accordingly. Also to increase outputs (yields) per unit of land, the use of high yielding varieties (e.g. NERICA rice) and agro-chemicals (e.g. fertilizers, pesticides and herbicides) through agricultural intensifications have been recommended. In addition, Sierra Leone has high potentials for irrigation technologies.

It has a total irrigable land of about 241,600 Ha. Exploiting this potential has also been an ambitious priority because it: (1) reduces the areas under cultivation leaving substantial space for some other economically viable activities; (2) is environmentally friendlier; (3) produces more yields through year-round cultivation; (4) provides the opportunity for the production of other varieties other than rice; (5) could be a potential source of drinking water, and (6) can promote aquaculture at the same time. Specifically over half of the irrigable area is in the SOUTH, especially Torma Bum and Gbundapi in Bonthe and Pujehun Districts respectively. Fortunately too, Torma Bum and Gbundapi have very high level of suitability for irrigation (75%) that will depend on the “never-dry” Sewa and Wanji Rivers. In the NORTH, Kumrabai Mamilla leads not only in terms of acreage (35,500 Ha) but also in relation to suitability (62.5%). Rhombe is also next (14,700 Ha with 75% respectively). Even though Rolako has low suitability (27%), it is very strategic in terms of location and access albeit with a problem of a drying Tabai River. Presently the main irrigation priorities are Toma Bum, Kumrabai Mamilla, Rhombe, Gbundapi and Rolako as shown in table 2.

**Table 2: Irrigation Priorisation in Sierra Leone**

| Priority | Location | District | Area (Ha) | Av. annual Rainfall(mm) | Water Source |
|---|---|---|---|---|---|
| 1. | Torma Bum | Bonthe | 51,300 | 3,344 | Sewa |
| 2. | Kumrabai Mamilla | Tonkolili | 35,500 | 2,750 | Panpana |
| 3. | Rhombe | Port Loko | 14,700 | 2,714 | Little Scarcies |
| 4. | Gbundapi | Pujehun | 41,100 | 3,344 | Wanjei |
| 5. | Rolaka | Bombali | 5,100 | 2,925 | Tabei |
| **Total** | | | **147,700** | | |

*Source: Adapted from MAFFS*

# 3. Research Method & Procedures

## 3.1 Study Area

The ideal setting of the research is the entire Sierra Leone. It is a small country with an area of approximately 72,300 km2 and population of 4.9 million (2004 census est.). 71% of the country's population comprises of those between ages 10-59 years; 24% are children under five years of age and 5% are 60 years of age and above. The country is endowed with significant natural and human resources. Despite all this, the economy has seen serious and prolonged socio-economic set-back, including low standard of living of the vast majority of its inhabitants. Unfavourable policies, corruption and civil strife are in part, some of the inhibiting factors responsible for such end-results.

Sierra Leone lies entirely within the tropics- Latitudes 6055´ and 10000´ north of the equator and Longitudes 10014´ and 13017´ west of the Greenwich Meridian. Based on its location, the country has a tropical climate: Dry season characterized by cool, dry and humid north-easterly (harmattan) trade wind which sometimes blow at intervals, and is accompanied by fine dust from the Sahara; Wet (Raining) season also characterized by a wet and moist southwest monsoon wind.

Sierra Leone has five distinct physical regions- Freetown Peninsular, Coastal Plain, Interior Lowland, Interior Plateau and the Mountain Ranges. Ideally, during the late 1970s to early 1980s, four agro-climatic regions were identified (with no further adjustment done to date) in the country (see figure). These identifications were done based on certain climatic features: (a) duration of growing periods of crops; (b) Physiographic influence of environmental conditions; and (c) altitude and effects of temperature of agro-climatic influence. The agro-climatice regions were therefore used for the purpose of this research.

## 3.2 Research Design

The nature and structure of the research seek to solicit in-depth information on the trend in climatic variations, state of climate change impacts on the farming population and their responses to such impact. Both personal interviews and Focus Group Discussions were used in the research. Descriptive and exploratory research designs were therefore implored in the research procedures. The descriptive research design was used to collect a set of scientific methods and procedures to collect raw data, from which data structures were developed to describe findings on key elements such as socio-demographic characteristics of farmers, crop diversities across agro-climatic regions, structured adaptation measures, state of capacity building, responses to climate change adaptation measures, etc. This was done using structured and coded questionnaires that were designed to generate quantitative data. The exploratory research was used to solicit in-depth farmers' emerging/adopted technologies in response to climate change impacts and documenting these practices by agro-climatic regions using informal/ unstructured procedures.

### 3.3 Types of Data/Data Collection Procedures

Both Primary and Secondary data were collected as part of the research. The primary data were collected using structured questionnaires. Initially, a pilot survey (PS) was done to determine in part, some scale measurement options on sources of climate change information, list of adaptations/innovations, etc. Primary information was also solicited from Focus Group Discussions (FGDs) with the farming communities in each of the regions. Soliciting Secondary information was also key in the research process. Scientific data on climatic parameters such as rainfall and temperature was obtained from the national meteorological department of Sierra Leone and the IPCC report for Sierra Leone. A thorough review of literature on climate change, climate variability, impacts and farming systems adaptations and innovations/technologies for climate change resilience in Sierra Leone and other parts of the world was also carried out.

### 3.4 Sample and Sampling Method

The sample frame of the research is the entire small-holder farming population of Sierra Leone. Given estimates of 75% of the population comprising of small-holder farmers, this gives a figure of 3.675 million farm families. A sample size of 500 farm families was selected; and this was done using multi-stage random sampling technique. First the four (4) agro-climatic regions in Sierra Leone were identified. The agro-climatic regions were then divided into districts, which were further cascaded into chiefdoms and localities. In all five (5) districts, twelve (12) chiefdoms and thirty-four (34) localities were randomly selected. One district was selected from each of the four (4) agro-climatic regions with the exception of the transitional zone (from which two districts were selected as a result on its elongated nature passing through most of the administrative regions of Sierra Leone). 125 questionnaires were equally administered to farmers using simple random sampling technique in each of the agro-climatic regions making a total of 500 respondents. In addition, ten (10) Focus Group Discussions (FGDs) were done with identified farmers' groups in each of the regions (see table 3 in appendix). Five (5) young enumerators from the universities/tertiary institutions were trained on elements of climate change and farming techniques, questionnaire design, interview techniques and were assigned to specific locations in all the agro-climatic regions across the country.

### 3.5 Specification of Model and Techniques

In terms of farmers' responses to adaptation measures, the Ajzen's and Fishbein's(1980:53-89) attitude-towards-behaviour model was used by adopting scale measurements to solicit information on outcome(ai) using the following formula:

$$\mathbf{AT}_{Br} = \sum_{i=1}^{n} \mathbf{b}_{ir}\mathbf{a}_{ir}$$

Where $\mathbf{AT}_{Br}$ is a separate indirect derived composite measure of the combined thoughts and feelings of farmers' groups for or against carrying out a particular adaptation measure or behavior towards climate change adaptation; $\mathbf{b}_i$ is strength of each group's response/belief (subjective probability) that the action or behavior will produce outcome **i**; $\mathbf{a}_i$ is the group's expressed feeling (affect) towards outcome **i** (e.g. favorableness feeling of adaptation measures working well in a particular agro-climatic region); **r** is the group; **n** is the total pair of questions ($\mathbf{b}_i$ and $\mathbf{a}_i$) asked on the salient action outcome on climate change adaptation measures, etc; $\mathbf{a}_i$ is an indicator that there are **n** salient action outcomes making up the behavior over which the multiplicative combinations of bi and ai for the outcome are summated. The scores were then interpreted to mean that the lower the value, the weaker the attitude and the higher the value, the stronger the attitude towards each given attribute of climate change adaptation options. The data were generated from the Statistical Package for Social Scientist (SPSS) and analyzed using the excel spreadsheet.

### 3.6 Data Analyses and Presentation

Post survey activities were data processing (including editing, validation and analyses) and presentation. The Statistical Package for Social Sciences (SPSS) and the excel spreadsheet were used for data capturing, validation and analyses. Presentations were done using descriptive statistical inferences vis-à-vis; frequency tables, cross-tabulations and statistical graphs.

A bivariate graphical presentation was also made to understand the relationship between expenditure on climate-related disease impacts and/or farming activities and returns from farm produce. This was in bid to predict the benefits derived from reducing climate-related disease prevalence through certain adaption measures.

# 4. Research Results & Discussions

Analyses of the research findings follow internal consistency of the research design. The findings present the socio-demographic dynamics of farmers interviewed. This is then followed by the extent of farmers' knowledge on climate change, how they perceive climate change influence and their reactions. Emerging technologies and innovations for climate change resilience, state of capacity building on climate change, climate variability, farmers' responses to climate change measures and linkages between climate change, diseases and food security/self-sufficiency were also captured in the analyses.

### 4.1 Socio-demographic Dynamics of Indigenous Farmers

The research did not intend testing hypotheses regarding differences between male and female respondents. Farmers were therefore targetted by the process of simple random sampling (irrespective of gender) through multi-stage random sampling plan. The analyses however, captured the sex composition of both male and female farmers in bid to make some comparative conclusions on specific emerging issues. Approximately 25% and 75% of female and male farmers were interviewed in the research respectively (see Figure 1).

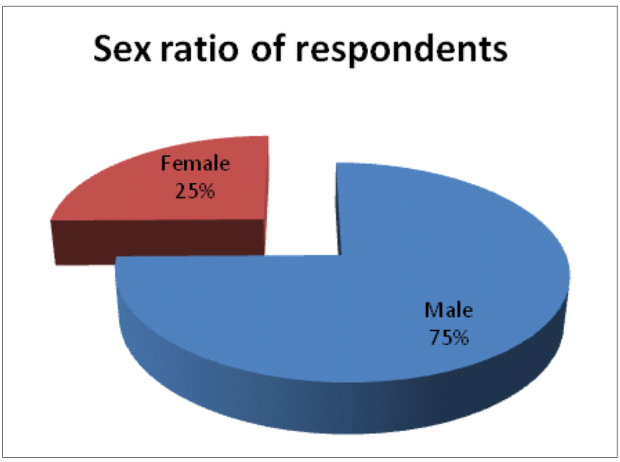



**Figure 1: Sex composition of farmers**

Most of the farmers interviewed fall between ages 35 and 49. Meaning 54% of all farmers interviewed are in the most active and responsible age brackets (see table 4). Their responses to farming systems, adaptations and climate-related components in the research findings would therefore play an invaluable role for generalization across the country and its surroundings.

**Table 4: Age composition of respondents**

| Age brackets | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|
| 18-25 Years | 13 | 2.6 | 2.6 | 2.6 |
| 26-33 Years | 77 | 15.4 | 15.4 | 18.0 |
| 34-41 Years | 141 | 28.2 | 28.2 | 46.2 |
| 42-49 Years | 130 | 26.0 | 26.0 | 72.2 |
| 50-56 Years | 74 | 14.8 | 14.8 | 87.0 |
| Above 56 Years | 65 | 13.0 | 13.0 | 100.0 |
| **Total** | **500** | **100.0** | **100.0** | |

In addition, most of these farmers (about 72%) have stayed on farming/farm settlement since birth and 24% reported staying on farm locations for over five (5) years (see Figure 2). The high experience in traditional farm practices clearly depicts the quality of farmers' experience on the impacts of the changing climatic variables in their farming activities.

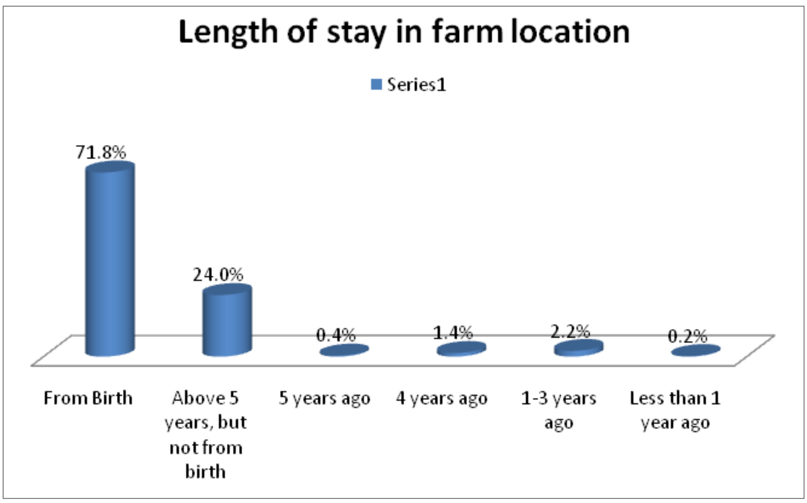



**Figure 2: Length of stay of farmers in their farm locations**

The major marital characteristics observed from the findings are polygamous and monogamous practices (see table 5). The view that most farmers are poor and as such lack the financial capability to undertake large-scale farming activities, presents a clear picture of why polygamous marriages (in this case 28%) are common among the farming communities in countries like Sierra Leone. Farmers tend to bind forces with many family members with the intention of raising their farm productivity, perhaps through additional family labour.

**Table 5: Marital status of respondents**

| Marital Status | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|
| Never Married | 22 | 4.4 | 4.4 | 4.4 |
| Engaged | 37 | 7.4 | 7.4 | 11.8 |
| Separated | 12 | 2.4 | 2.4 | 14.2 |
| Married Polygamous | 142 | 28.4 | 28.4 | 42.6 |
| Married Monogamous | 233 | 46.6 | 46.6 | 89.2 |
| Divorced | 22 | 4.4 | 4.4 | 93.6 |
| Widowed | 32 | 6.4 | 6.4 | 100.0 |
| **Total** | **500** | **100.0** | **100.0** | |

The aspect of polygamous marriages also starts giving signal of the size of individual farm families in the country. Over 70% (as shown in Figure 3) of farmers across the agro-climatic regions agreed having a total number of over 5 dependants. There is therefore a mixed feeling in the perception of farmers gaining more yields with a large number of dependants and poverty that overhangs them. The predictions of destructions emerging from the changing climate and farmers' low capacity to adapt to shocks explains much of why farmers will continue being in poverty in the absence of capacity building and adaptation policies in the country.

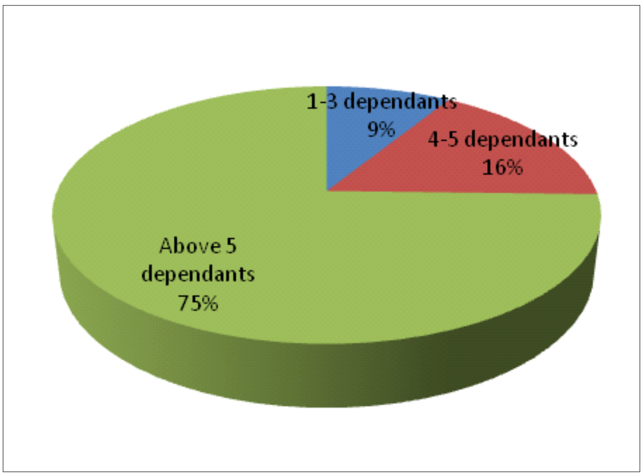



**Figure 3: No. of dependents reported by farmers**

Various farm practices were captured in the research. Food crops and livestock farming and fisheries were all agreed on as adopted farm practices across the agro-climatic regions. Meanwhile, the most widely used agricultural practices reported by farmers are swamp rice farming (77%), shifting cultivation (72%) and market gardening (61%) (see figure 4). Bush fallow and livestock farming showed up but of low score in terms of practice. Also, cash cropping which is one of the economic resource bases of the country for export overseas is practiced, but at low rate.

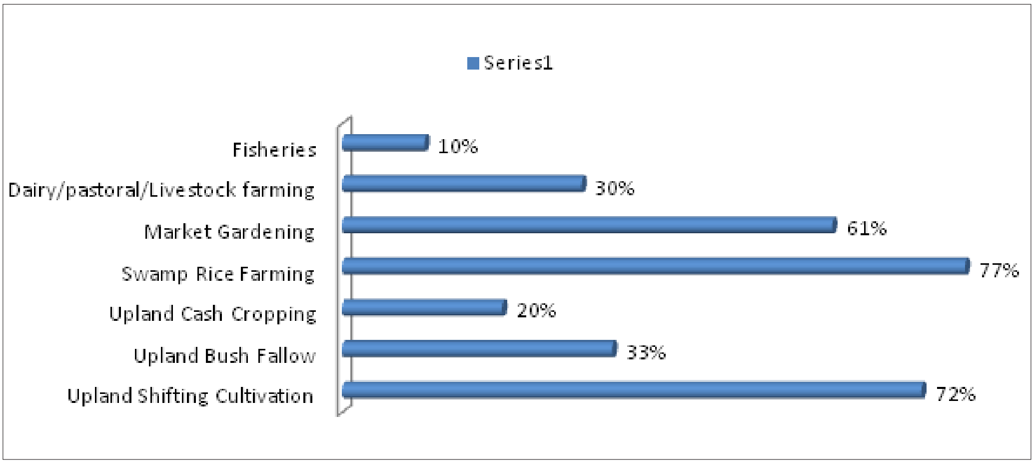



**Figure 4: Farm practices across agro-climatic regions**

### 4.2 Indigenous Farmers' Knowledge, Perceptions and Behaviour towards Climate Change

Climate change requires a long-term observation for confirmation. However, the speed at which modernisation is going and the widespread speculations about the impacts of climate especially on the poor, need to be proven at regular intervals. It is believed that famers are the most widely hit. Their knowledge and perception would give future directives on solutions to this problem. Meanwhile Figure 5 shows marked affirmative responses from farmers across all the agro-climatic regions that rainfall and excessive heat are mostly felt in all the regions. In addition, cool conditions have been observed by most Sierra Leoneans at particular periods in the year, but farmers in the Savannah Woodlands of Northern Sierra Leone especially reported extreme cold beyond the normal limit of tolerance (see Figure 5). A combination of these weather events might be very alarming for future agricultural development by small-holders in Sierra Leone especially in agro-ecological zones that are hardly hit.

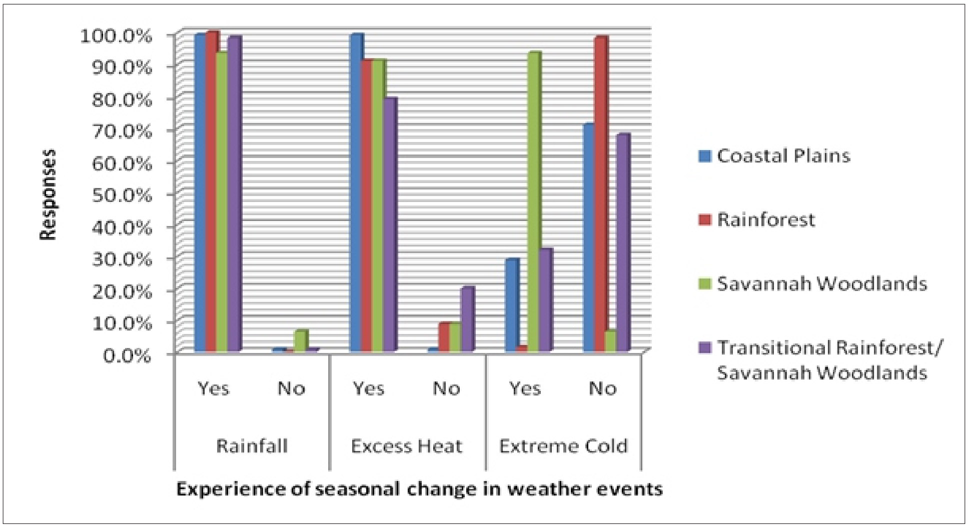



**Figure 5: Farmers' experience of seasonal change in weather events**

Mixed patterns of change in climatic variables were however observed from the findings. Generally, farmers have observed long rainfall duration (74% of responses), long drying season (61% of responses) and high temperatures (55% of responses). Short and heavy rainfall was also reported (42%). Meanwhile, regional confusing patterns were observed in terms of experiences in the phenomenal occurences of climatic parameters. Whilst the savannah woodlands and transition zone experience both long rainfall duration and short/heavy rainfall, the rainforest and coastal plains see more of long rainfall duration. In addition high temperature was reported by most respondents in the coastal plains (74%) and savannah woodlands (72%). Other climatic variables that were listed from the farmers are heavy storms, long and short harmattans.The resultant effects have been late start-of-farming in the transitional zone (56%) and coastal plains (40%) as well as early start-of-farming in the transitional zone (71%) and rainforest (62%).

**Table 6: Perceived views of the nature of weather events**

| Observations | Agro-Climatic Region | | | | |
|---|---|---|---|---|---|
| | Coastal Plains | Rain Forest | Savannah Woodlands | Transitional Rainforest/ Savannah Woodlands | Total |
| Long rainfall duration | 95(76.6%) | 105(84.0%) | 99(82.5%) | 67(53.6%) | 366(74.1%) |
| Short and heavy rainfall | 51(41.1%) | 15(12.0%) | 73(60.8%) | 70(56.5%) | 209(42.4%) |
| Long drying season | 94(75.8%) | 44(35.2%) | 104(86.7%) | 60(48.0%) | 302(61.1%) |
| Late start of farming | 50(40.3%) | 13(10.4%) | 10(8.3%) | 70(56.0%) | 143(28.9%) |
| Early start of farming | 30(24.2%) | 77(61.6%) | 30(25.0%) | 89(71.2%) | 226(45.7%) |
| High temperature | 92(74.2%) | 46(36.8%) | 86(71.7%) | 45(36.0%) | 269(54.5%) |
| Others | 122(98.4%) | 6(4.8%) | 109(90.8%) | 97(77.6%) | 334(67.6%) |

Farmers are gradually moving from a-priori situation of weather observation to a gradual building of culture on permanent weather change in Sierra Leone. It was reportedly agreed by most of the farmers (about 71%) that weather changes (particularly in rainfall, heat and cold) have really been observed in the past two to three years. In fact some responses (13%) even show that changes in these events have been observed since 2006 (see Figure 6)

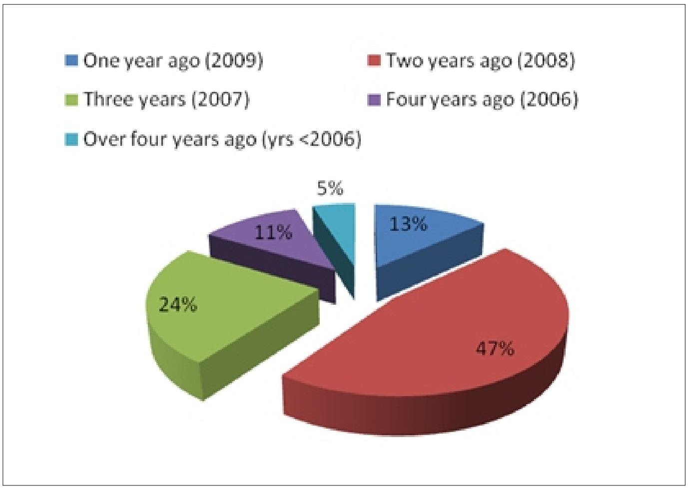



**Figure 6: Years of experiencing changes in weather events**

Whilst changes in patterns of climatic events are observed, patterns in agriculture production, especially food crop productions which are climate-sensitive in Sierra Leone need to be tracked. It was observed that rice, cassava, maize, groundnut, sweet potato, pepper and yams are the major food crops grown in the country as depicted in figure 7. Oil Palm, beans, banana and millet are also grown to an extent. Production of major livestock such as goat, sheep and cattle were also observed from the findings.

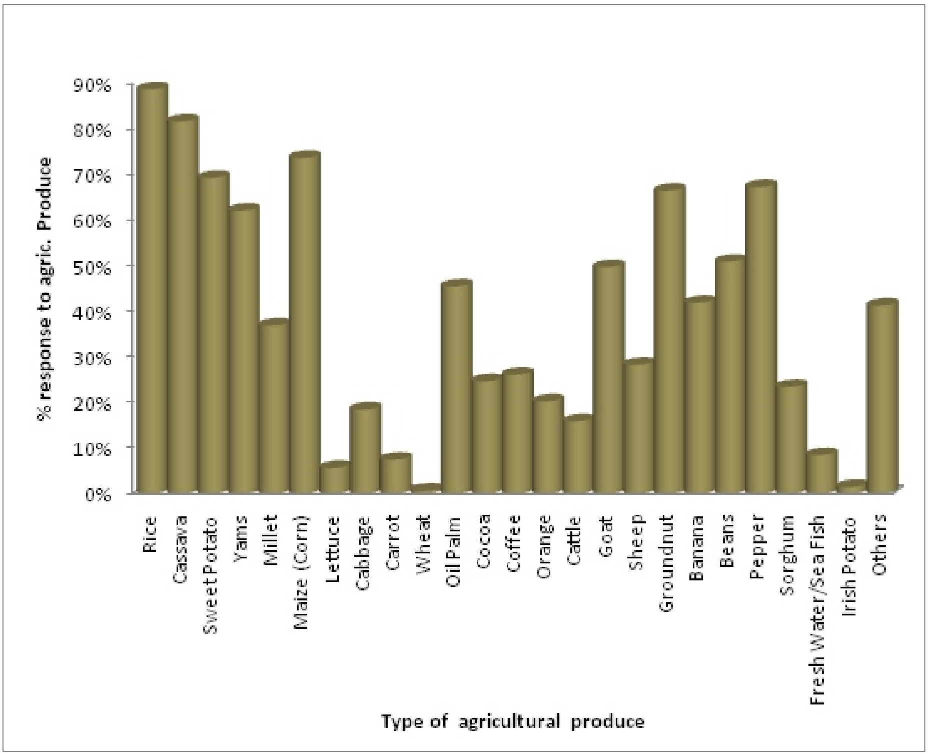



**Figure 7: Farmers' responses to agricultural produces across agro-climatic regions in Sierra Leone**

The findings also examined crop diversity across the various agro-climatic regions in Sierra Leone. This was in bid to observe changes that might have occured in agricultural production patterns in each of the regions. The agro-climatic regions were developed based on certain physiograhic and climatic characterics. Crops that respond well to these characteristics were identified in each of the regions. The findings show that rice, cassava and pepper are markedly grow across all the agro-climatic regions in the country (see figure 8)- given some directions on what staple food(s) Sierra Leoneans are presently leaning on. Groundnut production is highly practiced in the Savannah Woodlands, rainforests and transitional zones. Other crops are either found distinctly in each of the regions or two. For instance, cash crops such as cacao and coffee show clearly in the rainforest region; banana in the savannah woodlands; cabbage in the coastal plains, and sorghum in the trainsitional zone. Oil palm production on the other hand is high in the savannah woodlands and to some extent in the rainforest region. Also sweet potato is markedly grown in the savannah woodlands and coastal plains.


**Figure 8: Map showing agricultural diversity across the agro-climatic regions in Sierra Leone**

*NOTE: This map was adapted for the purpose of this research. The agro-climatic regions were not drawn to scale but were rather sketched from the original map depicting these regions. Hence diversity of agricultural produces does not necessarily mean that the positions on the map are the specific harvest areas. It shows the generalized picture of the types of major produces in each region.*

### 4.3 Indigenous and Emerging Technologies and Innovations for Climate Change Problems in the Study Area

The observation of/and agreement on climatic changes must be followed by responses to its impact on agricultural production as a focus in the findings. Almost all of the famers (99.6%) admitted that indeed they have experienced in one way or the other climate-related problems in their farming activities. This gives a clear picture of the extent to which climate change impacts have been felt in the country. The major problems reported by farmers, which they deemed have affected them most are low crop yields and prevalence of pests and diseases. An approximated 96% and 89% of farmers reported of low crop yields and pests and disease proliferation respectively (see table 7). In addition hunger was reported (87%) to be one of the resultant effects of climate change impacts on the farming. Specifically, the findings reveal that extreme hunger is felt among farm families in the savannah woodlands (97%), transitional zone (97%) and rainforest (95%) regions as opposed to those in the coastal plains (58%). This again explains in part, much of the food security/food self-sufficiency and poverty situations among farmers that dwell at distanced proximity to the city.

**Table 7: Farmers' responses to types of climate-related problems**

| Type of climate -related problems | Agro-Climatic Region | | | | |
|---|---|---|---|---|---|
| | Coastal Plains N=125 | Rain Forest N=125 | Savannah Woodlands N=125 | Transitional Rainforest/ Savannah Woodlands N=125 | Total N=500 |
| Prevalence of pests & diseases | 104(83.2%) | 101(80.8%) | 118(95.2%) | 123(98.4%) | 446(89.4%) |
| Low crop yields | 105(84.0%) | 125(100.0%) | 123(98.4%) | 125(100.0%) | 478(95.6%) |
| Hunger | 72(57.6%) | 119(95.2% | 121(96.8% | 121(96.8%) | 433(86.6%) |
| Flooding | 10(8.0%) | 12(9.6%) | 30(24.0%) | 16(12.8%) | 68(13.6%) |
| Land sliding | 0(0.0%) | 0(0.0%) | 8(6.4%) | 0(0.0%) | 8(1.6%) |
| Thunderstorm | 65(52.0%) | 1(0.8%) | 53(42.4%) | 12(9.6%) | 131(26.2%) |
| Extreme drought condition | 2(1.6%) | 8(6.4%) | 57(45.6%) | 4(3.2%) | 71(14.2%) |
| Displacement from homes/farm sites | 7(5.6%) | 3(2.4%) | 2(1.6%) | 5(4.0%) | 17(3.4%) |
| Less fish catches | 47(37.6%) | 0(0.0%) | 8(6.4%) | 16(12.8%) | 71(14.2%) |
| Others | 97(77.6%) | 14(11.2%) | 112(89.6%) | 69(55.2%) | 292(58.4%) |

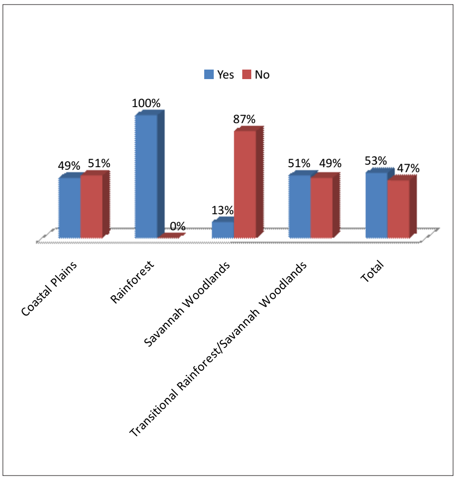
Adaptation practices to solve some of the impacting climate-related problems reported by farmers were also identified. Over twenty (20) ways in which farmers tend to respond to climate-related problems for agricultural production were noted in the findings. Meanwhile, findings show that farmers tend to maintain old traditional ways of responding to crop failures and animal deaths. The research underscores clearing around farm lands (81%), manual fencing of farm and setting of rodent traps (80%), green manure application (66%) physically clearing of un-burnt farm (64%), mulching (57%) and application of animal dung (56%) as the most highly adopted adaptation practices by farmers in Sierra Leone. However differences in practices were observed by agro-climatic regions. Farmers in the coastal plains and savannah woodlands admitted that on many occasions they move from unproductive zones/farmlands for high yields. Tree planting (60%) on the other hand was observed in the savannah woodlands. Also farmers in the savannah woodlands (79%) and rainforest (69%) agreed on change of crop varieties in periods of continuous failure and destruction. Adoption of modern innovative applications is rarely seen across the agro-climatic regions. Meanwhile irrigation of farm/garden and applying mixed animal feeds, capsule and powered tobacco were observed. (See table 8).

**Table 8: Adaptation practices in response to climate-related problems**

| Adaptation Practices | Agro-Climatic Region | | | | Total |
|---|---|---|---|---|---|
| | Coastal Plains | Rain Forest | Savannah Woodlands | Transitional Rainforest/ Savannah Woodlands | |
| | N=125 | N=125 | N=125 | N=125 | N=500 |
| Application of salt dung | 104(83.2%) | 3(2.4%) | 21(16.8%) | 11(8.8%) | 139(27.8%) |
| Irrigation of garden/farm | 32(25.6%) | 46(36.8%) | 41(32.8%) | 93(74.4%) | 212(42.4%) |
| Change of crop varieties | 8(6.4%) | 86(68.8%) | 99(79.2%) | 25(20.0%) | 218(43.6%) |
| Using kerosene and soap on plants | 10(8.0%) | 0(0.0%) | 5(4.0%) | 0(0.0%) | 15(3.0%) |
| Using crushed grasshoppers as pesticides | 12(9.6%) | 0(0.0%) | 9(7.2%) | 2(1.6%) | 23(4.6%) |
| Fencing farm and setting rodent traps | 59(47.6%) | 115(92.0%) | 102(81.6%) | 124(99.2%) | 400(80.2%) |
| Hunting | 44(35.2%) | 49(39.2%) | 99(79.2%) | 111(88.8%) | 303(60.6%) |
| Tree planting | 55(44.0%) | 61(48.8%) | 75(60.0%) | 6(4.8%) | 197(39.4%) |
| Mulching | 75(60.0%) | 33(26.4%) | 92(73.6%) | 85(68.0%) | 285(57.0%) |
| Harvest of bush yams | 12(9.6%) | 32(25.6%) | 83(66.4%) | 109(87.9%) | 236(47.3%) |
| Clearing around farm | 91(72.8%) | 111(88.8%) | 119(95.2%) | 86(68.8%) | 407(81.4%) |
| Performance of ancestral ceremony/spiritual invocation | 2(1.6%) | 0(0.0%) | 13(10.4%) | 88(70.4%) | 103(20.6%) |
| Physical clearing of un -burnt vegetation | 74(59.2%) | 6(4.8%) | 117(93.6%) | 121(96.8%) | 318(63.6%) |
| Applying animal dung to the soil | 101(80.8%) | 2(1.6%) | 58(46.4%) | 120(96.0%) | 281(56.2%) |
| Green manure application | 92(73.6%) | 9(7.2%) | 113(90.4%) | 118(94.4%) | 332(66.4%) |
| Applying mixed animal feed, capsule & powdered tobacco | 1(0.8%) | 1(0.8%) | 22(17.6%) | 73(58.4%) | 97(19.4%) |
| Creating fish ponds | 0(0.0%) | 1(0.8%) | 4(3.2%) | 1(0.8%) | 6(1.2%) |
| Using small-meshed fishing nets | 27(21.6%) | 0(0.0%) | 26(20.8%) | 2(1.6%) | 55(11.0%) |
| Using chemicals to catch fish | 1(0.8%) | 2(1.6%) | 1(0.8%) | 8(6.4%) | 12(2.4%) |
| Use of indigenous weather predictions | 51(40.8%) | 25(20.0%) | 28(22.4%) | 49(39.2%) | 153(30.6%) |
| Use of scientific weather forecasts | 1(0.8%) | 2(1.6%) | 4(3.2%) | 2(1.6%) | 9(1.8%) |
| Change of farming dates | 37(29.6%) | 36(28.8%) | 115(92.0%) | 17(13.6%) | 205(41.0%) |
| Use of rain water harvesting for farm irrigation | 1(0.8%) | 29(23.2%) | 1(0.8%) | 0(0.0%) | 31(6.2%) |
| Use of underground water for farm irrigation | 13(10.4%) | 5(4.0%) | 67(53.6%) | 1(0.8%) | 86(17.2%) |
| Construction of small dams for irrigation | 62(49.6%) | 3(2.4%) | 67(53.6%) | 0(0.0%) | 132(26.4%) |
| Change from farming to trading/other occupation | 13(10.4%) | 0(0.0%) | 3(2.4%) | 3(2.4%) | 19(3.8%) |
| Shift from crop production to animal production | 4(3.2%) | 3(2.4%) | 1(0.8%) | 2(1.6%) | 10(2.0%) |
| Shift from animal production to crop production | 2(1.6%) | 0(0.0%) | 1(0.8%) | 0(0.0%) | 3(0.6%) |
| Move from climate risk/unproductive zone/farm land | 82(65.6%) | 0(0.0%) | 105(84.0%) | 1(0.8%) | 188(37.6%) |
| Adoption of agro -forestry | 8(6.4%) | 0(0.0%) | 19(15.2%) | 1(0.8%) | 28(5.6%) |
| Others | 16(12.8%) | 125(100.0%) | 5(4.0%) | 4(3.2%) | 150(30.0%) |

Farmers' agreed that their adopted adaptation strategies have also been complimented by indigenous meteorological predictions. It was observed that small-holder farmers, particularly those in the rainforest (100%) and transitional zone (51%) have been using predictions to meet their start-of-farming periods[3]. But it was reportedly agreed that these predictions have failed them (44%) in many cases. (see Figure 9)

[3] *In-depth discussions on the meteorological predictions are made in the report on FGDs in the next section.*



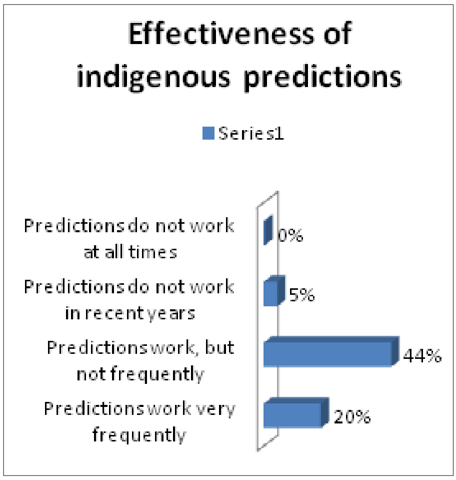




**Figure 9: Responses to indigenous weather predictions and effectiveness**

### 4.4 Outcomes of Focus Group Discussions on Farming Systems Adaptation for Climate-related Problems

A total of ten (10) Focus Group Discussions (FGDs) were done with selected farmers' groups across the four (4) agro-climatic regions in the country. The main aim of the FGDs is to have an in-depth understanding of the actual climate-related problems impeding farmers' activities and high agricultural productivity in the country and the associated indigenous responses to help ameliorate such problems. Qualitative analytical procedures were taken and documentations of the solicited information were done in blocks of agro-climatic regions.

#### A. The Coastal Plains

Four (4) FGDs were conducted in the coastal plains with farmers' groups namely: (i) Youth Coalition for Peace and Agricultural Development; (ii) Tamaraneh Farmers' Group; (iii) Vegetable Growers Association- Regent Village, and (iv) Kalameara FMP Co-operative Society.

**a. Key Issues/Problems:** Farmers complained of the occurrence of short and heavy rainfall in an uneven pattern (usually falling late) in recent years as opposed to the past when rainfall used to be for a long duration. This has been accompanied by heavy winds and thunderstorms. Excessive heat and bright sunlight for a long duration, as well as less cold were also reported. Such unanticipated weather events, according to farmers have led to:

> Seeds sown on the soil germinate poorly;

> Over flow of water in swamps impeding farmers to take-up swamp rice farming;

> Late rainfall has encouraged the proliferation of pest such as grasshoppers, termites, bugs, etc, and fungal diseases that often affect crops and farm animals leading to dramatic reduction in yields;

> Crops such as lettuce now take longer days (45 days on average) for harvest instead of the usual 21-30 days. Runner beans no longer grow well in the absence of artificial fertilizer;

> Too much heat leading to warm sea both day and night have led to numerous rotten fish in short duration before reaching the land. Dead fish floating on sea surface have also been observed in

the past two years. In particular there has been significant reduction in the quantity of species called Herring.

> Heavy wind and intermittent flooding destroying boats, houses and killing several people.

**b. Indigenous Meteorological Predictions:** Various traditional meteorological predictions used by indigenous farmers to combat the problem of lost of farming dates were documented from the FGDs in the coastal plains. However farmers reported that most of these predictions have failed them in recent years. Some of these predictions and their corresponding evaluations are given in Table 9.

**Table 9: Description of indigenous meteorological predictions in the coastal plains**

| Description of Predictions | Have worked well? |
|---|---|
| Lunar Direction: Leaning of the new moon in a westward direction signifies heavy rainfall in that particular month. Towards the east, hot dry season would be expected. | No for 4 years now. |
| Appearance of a flower called "Lortor" in Loko language indicates the beginning of raining season. | No for 4 years now |
| Croaking of frogs indicates the beginning of raining season. | No for 4 years now |
| Appearance of a large number of termi tes at the beginning of raining season indicates excess rainfall and long raining season. | No for 4 years now |
| Crying sound of a particular insect called "Tengai" in Loko indicates the beginning of dry season. | Hardly works in recent years |
| Dividing cloud with blue coloured sky in between signifies very hot dry season. | Hardly works in recent years. |
| Three particular stars appearing in a straight line at 19:00 GMT indicates hot dry season. | Hardly works in recent years |
| Sea appearing black at a distance with dark cloud signifies rains. | Not working recently |
| Clear sea and excess wind indicates hot sunny day and dry season. | Not working recently |
| Germination of yams in March indicates that rainy season is drawing near. | Fails in recent years. |
| Appearance of certain types of snakes signifies raining season. | No longer works. Rains come without seeing them |
| Appearance of mushrooms and millipedes indicates rainy season. | Still works well |
| Appearance of cattle egrets indicates that raining season is drawing near. | Still works well |

**c. Farming Systems Adaptations and Indigenous Technologies/Innovations:** Farmers were in place to explain the various adaptation techniques (including emerging innovations) they have adopted to tackle the problems climatic events have posed in their farming activities. The documented responses a given in Box 1.

**Box 1: Adaptation/Innovations Practiced in the Coastal Plains**

**1. Control of Grasshopper Prevalence on Crops**

Farmers complained that grasshoppers eat the leaves and stem of cassava and potatoes. To minimize this infestation, farmers have been killing these insects physically. The farmers observe that grasshoppers bunch themselves around the stem of plants. Every morning the farmers place a container filled with water under the stems and shake the grasshoppers to fall in the water and die. This process continues until harvest time is reached. Meanwhile, this activity has been improved on. An empty bag is used to capture the grasshoppers early in the morning when they are clustered together. They are then killed, crushed and stirred with water. This results to a very stinky odour that is sprayed on plants; and it has been very help in preventing further attacks by grasshoppers.

Also farmers tie a bunch of dry grass on sticks and set fire on it. The flame is then slightly moved over the leaves, which destroys the grasshoppers without any harm on the leaves. In addition, a collection of cigarette filter is stirred with water and placed in the sun for a while. After that, the water is immediately poured into a watering can and is then sprayed on the plants. This kills grasshoppers and other insects that affect the plants.

**2. Control of Soil Bugs**

Farmers agreed that soil bugs eat the root and stem of plants such as rice, pepper, etc.  To solve this problem, a red chemical called 'malatium' is mixed with water and sprayed on plants, especially on the stem and roots. This kills away the bugs and it usually has long-term effect.

**3. Control of Caterpillars**

Caterpillars are said to destroy plants such as okra and other vegetables by eating the leaves. They are driven away by collecting appreciable amount of dry ash and sprinkling it on the plant.

**4. Control of Birds Flu**

Birds' flu was also reported to be common in recent years. It attacks birds like ducks and domestic fowls. One control measure adopted by farmers is mixing chloramphenicol (red and yellow) capsule with water; and is then given to the infected birds which helps them recover very fast.

**5. Control of Sheep and Goat Flu**

Farmers explained that this kills the animal very quickly. Farmers use palm wine and Oral Rehydration Salt (ORS) to heal the animals from the flu. An appreciable amount of palm wine is diluted with ORS and given to these animals at frequent intervals. It helps them return to normal condition very fast. Sometimes animals are also attacked by ticks. The affected animals are dipped into palm wine to prevent them from tick invasion.

## B. The Rainforest Region

Two (2) FGDs were done in this region. Farmers groups that were engaged are the "Tegloma Farmers' Association-Bandajuma Town" and "Amuloma Farmers' Youth Organisation-Bayama".

**a. Key Issues/Problems:** Farmers in the region agreed that the weather has absolutely changed when compared to the past. They reported the observance of abnormal rainfall events- taking place either early or late. This according to them has not been witnessed in previous years. The major problems they reported encountering are poor crop and animal yields which results from untimely farming activities, severe dry conditions, pest and disease prevalence.

**b. Indigenous Meteorological Predictions:** The farmers in the rainforest region also mentioned some traditional predictions they have been using during their farming periods. These predictions were also documented as shown in Table 10.

**Table 10: Description of indigenous meteorological weather predictions in the Rainforest region**

| Description of Predictions | Have worked well? |
|---|---|
| The crocking of frogs determines rainfall. | Hardly works in recent years |
| Cloud at the top of a mountain asa belief in some areas signals rainfall and better yields in the year. | Yes |
| Continuous calling of the young sheep by the mother indicates the arrival of rains. | Still works |
| The steady position of the plantain leaves determines rainfall | Hardly works in recent years. |
| Ancestral Ceremony can bring rains in times of dryness. | Hardly works in recent years |

**c. Farming Systems Adaptations and Indigenous Technologies/Innovations:** Very interesting farming systems adaptations and emerging indigenous technologies and innovations were also observed in the rainforest region. These technologies have been tested and rated by the farmers themselves as very effective in the value food chain. Box 2 presents some of the explanations gathered from farmers in the region. Some of these emerging technologies and innovations were introduced by organizations such as GTZ and "Bio-united Program on Organic Manure Farming System".

## Box 2: Emerging Technologies /Innovations Practiced in the Rainforest

### 6.Controlling Post-harvest Lost of Coffee, Cacao and Cereal Crops through Solar Dryer Technology and Innovation

Post-harvest losses have often been one of the problems faced by indigenous coffee and cacao growers in the rainforest region. This has had negative impacts on the livelihoods of farmers due to spoilage, physical loss, quality degradation and contamination. Coffee and Cacao have in the past been the main export cash crop source of earning in Sierra Leone. Export has fallen dramatically due to the stated problems in addition to poor road infrastructure. The recent and most affordable and effective technology that has been introduced in the rainforest is Solar Drying Technology and Innovation. The solar dryers apply high temperatures, faster drying rates and lower final moisture contents. The high temperature generated acts as deterrent to insect and mould growth and the products are protected from dust. The Solar drying machine operates by starting a generator that supplies air which produces flame in the primary collector, which then supplies heat to the drying chamber until the seeds are dried up and collected into the secondary collected. The figures below show how this technology works. The Polythene solar dryer is another innovative way of applying natural solar energy for high quality product for sales in the market. It is characterized by a transparent polythene material, used as a greenhouse to trap the sun's rays. This protects the product from rain and wind and reduces the scale of labour.

*The Solar Drying Machine*

*The Polythene Solar Dryer*

The Solar drying technology and innovation, according to farmers are comparatively cheap and simple to use and have recently raised the earning power of farmers and traders.

### 7.Control of high Termite Prevalence in Swamp/ Swamp irrigation

Farmers reported that termites also serve as impediment in their swamp rice farming. As a control measure, lime water is often poured in swamps, which kills the insects. Through training from GTZ, farmers are also practicing local irrigation technology, and water has been easily channeled to

**C. The Savannah Woodlands**

Focus Group Discussions were held with two (2) farmers' groups in the Savannah Woodlands as well. The groups engaged were: (i) “Cam Wok Agricultural Farmers Corporative-Gbawuru II”, and “United We Stand Farmers Association”.

**a. Key Issues/ Problems:** Start-of-season is no longer known by farmers in the Savannah Woodlands. They complained of the relative yearly alteration in the length of rainfall- sometimes long and sometimes short and erratic. According to farmers in this region, there has been a “7-days” rainfall- a period that continuous rainfall is observed for seven consecutive days; but this no longer occurs in recent years. They are also observing long and hot drying season, and heavy cold and chilly wind. To them the region is known to be cold, but the present cool weather condition is gradually exceeding their tolerance capacity. These phenomenal weather events have resulted in one way or the other in the following farming problems in the region:

- Never-dry streams are presently seen dried up- resulting to disease proliferation such as cholera- greatly posing burden on farmers during their farming activities.
- The extreme cold conditions has often resulted to frequent marked death of creations and stunting in crop growth.
- Swamps dry up and crack, making it impossible to grow any type of crop on the lands.
- Frequent and extreme cold conditions also prevent farmers from carrying out their normal farming activities.
- Disease and pest proliferation have in many cases led to the death of animals and destruction of plants.

**b. Indigenous Meteorological Predictions:** Various traditional predictions that farmers' have been using in the Savannah Woodlands to determine the farming seasons were also identified. Meanwhile they generally confessed that most of these predictions are no longer of good use to them (see table 11).

**Table 11: Description of indigenous meteorological weather predictions in the Savannah Woodlands**

| Description of Predictions | Have worked well? |
|---|---|
| Hot temperatures in the early months of the year had been used to predict that early rainfall in that year. | Hardly works in recent years |
| Long Harmattan indicates short dry seasons | Yes |
| Disappearance of lizards signifies the occurrence of hot dry season. | No in recent years |
| A bird named as “Gbokidondo” in Limba reminds farmers about due time to work. It cries “gbokidondo” to tell farmers that rains are over. Also when farmers heard it cry “ekokonday”, it tells them to stand up for it is due time to work. | No in recent years |
| Drying up of streams signifies dry season | Hardly works in recent years |
| Appearance of fresh cotton tree signifies the approach of rainy season | Hardly works in recent years |
| Appearance of a fish called “Cowreh” predicts that thunderstorm is about to occur | No in recent years |
| Wind blowing in a southward direction indicates dry season | Hardly works in recent years |
| The year farmers see an animal called “Dekpelemgbeso” signals expectation of good yields that year. | Hardly works in recent year |
| A bird called “Tabadufa” in Fullani language informs farmers about early rainsthrough it cries at 04:00 GMT in the morning and 19:00 GMT in the evening. | No in recent years |
| A surat in the Holy Kuran pronounced ‘AYATHALKOORSIYOU’, when read would neither prevent rodents from the farm, nor destroy the crops. | Yes |

**c. Farming Systems Adaptations and Technologies/Innovations:** No new/ emerging technologies/innovations were observed in the Savannah Woodlands. Meanwhile farmers have been using some adaptation strategies to cope with the changing climatic impacts in their farming activities. In particular, the most common practices include: (a) Clearing round farmlands to scare rodents; and (b) Using hand-dug wells and small dams for irrigation purposes.

### D. The Transitional Rainforest/Savannah Woodlands

Two farmers' groups were also engaged on the FGDs in the Transitional Zone- the "Deegloma Farmers Association-Mokassie" and "Muude (ours) Farmers Association- Dandabu".

**a. Key Issues/Problems:** Farmers in the transitional zone reported fluctuating patterns in climatic parameters such as rainfall, temperature and wind. This according to them, has caused serious problems in their farming activities:

> Unanticipated rainfall patterns have often resulted to un-burnt farms, wild weed encroachments- which lead to low crop yields, less earning power to purchase seeds, agricultural tools and poor living standards of farmers.

> Appearance of swam of insects such as grasshoppers have in recent years led to the destruction of young shoots of crops before maturity.

> The flowering period of crops such as beans, mangoes, etc have often been disrupted by untimely rainfall and heavy winds- leading to food crop damage during flowering stage.

> Excess heat and less rainfall have often resulted to the frequent death of livestock such as goat, sheep, fowls, pigs, ducks, etc.

> Short and erratic rainfall also causes overflow of water on farmlands- particularly common during the flowering stage of plants.

**b. Indigenous Meteorological Predictions:** Farmers in the transitional region on the other hand agreed on the fact that they have indeed observed weather patterns through traditional predictions. They however reiterated that most of these predictions no longer serve them well in recent years as a result the acrobatic patterns of the weather systems. Table 12 presents some of these predictions.

**Table 12: Description of meteorological weather predictions in the Transitional Rainforest/Savannah Woodlands**

| Description of Predictions | Have worked well? |
|---|---|
| Lunar Direction: Leaning of the new moon in a westward direction signifies heavy rainfall in that particular month. Towards the east, hot dry season would be expected. | No in recent years |
| Cold and chilly wind indicates the arrival of rains | No in recent years |
| Crying of the Kennedy bird and the singing of a pigeon signifies hot sunlight | No in recent years |
| Wind blowing northwards signifies raining season | No in recent years |
| Excessive heat from the ground signifies rains | Hardly works in recent years |
| The appearance of large number of soil organisms indicates thearrival of rainy season | Hardly works in recent years |
| The appearance of insects called "Kpaagbelui" in Mende language during farm burning period signals that the farms will fail to burn. | Yes. |
| Sprouting of leaves of a flamboyant flower indicates the arrival of rainy season | Yes |
| Continuous dew formation signifies the time for dry season. | Hardly works in recent years |
| Spiritual invocations through pouring of libations during low rainfall brings rain | Fails in recent years. |

**c. Farming Systems Adaptations and Technologies/Innovations:** New innovations are rare in the transitional zone. Meanwhile farmers reported changing old crop varieties with new ones that cope with the weather systems. Presently the new variety called 'Pla-Camp' is regarded by farmers as new hope to reduce the on-going climatic shocks in their farm production. According to the farmers, this crop is a variety that does not question the type of soil. It is a fast bearing rice and very fruitful. Other new varieties include 'Flajuai' and 'Ngenekie' which are also fast-growing and very palatable.

## E. State of Climate Change and Variability across Agro-climatic Regions

The state of climate change and variability were observed from this study based on secondary information from existing data. The IPCC TAR on climate change for Sierra Leone presents a baseline scenario based on data from 1961 to 1990. Data were collected from meteorological stations from Lungi, Bonthe, Kabala, Njala and Bo. Presentations on the pilot survey are based on climatic parameters such as rainfall and temperature.

Rainfall has been taken normal routine of occurrence between 1960 to 1961- during which the highest amount of rainfall was observed between May and November (see Figures 10 and 11). From the period 1961 to 1990 rainfall average in the country was about 2746 mm. It varied from 3659 mm at Bonthe (along the coastal plains), 2979 mm at Lungi (along the coastal plains), 2618 mm at Kabala (in the Savannah Woodland) and 2618 mm at Bo (Savannah Woodland and Rainforest transition). Rainfall average was however projected to decrease by 3% (using the CSIRO-TR model) and 10% (using HADCM2 model) by the 2100

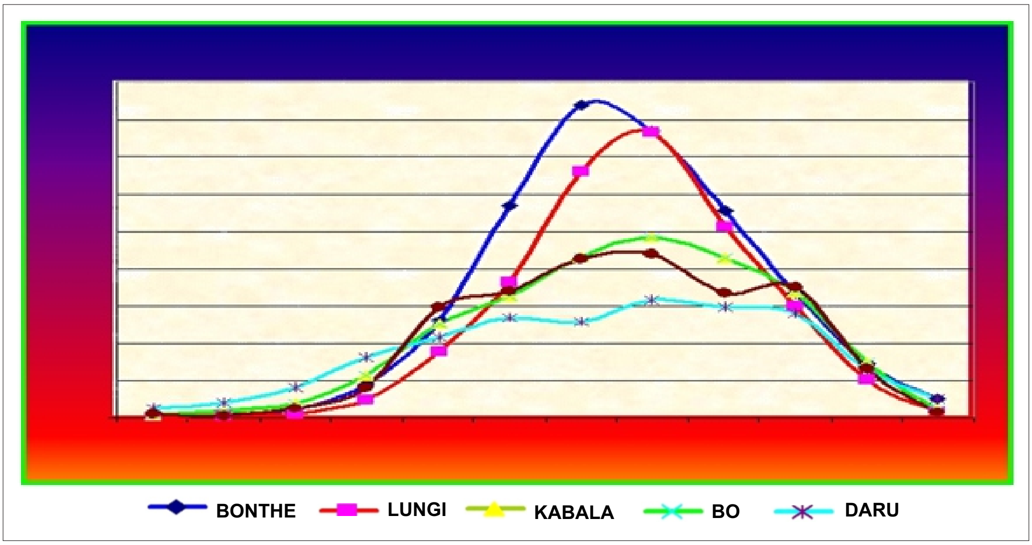



**Figure 10: Rainfall estimates by available meteorological stations**

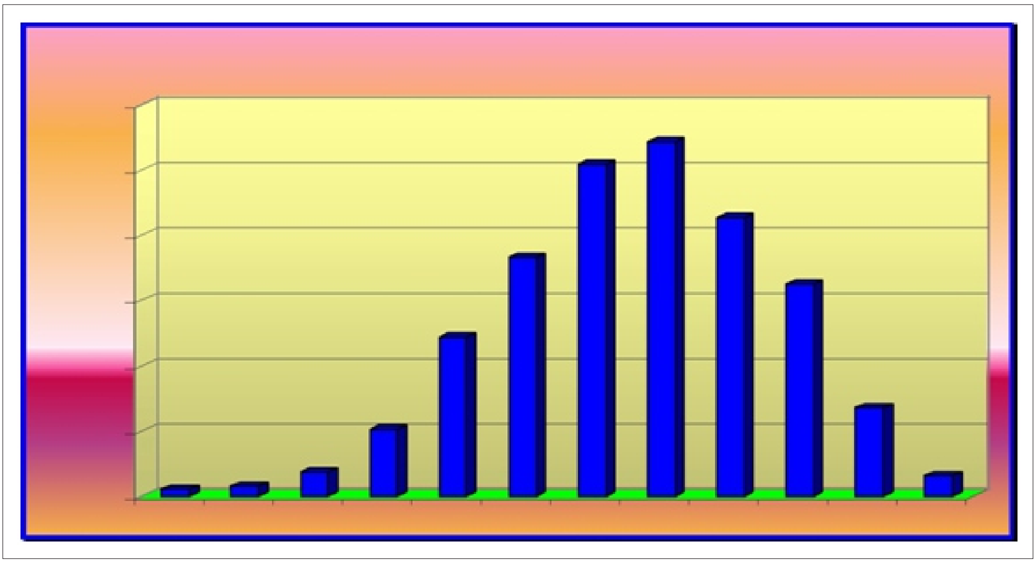


**Figure 11: Mean monthly estimates of rainfall**

Similarly the mean long-term air temperature regime has normally shown a monthly average of 260-280C from June to October with a maximum of 320C. Temperature of up to 360C has also been recorded particularly in the month of March. Mean minimum temperature of 200C has been observed- mostly in the months July and August, mainly due to continuous cloudiness and rain during these months (see figure). The average annual temperature as recorded from 1961 to 1990 is 26.70C. When this annual average temperature was combined with the 2*CO2 output from the GCMs, the project increase would be 7 to 9% by 2100. (See Figure 12 & Table 13).

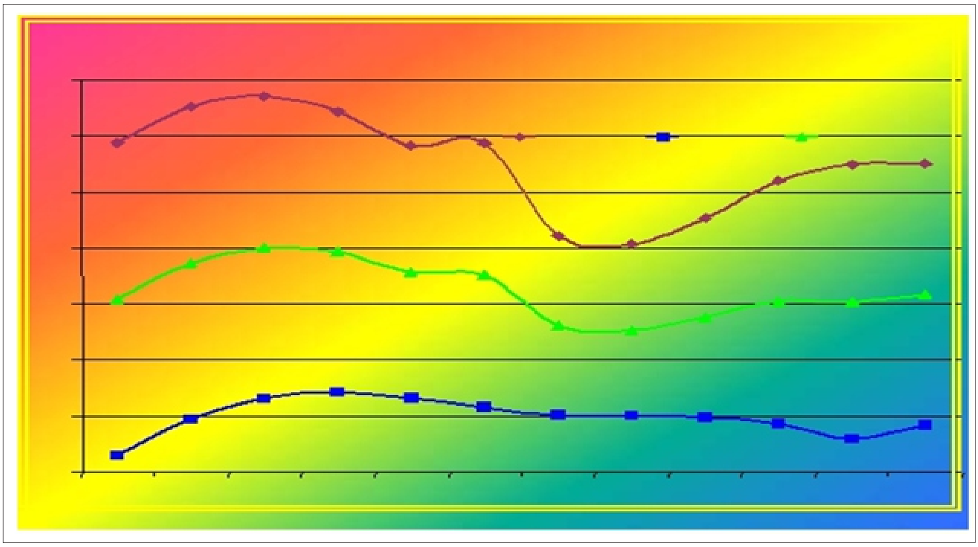


**Figure 12: Average monthly temperatures of Sierra Leone for the period 1961-1990**

**Table 13: Current climate (1961-1990) and projected climate change temperature scenarios at 2100**

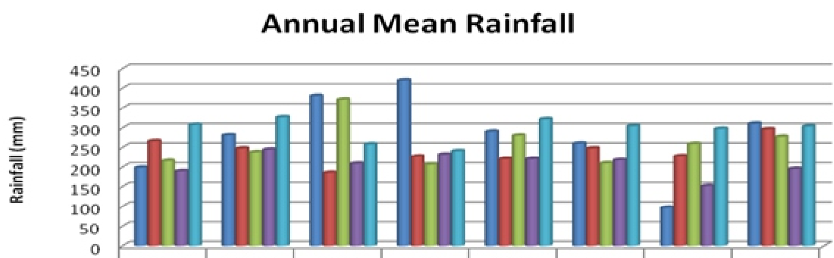
| Scenario | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | ANN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1961-1990 | 26.2 | 27.5 | 28.0 | 27.9 | 27.1 | 27.0 | 25.2 | 25.1 | 25.5 | 27.8 | 26.1 | 26.3 | 26.7 |
| HADCM2 | 28.7 | 30.1 | 30.5 | 30.6 | 30.2 | 29.7 | 27.6 | 27.4 | 27.8 | 30.0 | 28.5 | 28.8 | 29.2 |
| UKTR | 28.3 | 29.3 | 29.8 | 30.0 | 29.3 | 29.0 | 27.3 | 27.1 | 27.4 | 29.9 | 28.3 | 28.5 | 28.7 |
| CSIRO TR | 28.1 | 29.5 | 29.9 | 29.8 | 28.9 | 28.8 | 27.0 | 26.8 | 27.1 | 29.5 | 27.9 | 28.3 | 28.5 |
| ECHAM4 | 28.6 | 29.8 | 30.3 | 30.1 | 29.3 | 29.0 | 27.1 | 26.9 | 27.3 | 29.7 | 28.3 | 28.7 | 28.8 |

*Source IPCC TAR for Sierra Leone*

Recent data were also sourced from meteorological stations from Freetown, Bo, Makeni, Lungi and Bonthe in bid to understand variations in mean annual maximum estimates for rainfall and temperature in Sierra Leone.

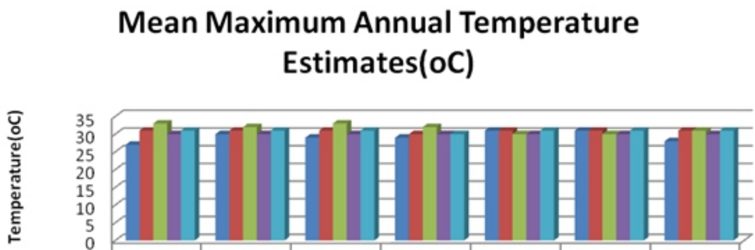
Random selection of yearly average estimates between 1991 to 2008 show relative uneven trend in rainfall as well as differences across agro-climatic regions. Bonth (along the coastal plain) seems to be having intensive downpour of rain fall averaging around 300mm compared to other regions. Other regions somehow show similar rainfall average with the exception of Lungi which shows relatively lower fluctuations in annual rainfall average. Freetown on the other hand experienced its lowest average in 2006 with an average rainfall of 97mm. (See figure 13)

Mean maximum annual temperatures seem to take similar trends but somehow higher in comparison to past estimates. Makeni (in the savannah woodland) however experiences a distinctively higher temperature regime- signifying that annual rainfall experienced is short and intensive. (See figures 13 and 14)




| | 1991 | 1993 | 1994 | 1996 | 2003 | 2004 | 2006 | 2008 |
|---|---|---|---|---|---|---|---|---|
| Freetown | 199 | 281 | 381 | 421 | 291 | 260 | 97 | 311 |
| Bo | 266 | 248 | 186 | 227 | 221 | 248 | 228 | 297 |
| Makeni | 216 | 238 | 372 | 207 | 280 | 210 | 259 | 277 |
| Lungi | 190 | 245 | 209 | 232 | 221 | 218 | 152 | 196 |
| Bonthe | 308 | 327 | 258 | 241 | 322 | 305 | 298 | 304 |

**Figure 13: Annual Mean Rainfall**




| | 1991 | 1993 | 1994 | 1996 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|---|---|
| Freetown | 27 | 30 | 29 | 29 | 31 | 31 | 28 |
| Bo | 31 | 31 | 31 | 30 | 31 | 31 | 31 |
| Makeni | 33 | 32 | 33 | 32 | 30 | 30 | 31 |
| Lungi | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| Bonthe | 31 | 31 | 31 | 30 | 31 | 31 | 31 |

**Figure 14: Mean Maximum Annual Temperatures**

Recent reports from CILSS/FAO/FEWS Net in October 2009 shows that though changes in climatic variables depicts slight increases, the impact of climate change is highly felt by vulnerable farm families in Sierra Leone. Rainfall is becoming erratic and small-holder farmers no longer have the ability to predict. The report shows that recent flood affected total of 30 localities, 499 farm families and 1157 acres of farm lands (see Table 14). The flood height was estimated to be 2.5 feet after 2 days destroying 28 houses and displacing 823 people (whose coping strategy was living on bush yams).

**Table 14 : Climate Variability Depicted by Flooding**

| CHIEFDOM | SECTION | VILLAGE | ECOLOGY | NO. OF FARM FAMILIES AFFECTED | TOTAL ACREAGE |
|---|---|---|---|---|---|
| Mambolo | Mambolo | Mambolo | Mangove | 46 | 85.5 |
| | Rowollon | Makoth | | 31 | 70.5 |
| | Robis | Robis | Asso Mangrove | 20 | 45 |
| | | Mando | | 126 | 276.5 |
| | | Rokethegbeh | | 20 | 48.5 |
| | | Malambay | | 35 | 72 |
| | Rotein | Rotein | Mangove | 40 | 92.5 |
| | Tombo -walla | Tombo Walla | | 7 | 26 |
| | | Makribo | | 9 | 25 |
| | | Robali | | 11 | 46 |
| | | Kalainkay | | 6 | 32 |
| | | Royal -Kankokon | | 4 | 9 |
| Total | | 12 | | 355 | 837.5 |
| Magbema | Kagbulor | Gbonkor Maria | Mangove | 17 | 47 |
| | | Mapangbo | | 2 | 4 |
| | | Rokeinhen | | 2 | 4 |
| | | Makasa | | 2 | 4 |
| | | Kabaya | | 4 | 11 |
| | | Gbonko-maparay | | 6 | 17 |
| | | Mayana | | 2 | 6 |
| Total | | 7 | | 35 | 91 |
| Bramaia | Kuluna | Kukuma | Bolis | 7 | 25 |
| | Konomaka | Kuluru | | 5 | 16 |
| | Kukuna | Teneba -Bramaia | Inland Valley Swamps | 1 | 2 |
| | | Bobalia | (IVS) | 1 | 3 |
| | Konimaka | Kabaya | | 3 | 11 |
| Total | | 5 | | 12 | 57 |
| Tonko Lima | Madina | Madina | Bolis | 5 | 8 |
| | | Banekeh | | 4 | 5 |
| | | Kasumle | | 11 | 14 |
| | | Petefu | IVS | 15 | 22 |
| | | Kamasasa | Boli | 51 | 111 |
| | | Yankanbor | IVS | 11 | 20 |
| Total | | 6 | | 97 | 180 |
| **Grand Total** | | **30** | | **499** | **1156.5** |

*Source: CILSS/FAO/FEWS NET (2009)*

## F. State of Capacity Building of Farming Communities to Adapt to Climate Change Impacts

Capacity building of farmers to adapt to climate change problems is crucial, if only sustainable agricultural development and steady economic growth should be achieved. Farmers must be able to respond to, prepare for and tackle climate change impacts through information, training and technical assistance. The research however revealed that farmers are aware of climate change. About 81% of farmers agreed that they have heard of some climate-related issues. Meanwhile, regional differences still show in terms of the extent on awareness raising on climate change. Farmers in the transitional zone seem to have less knowledge on climate change as do those in the other zones. Whilst those in the coastal plains (93%), rainforest (100%) and savannah woodlands (91%) admitted to have got some information on climate change, only 41% in the transitional zone agreed. In terms of gender perspectives, there seem to be close rate of accessing information between both male (80%) and female (86%) across the regions. (See figure 15)

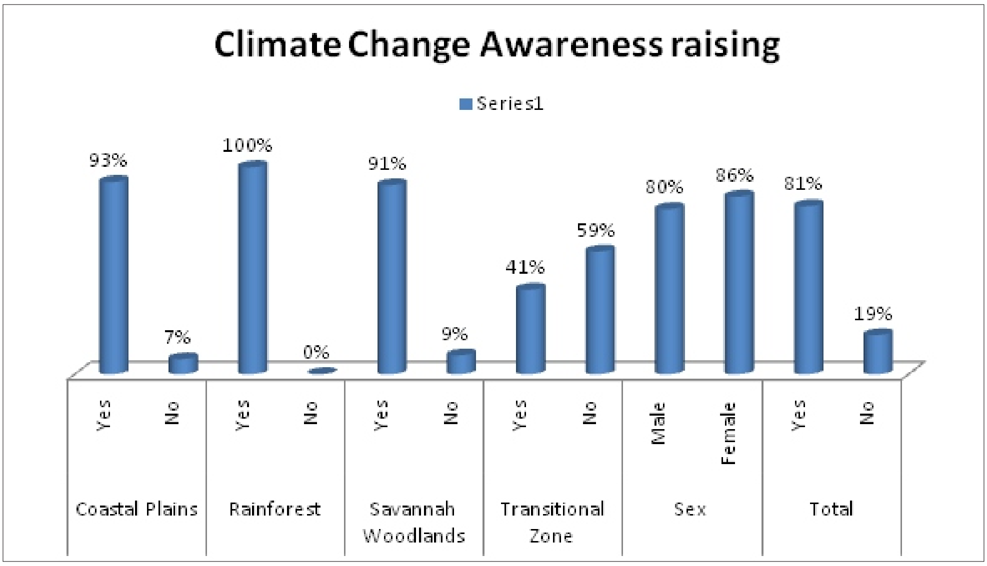



**Figure 15: State of Climate Change Awareness raising by agro-climatic region and sex**

Key information farmers reported acquiring include: (i) the importance of tree planting (59%); (ii) rainfall/weather information (57%), and (iii) impact of deforestation (54%). Again, a wide regional gap in terms of accessing this information does exist. More than half, (54%- 116 respondents) of all those getting information (295 respondents) on the importance of tree planting come from the coastal plains; 38% (112 respondents) come from the savannah woodlands, and the remaining 8% come from the other regions. Rainfall/weather information is mostly accessed by farmers in the rainforest (59%) and savannah woodlands (57%). Information on impacts of deforestation is on the other hand highly accessed by farmers in the coastal plains (93%) and savannah wood lands (86%). Most interesting also is that it was reportedly agreed by most farmers in the savannah woodlands (86%) that planting dates have been shared; and most of them (81%) acknowledged that the information were useful. (See Table 15)

## Table 15: Types of climate-related information accessed by farmers

| Type of climate - related information | Agro-Climatic Region | | | | Sex | | |
|---|---|---|---|---|---|---|---|
| | Coastal Plains N=125 | Rain Forest N=125 | Savannah Woodlands N=125 | Rainforest/ Savannah Woodlands N=125 | Male N=374 | Female N=126 | Total N=500 |
| Importance of tree planting | 116(92.8%) | 46(36.8%) | 112(89.6%) | 21(16.8%) | 213(57.0%) | 82(65.1%) | 295(59.0%) |
| Rainfall/weather information/forecast | 42(33.6%) | 74(59.2%) | 111(88.8%) | 51(40.8%) | 213(57.0%) | 65(51.6%) | 278(55.6%) |
| Impact of deforestation | 116(92.8%) | 19(15.2%) | 112(90.3%) | 23(18.4%) | 196(52.4%) | 74(59.2%) | 270(54.1%) |
| Planting dates | 29(23.2%) | 0(0.0%) | 106(85.5%) | 4(3.2%) | 108(29.0%) | 31(24.6%) | 139(27.9%) |
| Others | 2(1.6%) | 110(88.0%) | 26(20.8%) | 1(0.8%) | 101(27.0%) | 38(30.2%) | 139(27.8%) |
| Was the information useful? | | | | | | | |
| Yes | 116(92.8%) | 125(100.0%) | 114(91.2%) | 51(40.8%) | 298(79.7%) | 108(85.7%) | 406(81.2%) |
| No | 9(7.2%) | 0(0.0%) | 11(8.8%) | 74(59.2%) | 76(20.3%) | 94(18.8%) | 94(18.8%) |

Despite the fact that most farmers agreed they had heard some climate-related information, most of these information were gained from either a single source or through limited channels. Radio was reported to be the most widely used source of information - though farmers in the transitional zone seem to have limited access to it. Other means which farmers (mostly those in the savannah woodlands) reported are friends (82%) and community members (91%). Hence it is seen that awareness raising by both government and NGOs seem to be of less interest. (See table 16)

## Table 16: Sources of climate-related information accessed by farmers

| Source of information | Agro-Climatic Region | | | | Sex | | |
|---|---|---|---|---|---|---|---|
| | Coastal Plains | Rain Forest | Savannah Woodlands | Transitional Rainforest/ Savannah Woodlands | Male | Female | Total |
| Radio | 113(90.4%) | 83(66.4%) | 89(71.2%) | 50(40.0%) | 243(65.0%) | 92(73.0%) | 335(67.0%) |
| Government | 38(30.4%) | 0(0.0%) | 61(48.8%) | 9(7.2%) | 87(23.3%) | 21(16.7%) | 108(21.6%) |
| Friends | 29(23.2%) | 1(0.8%) | 103(82.4%) | 32(25.6%) | 128(34.2%) | 37(29.4%) | 165(33.0%) |
| News Papers | 6(4.8%) | 0(0.0%) | 11(8.8%) | 9(7.2%) | 21(5.6%) | 5(4.0%) | 26(5.2%) |
| Television | 2(1.6%) | 1(0.8%) | 2(1.6%) | 5(4.0%) | 8(2.1%) | 2(1.6%) | 10(2.0%) |
| NGOs/CBOs | 14(11.2%) | 49(39.2%) | 42(33.6%) | 7(5.6%) | 85(22.7%) | 27(21.4%) | 112(22.4%) |
| Community Members | 24(19.2%) | 0(0.0%) | 114(91.2%) | 20(16.0%) | 119(31.8%) | 39(31.0%) | 158(31.6%) |
| Others | 7(5.6%) | 125(100.0%) | 1(0.8%) | 3(2.4%) | 97(25.9%) | 39(31.0%) | 136(27.2%) |

Farmers' responses on assistance to solve climate-related problems seem to be very weak. Only an average proportion of 37% agreed to have acquired some forms of assistance to respond to shocks and climate-related uncertainties; and most of the farmers (100%) who affirmed to this come from the rainforest region. Only 15%, 9% and 8% of farmers from the coastal plains, transitional zone and rainforest respectively agreed on any form of assistance rendered to them. Moreover, more of female farmers seem to acquire assistance than male farmers.

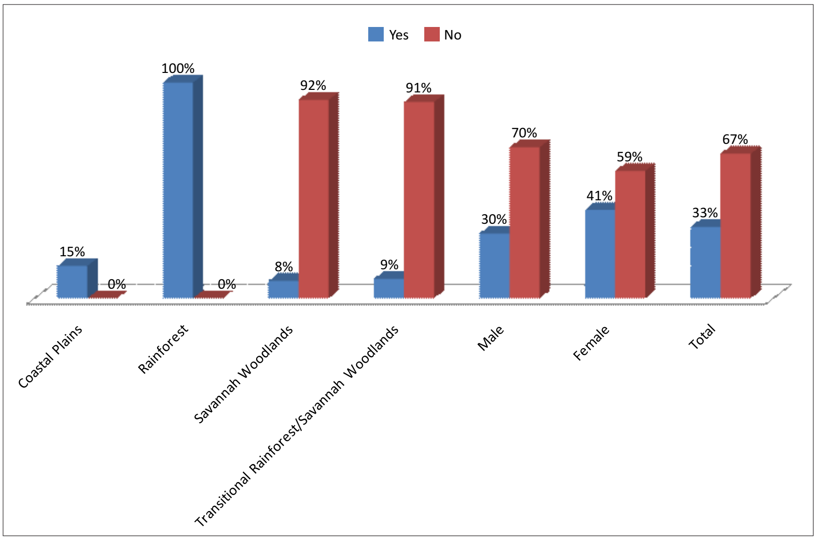
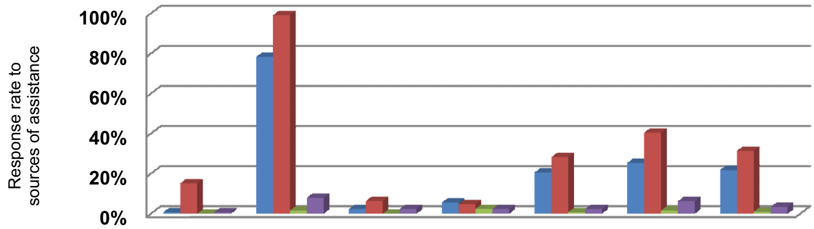



**Figure 16: Responses to assistant for climate-related risks in farming activities**

The research revealed that the sources of assistance are few and very difficult to access. NGOs/CBOs emerged to be the highest available source of assistance on farming systems adaptations; but even so, only few farmers (about 31%) have access to whatsoever form of assistance they render. The public sector was also reported to be assisting, but at low scale (22%). Another observation was that both the public sector and NGOs seem to be focusing more of the farmers in the rainforest than other regions- 99% and 78% of farmers in this region agreed to be receiving assistance from NGOs and the public sector respectively; whilst the second highest assistance coming from the NGO targets only 15% of farmers in the coastal plains. In addition, the proportion of female farmers receiving assistance from NGOs nearly doubles those of male farmers. (See figure 17)




| | Coastal Plains | Rain Forest | Savannah Woodlands | Transitional Rainforest/ Savannah Woodlands | Male | Female | Total |
|---|---|---|---|---|---|---|---|
| Government | 1% | 78% | 2% | 6% | 21% | 25% | 22% |
| NGO/CBO | 15% | 99% | 6% | 5% | 28% | 41% | 31% |
| Private Company | 0% | 2% | 0% | 2% | 1% | 2% | 1% |
| Community members | 1% | 8% | 2% | 2% | 2% | 6% | 3% |

**Figure 17: Sources of assistance to respond to climate-related risks**

The kinds of assistance are many, but (as revealed from the findings) very limited in supply. For instance supply of seed rice for farming came up as the most available kind of assistance, but only 30% of farmers mostly coming from the rainforest (24% of the total beneficiaries), reported accessing this kind of assistance. 20% of farmers also agreed to have received training on farm practices- again 19% of this proportion are farmers from the rain forest. In addition most of those receiving assistance on food supply and supply of farm tools/machinery are farmers from the rainforest region. Meanwhile, the most useful kinds of assistance such as provision of high yielding varieties (HYVs), post-harvest facilities, provision of credits/loan facilities, etc are of very low or no supply across the agro-climatic regions.

### Table 17: Types of assistance on climate-related risks in farming activities

| Type of assistance on climate related risks in farming activities | Agro-Climatic Region | | | | Sex | | |
|---|---|---|---|---|---|---|---|
| | Coastal Plains | Rain Forest | Savannah Woodlands | Transitional Rainforest/ Savannah Woodlands | Male | Female | Total |
| Provision of seed rice for farming | 16(12.8%) | 118(94.4%) | 6(4.8%) | 10(8.0%) | 104(27.8%) | 46(36.5%) | 150(30.0%) |
| Provision of chemicals/Pesticides | 1(0.8%) | 2(1.6%) | 1(0.8%) | 4(3.2%) | 7(1.9%) | 1(0.8%) | 8(1.6%) |
| Provision of credits/loan facilities | 0(0.0%) | 29(23.2%) | 2(1.6%) | 4(3.2%) | 24(6.4%) | 11(8.7%) | 35(7.0%) |
| Training on farm practices | 1(0.8%) | 93(74.4%) | 5(4.0%) | 1(0.8%) | 68(18.2%) | 32(25.4%) | 100(20.0%) |
| Training on weather forecasts | 0(0.0%) | 2(1.6%) | 1(0.8%) | 0(0.0%) | 1(0.3%) | 2(1.6%) | 3(0.6%) |
| Distribution of farming calendars | 0(0.0% | 0(0.0%) | 2(1.6%) | 0(0.0%) | 1(0.3%) | 1(0.3%) | 2(0.4%) |
| Provision of fertilizers | 1(0.8%) | 6(4.8%) | 1(0.8%) | 5(4.0%) | 8(2.1%) | 5(4.0%) | 13(2.6%) |
| Construction of small irrigation dams | 0(0.0%) | 1(0.8%) | 1(0.8%) | 0(0.0%) | 0(0.0%) | 2(1.6%) | 2(0.4%) |
| Provision of farm tools/machinery | 1(0.8%) | 84(67.2%) | 3(2.4%) | 3(2.4%) | 65(17.4%) | 26(20.6%) | 91(18.2%) |
| Provision of fast-growing seed varieties | 0(0.0%) | 3(2.4%) | 6(4.8%) | 7(5.6%) | 9(2.4%) | 7(5.6%) | 16(3.2%) |
| Provision of post-harvest facilities | 0(0.0%) | 3(2.4%) | 2(1.6%) | 0(0.0%) | 3(0.8%) | 2(1.6%) | 5(1.0%) |
| Provision of food | 1(0.8%) | 86(68.8%) | 5(4.0%) | 1(0.8%) | 65(7.4%) | 28(22.2%) | 93(18.6%) |
| Provision of settlements/farmlands | 0(0.0%) | 4(3.2%) | 3(2.4%) | 1(0.8%) | 4(1.1%) | 4(3.2%) | 8(1.6%) |
| Construction of fish ponds | 1(0.8%) | 0(0.0%) | 0(0.0%) | 0(0.0%) | 0(0.0%) | 1(0.8) | 1(0.2%) |
| Provision of fishing nets/boats | 0(0.0%) | 0(0.0%) | 0(0.0%) | 0(0.0%) | 0(0.0%) | 0(0.0%) | 0(0.0%) |
| Others | 18(14.4%) | 96(76.8%) | 1(0.8%) | 0(0.0%) | 77(20.6%) | 38(30.2%) | 115(23.0%) |

## G. Linkages between Climate Change, Human Health, Food Security and Local Economic Growth

Identifying the relationship between climate change impacts on health and the corresponding effects on food security and economic growth is also very vital in developing strategies for climate change resilience in a region. The burden of disease on the farming population reduces their working capacity, yields and local economic viability. It was therefore realized from the findings that various climate-related pests and diseases are strongly impacting on farmers across all agro-climatic regions in the country. Malaria emerged to be the highly prevalent disease across the regions, followed by yellow fever, diarrhea and cholera (see figure 18). Farmers also reported high episode of pest and disease effects on food crops and animals. Malnutrition also showed, giving some signals of shortages in sufficient balanced diet in the regions. Another very important issue that came up from the findings is that disability caused by climate-related events showed up (affecting about 2% of farm families) - also giving new directions on the importance of adopting research on disability adjusted life year (DALY) in agriculture.

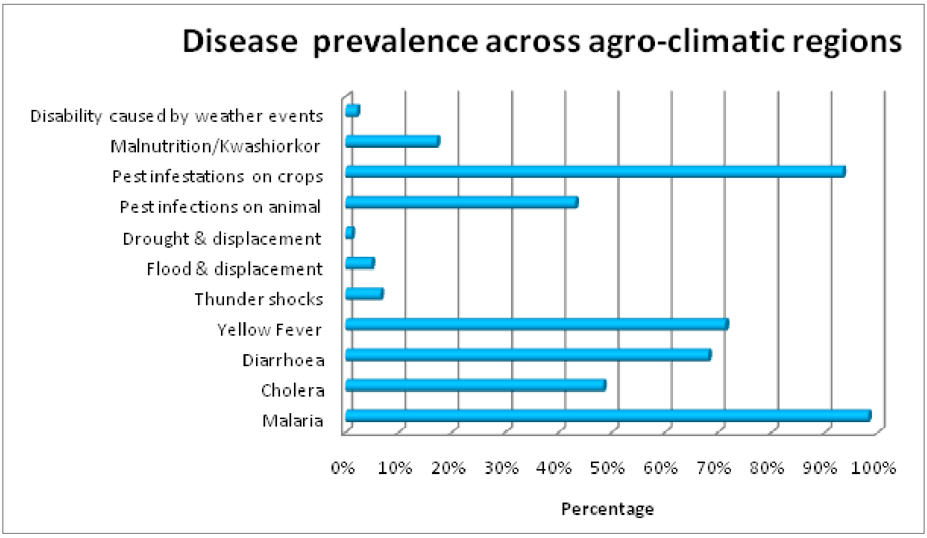



**Figure 18: Disease prevalence across agro-climatic regions**

Death/destructions resulting from the identified diseases were also noted. The findings revealed that at least two members in 3% of the farm families are exposed to malarial death. 2% and 1% of farmers also reported loosing at least two family members from the prevalence of cholera and diarrhea respectively. Farm animals have also been reportedly affected by climate-related pests and disease invasion. About 10% of farmers reported that lost of more than 10 animals from disease attacks in their regions. (See table 21 in appendix). The burden of disease on farmers in the farming activities was also shown to be very impacting. Nearly 50% of farmers reported having disease attacks that have led to an approximated two weeks on seek bed. Attacks that last for over one month on sick bed were also revealed by 15% of farmers across the agro-climatic regions. Meanwhile, regional analysis reveals that the burden of disease prevalence on farmers is mainly felt by those in the savannah woodlands (51% for over one month on sick bed) as shown in table 18.

**Table 18: Perceived responses of longest period taken on sick bed by family members**

| | Agro - Climatic Region | | | | |
|---|---|---|---|---|---|
| **What was the longest duration of recovery for any sick member of your family in the past five years?** | **Coastal Plains** | **Rain Forest** | **Savannah Woodlands** | **Transitional Rainforest/ Savannah Woodlands** | **Total** |
| Less than 7 days | 27(21.6%) | 28(22.4%) | 21(16.8%) | 17(13.6%) | 93(18.6%) |
| 7-14 days | 84(67.2%) | 61(48.8%) | 28(22.4%) | 71(56.8%) | 244(48.8%) |
| 15-21 days | 8(6.4%) | 23(18.4%) | 3(2.4%) | 22(17.6%) | 56(11.2%) |
| 22-28 days | 1(0.8%) | 9(7.2%) | 9(7.2%) | 9(7.2%) | 28(5.6%) |
| Above 28 days | 5(4.0%) | 4(3.2%) | 64(51.2%) | 5(4.0%) | 78(15.6%) |

The health impacts on agricultural productions, yields and economic returns were critically examined in the research findings. A simple bivariate excel based graphical analyses were done to determine the relationship between the combined effect of expenditure on health and farming activities on economic returns from farm produce. Given that the research can only account for 72.8% of this finding at R2=0.728 for % returns from farming (y) = 0.422x +0.022 (for which x is the combined expenditure on health and farming), the findings revealed that the combined expenditure on health and farming more than doubles the economic returns derived from agricultural production. That is, at any 1% rate of expenditure on both health and farming, the rate of economic returns from yields would only be at 0.4% (see figure 19). Meaning there is an inextricable link between additional expenditure on health burden from climate-related diseases and poor economic outcomes from agricultural production. For instance, taking expenditure on sickness alone (see figure 19 b) and its relationship with farming will give the linear relationship, y= 0.649x + 0.059 at R2=0.494. This will yield 0.7% rate of economic returns for a 1% expenditure on climate-related disease burdens. Meaning expenditure on health will lead to a 30% loss in returns and that a reduction of just 30% of expenditure on sickness will put farmers return to an equilibrium state. Also as shown in figure 19 a, it was revealed that expenditure on farming has less impact in the absence of any externality such as sickness, diseases proliferation on food crops and animals, etc. Given the relationship, y= 0.967x + 0.001 at R2= 0.925, a 1% investment on farming will be equal to an economic return at an approximated 1% rate. Thus conclusively, just a 30% decrease in all expenditure on climate-related sicknesses and very little reduction in high investment on farming through the introduction of certain adaptation strategies will lead to an increase in the earning power of small-holder farmers and local economic growth.

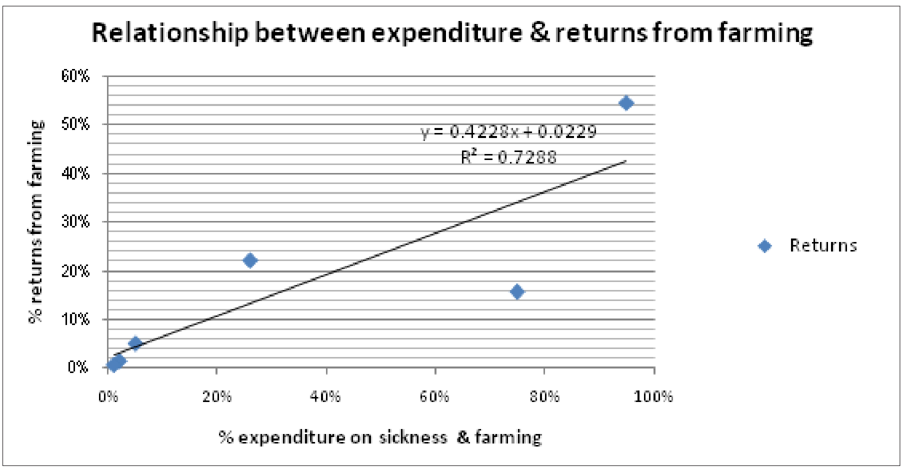
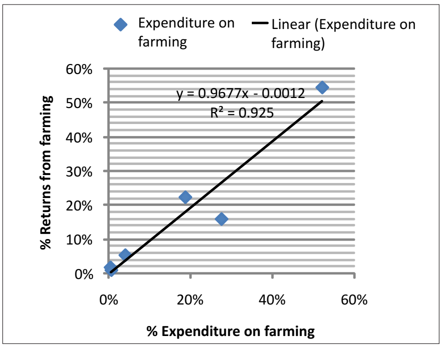
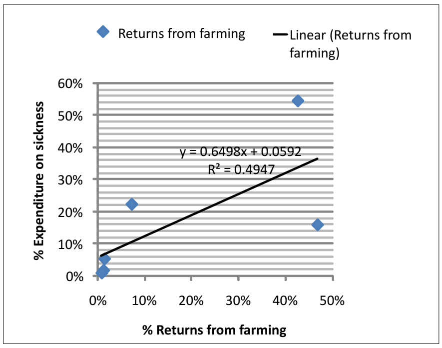



**Figure 19: Expenditure on sickness versus returns from agricultural produces**




19 a. expenditure on farming vs. returns from farming




19 b. expenditure on sickness vs. returns from farming

Farmers' perception of the impact of health on their farming activities was somehow negative. Almost half (49%) of all farmers, mostly from the coastal plains (72%) and the transitional zone (65%) perceived low yields in the year they experienced longest period on sick bed/high cost on sickness in the past five years. Meanwhile on the contrary, it was perceived by farmers in the coastal plains to be less impacting, mainly due to less expenditure (see tables 21 and 22 in the appendix).

**Table 19: Nature of yields in the year of highest expenditure on sick bed**

| | Agro-climatic Regions | | | | |
|---|---|---|---|---|---|
| **Yields in the year of longest time on sick bed/highest expenditure on sickness** | **Coastal Plains** | **Rainforest** | **Savannah Woodlands** | **Transitional Rainforest/Savannah Woodlands** | **Total** |
| Extremely low | 12(9.7%) | 17(13.6%) | 0(0.0%) | 16(12.8%) | 45(9.0%) |
| Somehow low | 23(18.5%) | 57(45.6%) | 3(2.4%) | 19(15.2%) | 102(20.4%) |
| Low | 89(71.8%) | 51(40.8%) | 22(17.6%) | 81(64.8%) | 243(48.7%) |
| High | 0(0.0%) | 0(0.0%) | 64(51.2%) | 0(0.0%) | 64(12.8%) |
| Somehow high | 0(0.0%) | 0(0.0%) | 36(28.8%) | 8(6.4%) | 44(8.8%) |
| Extremely high | 0(0.0%) | 0(0.0%) | 0(0.0%) | 1(0.8%) | 1(0.2%) |

Most farmers (about 92%) agreed that they have had agricultural reserves in the past five years particular in the year they experienced high expenditure on sickness. Meanwhile, most of these reserves, according to them went back to farming activities and feeding of family members. Only few farmers- 54% and 42% in the savannah woodlands and transitional zones respectively agreed making reserves for external shocks and 55% each from the coastal plains, savannah woodlands and transitional zones acknowledged using some reserves for marketing purpose. (See figure 20)

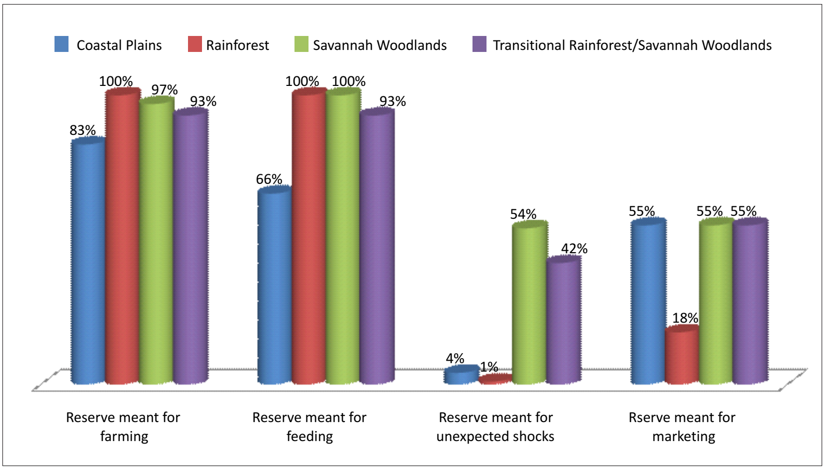



**Figure 20: Agricultural reserves and purpose of reserves**

Despite the fact that farmers have made some forms of reserves in the past five years, food insecurity/self-sufficiency is a major problem observed from the findings. Only few members agreed at a moderate of having reserved food for feeding, and most of them are from the savannah woodlands (52%) and transitional zone (50%). An average proportion of 45% of farmers from all agro-climatic regions only feed on their reserved food for about 3-5 months. (See figure 21)

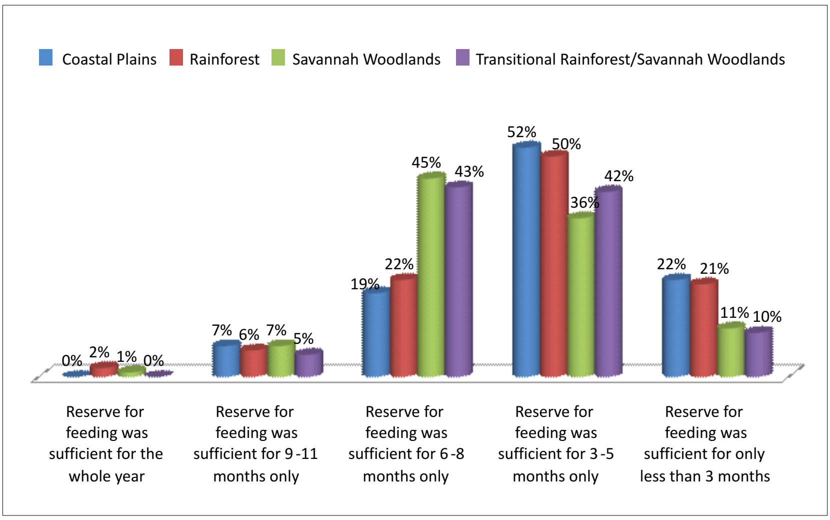



**Figure 21: Perceived responses to food self-sufficiency**

## H. Responses and Behavioural Changes of Indigenous Farmers towards Climate Change Adaptation Measures

Local ownership of policies, projects and programmes is crucial in any development endeavors. The crafting and implementation of such activities should therefore engage those that would be mostly affected. Climate change policies/adaptation measures must follow suit. Small-holder farmers who would be highly affected by adaptation measures for climate change resilience in the agricultural sector should be engaged on any adaptation measures for feasibility and acceptability in their respective regions. The research therefore identified adaptation measures that would be potentially feasible to implement across the agro-climatic regions in Sierra Leone and other parts of Africa. Thirteen (13) adaptation strategies were identified, after which measurement scales (Likert Scales) were developed at two levels. First, importance measurement scales were developed at a range of 5 (very important) to 1 (not important) to capture farmers priority in terms of the usefulness of each of these adaptation measures. Second, scales of location-specific suitability were developed from a range of 5 (work very well) to 0 (not applicable) to capture farmers behaviors in terms of acceptability towards each of the given adaptation attributes.

The Adzen's and Fishbein's (1980: 53-39) “Attitude-toward-behaviour” model was therefore adopted to analyse the results of farmers' behavior towards each of the given adaptation attributes. The 500 respondents were all engaged on each of these attribute, after which a multiplicative-summative model was used to identify the most preferred adaptation measures in each of the agro-climatic regions and in the country as a whole. It is taken that the higher the summation for each measure, the most preferred it is, and the lower the result indicates low acceptability. In this case the highest possible target is 325- that is 13 attributes x a scale of 5 (very important) x 5 (work very well) = 325. Also the lowest possible target is 13 attributes x 1(not important x 1 (cannot work well) =13. Each farmer's response was noted and the average summation was divided by 125 (no. of respondents by location) to obtain the global priorities from the given measures in each region.

It was realized from these analyses that the adaptation measures have varying location-specific acceptability. In the coastal plains, the most preferred adaptation measure is value addition/access to market finance, followed by formation of early warning systems to inform farmers on start-of-farming and start-of-season dates. Introducing HYVs and provision of food storage facilities are the most preferred measures in the rainforest. All scores are actually too weak from farmers in the savannah woodlands- with the highly preferred been the provision of food storage facilities. Similarly in the transitional zone, provision of food storage facilities and value addition/access to market finance are the most preferred. Other priorities are highlighted in table 20). Overall introducing high yielding varieties, value addition/ access to market finance, provision of food storage facilities and constant monitoring of water qualities are national priorities noted from the farmers.

## Table 20: Farmers' Responses and Recommendations to Climate Change Adaptation Measures

| Agro-climatic Region | The Coastal Plains N=125 | | | | Rainforest Region N=125 | | | | Savannah Woodlands N=125 | | | | Transition Rainforest/Savannah N=125 | | | | Global Affect |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Adaptation measures | $\sum b_i/N$ | $\sum a_i/N$ | $\sum[(b_i)(a_i)]/N$ | x(13) | $\sum b_i/N$ | $\sum a_i/N$ | $\sum[(b_i)(a_i)]/N$ | x(13) | $\sum b_i/N$ | $\sum a_i/N$ | $\sum[(b_i)(a_i)]/N$ | x(13) | $\sum b_i/N$ | $\sum a_i/N$ | $\sum[(b_i)(a_i)]/N$ | x(13) | N=500 |
| Formation of early warning Systems | 5 | 5 | 24 | 306 | 1 | 1 | 1 | 13 | 4 | 3 | 14 | 180 | 5 | 5 | 21 | 273 | 193 |
| Introducing High Yielding Varieties | 4 | 4 | 19 | 246 | 5 | 5 | 25 | 325 | 3 | 2 | 7 | 85 | 5 | 5 | 21 | 276 | 233 |
| Training of farmers on agro -climatology | 4 | 4 | 18 | 231 | 3 | 5 | 15 | 196 | 4 | 3 | 10 | 129 | 4 | 5 | 20 | 156 | 178 |
| Construction of embankments | 3 | 3 | 12 | 157 | 4 | 4 | 16 | 208 | 3 | 3 | 8 | 102 | 3 | 2 | 6 | 78 | 136 |
| Construction of drains | 3 | 4 | 12 | 156 | 2 | 2 | 4 | 52 | 3 | 3 | 8 | 105 | 3 | 2 | 8 | 104 | 104 |
| Constant Monitoring of water quality | 4 | 4 | 20 | 265 | 4 | 4 | 16 | 208 | 3 | 3 | 11 | 136 | 4 | 4 | 18 | 228 | 210 |
| Production of energy -saving technologies | 3 | 4 | 12 | 158 | 1 | 1 | 1 | 13 | 2 | 2 | 5 | 69 | 3 | 3 | 12 | 155 | 99 |
| Construction of small dams for crops | 4 | 4 | 15 | 195 | 2 | 3 | 6 | 78 | 4 | 3 | 10 | 135 | 3 | 3 | 11 | 147 | 139 |
| Provision of ponds /wells for livestock | 3 | 3 | 9 | 121 | 1 | 1 | 1 | 13 | 3 | 3 | 10 | 133 | 3 | 3 | 12 | 152 | 105 |
| Construction of discharge control dams | 3 | 3 | 9 | 123 | 1 | 1 | 1 | 13 | 3 | 3 | 8 | 100 | 3 | 2 | 6 | 82 | 80 |
| Value addition/access to market finance | 5 | 5 | 25 | 320 | 4 | 3 | 12 | 156 | 4 | 3 | 12 | 155 | 5 | 5 | 23 | 303 | 233 |
| Introducing rain harvest technology | 4 | 3 | 15 | 201 | 1 | 1 | 1 | 13 | 2 | 1 | 3 | 35 | 3 | 2 | 8 | 102 | 88 |
| Provision of food storage facilities | 5 | 5 | 23 | 296 | 5 | 5 | 25 | 325 | 4 | 4 | 14 | 182 | 5 | 5 | 24 | 313 | 279 |

Where: $\mathbf{b_i}$ is the strength of the respondent's belief (importance weight) that a particular attribute (adaptation measure) would result to a positive or negative impact in the region; $\mathbf{a_i}$ is the respondents expressed feeling (affect) that the action would be suitable in a agro-climatic zone or not; **N** is the number of respondents; $\sum$ indicates that there are **n** salient of action outcomes (in this case **1≤n≤325**) that makes up the behavior over which the multiplicative combinations of the $\mathbf{b_i}$ and $\mathbf{a_i}$ of those outcomes are summated. The scales are rated as:

**a. Scales for $\mathbf{b_i}$:** 5=Very Important; 4=Somehow Important; 3=Important; 2=Somehow not Important and 1=Not Important

**b. Scales for $\mathbf{a_i}$**: 5=Work Very Well; 4=Generally Work Well; 3=Somehow Work Well; 2=Slightly Work Well; 1=Cannot Work Well; 0=N/A (Not Applicable)

# 5 Conclusions & Recommendations

Various issues that need urgent and periodic attentions came up very strongly in the research. The findings revealed that climate change impact is not a story, especially when it comes to agricultural development and socio-economic rejuvenation in a country like Sierra Leone. Farmers, who have been considered as aliens to the emergence of climate change and its impacts, already believe that the occurrence of climatic events such as rainfall and temperatures are no longer based on normal patterns observed s before, and most of these events have been erratic over the past two to three years. This has caused abrupt and unstable shifts in start-of-farming dates in the local farming calendars- as agricultural activities in the country are linked to rainfall and mild temperatures, with no due consideration of technological application. Small-holder farmers have therefore been greatly affected by slow and low returns from their farming activities, and hence have very often been gripped by poverty leading to poor economic status of their families. Specifically key observations that need urgent attention from the state, donors, NGOs/CSOs, the private sector, the academia, science experts, etc, were made:

**5.1**

Farmers are still adopting the old methods of farming; and quite too often these methods have failed them to produce yields even as the low yields they have had in the past because of lack of the adaptive capacity to address failures. The climate has been erratic with strange occurrences. Temperatures are almost about to exceed the tolerance limit for most crops, animals and humans. Rainfall is becoming uneven- areas with low rainfall patterns having intensive rainfall, and those with high rainfall experiencing low rainfall and intensive heat. In addition, it was observed from the findings that there is gradual shift in patterns of agricultural diversity identified during the demarcation of the agro-climatic regions: (a) in the coastal plains high adoption of new agricultural productions such as rice, sweet potatoes, cassava, pepper and maize is seen, and old crops such as carrot, lettuce are gradually disappearing; (b) only small amount of lettuce, carrot and cabbage are presently being produced in the savannah woodlands; (c) in the transitional zone, cowpea, oil palm, rubber, sisal, and sugar cane productions are gradually disappearing; and (d) yams, avocado and citrus plants are gradually disappearing or grown at low pace in the rain forest. To address these issues the following recommendations have therefore been made:

**5.1.1**

There is need for collaborated efforts by the national science and technology council of Sierra

Leone (NaSTEC), the Ministry of Agriculture, Forestry and Food Security (MAFFS), the meteorological department, poverty-/Science and technology- oriented institutions/NGOs, national and international agencies, etc to pool resources and promote research and development in the country. In particular, the adoption of agro-meteorological technology should be essential to test the climatic requirements of crops across the country to identify crop suitability in each of the agro-climatic regions.

### 5.1.2

A shift in the agro-climatic regions might have occurred. It is recommended that the meteorological department, statistics office, the agriculture ministry, World Food Programme (WFP) and FAO be engaged in bid to develop new agro-ecological zones based on observed climatic variability. Meanwhile the meteorological department is a key player, but has low technical and human capacities to carry out effective and efficient meteorological data collection; the institution's capacity therefore needs to be built in terms of training and provision of modern agro-meteorological equipments that would be relocated in each of the agro-climatic regions for weather observations.

### 5.2

Capacity building amongst small-holder farmers has been very low across the agro-climatic regions in the country. Farmers are already knowledgeable about the changing and erratic nature of climatic events, but they lack the capacity to adapt. They have in the past used indigenous meteorological predictions to catch up with their start-of-farming and start-of-seasons dates, but these too have failed them in recent years. Proliferation of pests and diseases, low crop yields and hunger were reported as the results from climate variability in their farming periods. There are emerging indigenous adaptations/ innovation for the climatic impacts on small-scale agriculture which are far-fetched to address the food self-sufficiency/insecurity problems across the country. It was observed that farmers, particularly those in the farther regions from the urban areas have mostly used a single-source (the radio) of climate-related information, but with very limited access: (i) farmers in the coastal plains and transitional zone have limited information on weather; (ii) those in the rain forest, coastal plains and transitional zones have little or no information on planting dates; (iii) information on the importance of tree planting is especially accessible by farmers in the coastal plains and savannah woodlands than the other regions. NGOs/CBOs and government institutions were identified as playing a leading role in helping farmers adapt to climate-related problems in their farm activities. Meanwhile, these assistances are highly concentrated in the rainforest region, and at a very low strength. For instance the supply of seed rice was identified as the highest form of assistance, but only 30% of farmers (24% of which are from the rain forest) have been reached. Other assistances are of very infinitesimal importance in terms of supply and impacts. The following recommendations have therefore been made to address these issues:

### 5.2.1

There is need to develop a science and technology communications strategic framework in the country. In particular, expert institutions such as the National Council of Science and Technology, African Technology Policy Studies (ATPS) Network and the National Telecommunication Commission (NATCOM) should play a leading role in this process. Specifically, the framework must include the formation of an advocacy committee to promote the adoption of science and technology for full-scale mainstreaming in national and sectoral development with specific emphasis on spurring small-scale agricultural development. In addition the framework should include the formation and networking of early warning committees in each agro-climatic region that would be linked directly to small-holder farmers for improved viability of their agricultural produces. The committee must include the media, meteorologists, and farmers' representatives locally based in each region; and should be coordinated by the National Early Warning Committee.

**5.2.2**

Innovations/technologies for climate change resilience are very uncommon across the country. Meanwhile few indigenous and emerging technologies/innovations were identified in the coastal plains and rainforest. Improvement on such innovations should be made and diffused across the country. The agricultural sector (including research institutions), NaSTEC, etc should link with the National Farmers' Federation of Sierra Leone to further identify new and cost-effective innovations/technologies that farmers would be willing to adopt for food security/self-sufficiency and local economic growth. HYVs and other hybrids (which are drought and disease-resistant) should be introduced at a large and faster rate to small-holder farmers across the country.

**5.2.3**

Capacity building on climate change is very essential and should be done in a sustainable manner. Farmers should be trained on farm and other practices that would help mitigate greenhouse gas emissions (which will otherwise create cyclic but negative impacts on the farming systems). In addition, adaptation of the educational curriculum (especially in science courses) should be made by incorporating some form of education on causes of climate change and impacts.

> Capacity building in terms of technical assistances such as supplies and introduction of post-harvest technologies are also very crucial in small-holder agricultural production and commercialization. Meanwhile an attitude-toward-behavior model was adopted to gain farmers perception on possible and acceptable adaptation measures for climate change resilience in the country. The national priorities that were identified include: (a) introducing high yielding varieties (b) value addition/ access to market finance (c) provision of food storage facilities, and (d) constant monitoring of water qualities. Regional-specific priorities are presented in table 20.

**5.3**

Climate change impact on human health was also identified to have strong negative repercussions on food production and local economic growth. Climate-related diseases such as malaria, cholera, diarrhea and yellow fever were identified to have debilitating effects on the farming population-leading to more than 30% decrease in economic returns from agriculture, taken all other assistances constant. This in part gives a clear picture of low health and environmental campaigns/treatments to reduce the proliferation of these diseases. Massive campaigns on the climatic factors that encourage the prevalence of these diseases must be effected. In addition, public health policies should incorporate discount rates of treatment for highly agriculture-oriented small-holder farmers. They should be encouraged with subsidies to increase their earning powers to tackle such externalities.

### 5.4

Recommendations for further research have also been identified. In-country and international support for such research should be made to track progress in effectiveness of climatic data collections, improvements in the low adaptive capacity of small-holder farmers to tackle climate-related impacts on their farming activities, as well as technology and innovation diffusions across the agro-climatic regions in the country, etc. The need for specific research on the burden of diseases on the farming population, by calculating and documenting the Disability Adjustment Life Year is also paramount.

### 5.5

Funds for the National Adaptation Programme of Action (NAPA) should not only be directed towards research on emissions of greenhouse gases. The implementation of NAPA should ensure that funds are allocated for research on climate change impact on small-holder farming, as well as mitigation benefits for small-holder agricultural commercialization. The effort to build the quadruple helix by ensuring that climate-sensed programmes build coherence between policy makers, science experts, the private sector actors and civil society actors for stronger and more sustainable adaptation programme of action must be made and achieved.

# Bibliography

Ajzen, I and Fishbein, M. (1980:53-89): 'Understanding Attitudes and Predicting Social Behavior', Eaglewood Cliffs, NJ.

Bruinsma, J. (2003): 'World Agriculture: towards 2015/2030', Earhtscan, London.

Callaway, J.M et al (2006), "The Berg River Dynamic Spatial Equilibrium Model: A New Tool for Assessing the Benefits and Costs of Alternatives for Coping with Water Demand Growth, Climate Variability and Climate Change in the Western Coast", International Start Secretariat, Washington D.C.

Dieudonne, G. (2001): 'Afrique: Le Continent le Plus Vulnerable', Bulletin Africaine No.14. Available at: http://www.enda.sn/Bulletin%20Africain/011%20Goudou%20&20 Isabelle.pdf

Dione, J and UNECA (2001), "Ad Hoc Expert Group Meeting on Indigenous Food Technology for Food Security in Africa: Opening Statement", Food Security and Sustainable Development Division, UNECA, Addis Ababa.

Eade, D. and Suzanne, W (1995), "The Oxfam Handbook of Development and Relief", Oxford, Oxfam.

Freeman, C. (1992): 'The economics of hope', New York, Pinter Publishers

Funk, C.C and Brown, M.E (2009): 'Declining Global Per Capita Agricultural Consumption and Warming Oceans Threaten Food Security', Department of Geography, University of California, Elison Hall, UCSB, CA 96105, USA.

GEF (2009), "Helping the Poorest Adapt to Climate Change", GEF, Washington D.C USA.

Global Environmental Funds(GEF, 2009): ' Integrated Adaptation to Climate Change into Agricultural Production and Food Security', Washington DC 20433 USA.

IFRC (2002), "World Disaster Report 2002", Geneva, Switzerland.

IPCC (2001), "Climate Change 2001: Third Assessment Report", Cambridge University Press, Cambridge, UK.

International Panel on Climate Change (IPPC, 2001): 'Climate Change 2001: Synthesis Report', Core Team (Eds.), Cambridge University Press.

McMichael, A.J et al (2004), "Climate Change: Comparative Quantification of Health Risks", WHO, Geneva

Partz, J.A et al (2005), “Impacts of Regional Climate Change on Human Health”, Nature 438:310-17.

Parry, M.L (2004), “Global Impacts of Climate Change Under the SRES Scenario”, Global Environmental Change, 14:1.

Philips, D.R and Verhasselt, Y. (1994): 'Health and Development', Routledge.

Roy, J (2006), “The Economics of Climate Change: A Review of Studies in the Context of South Asia with a Special Focus on India”, Jadavpur University.

Schär, C. et al. (2004): 'The role of increasing temperature variability in European summer heatwaves', Nature 427: 332-336, doi: 10.1038/nature02300

Sivakumar, N.V.K and R. Stefanski (WMO, 2008), “Climate Change Mitigation, Adaptation and Sustainability in Agriculture”, Available at: http://www.wamis.org/agm/meetings/sycram08/S3-Sivakumar.pdf

Schellnhuber, H.J. (ed.) (2006): 'Avoiding dangerous climate change', Cambridge, Cambridge University Press.

Sesay, J.S (2009), “Synopsis, Challenges, Potential and Vision for Agriculture in Sierra Leone with Special Emphasis on Rice Production”. MAFFS, Sierra Leone.

Slingo J.M, et al (2005), “Introduction: Food Crops in a Changing Climate”, Philosophical Transaction of the Royal Society, B360: 1983-1989.

Sokona, Y. and Denton, F. (2001): 'Climate Change Impacts: Can Africa Cope with the Challenges?' Climate Change Policy1:117-123

Taylor, J.B (2001), “Principles of Macroeconomics: Labour and Capital with Technology”, Houghton Mifflin Company, Boston, NY, USA

UNCED (1992), “Global Climate Change: Capacity Building”, available at:
http://www.usaid.gov/our_work/environment/climate/policies_prog/capacity.html#f1

United States Agency for International Development (USAID, 2007): 'Adapting to Climate Change Variability and Change: A Guidance Manual for Development Planning', 1300 Pennsylvania Avenue, NW Washington DC.

USAID (2007), “Adapting to Climate Variability and Change: A Guidance Manual for Development Planning”, USAID, USA

Venton C and P. Venton (2004), “Disaster Preparedness Programme in India: A Cost Benefit Analysis”, Humanitarian Practice Network, ODI, London.

Warren, R. et al (2006): 'Understanding the Regional Impacts of Climate Change'. Available at: http://www.tyndall.ac.uk/publications/working_papers/twp90.pdf

WHO (2005), “Climate Change and Human Health”, available at: http://www.who.int/en/
Wiki (2005): 'Theories to Explain Temperature Change'. Available at Wikipedia: http://en.wikipedia.org/wiki/Global_warming

World Bank (1997), “Taking Action to Reduce Poverty in Sub-Saharan Africa”, The World Bank, Washington D.C

World Health Organisation (WHO, 2002c), 'World Health Report'. Available at: http://www3.who.int/whosis/menu.cfm?path=whosis,burden&language=english

# Appendices

## Table 3: Sampling selection through multi-stage sampling technique

| Research Code | Locality Name | Chiefdom/ward | District | Agro-climatic Region | No. of Respondents |
|---|---|---|---|---|---|
| 1 | Affia | Wara Wara Yagala | Koinadugu District | Savannah Woodlands | 8 |
| 2 | Baima Mandu | Mandu Chiefdom | Kailahun District | Rain Forest | 14 |
| 3 | Bandajuma | Bagruwa Chiefdom | Bo District | Transitional zone | 10 |
| 4 | Bandamjuma Town | Luawa Chiefdom | Kailahun District | Rain Forest | 14 |
| 5 | Bayama | Kissi Teng Chiefdom | Kailahun District | Rain Forest | 13 |
| 6 | Bumpeh | Kori Chiefdom | Bo District | Transitional zone | 25 |
| 7 | Dodo | Luawa Chiefdom | Kailahun District | Rain Forest | 11 |
| 8 | Dandabu | Bagruwa Chiefdom | Bo District | Transitional zone | 10 |
| 9 | Fadugu | Kasunko Chiefdom | Koinadugu District | Savannah Woodlands | 26 |
| 10 | Fowa Ngopi | Kissi Teng Chiefdom | Kailahun District | Rain Forest | 12 |
| 11 | Gbonkogbon | Kasunko Chiefdom | Koinadugu District | Savannah Woodlands | 11 |
| 12 | Kabala | Wara Wara Yagala | Koinadugu District | Savannah Woodlands | 24 |
| 13 | Kafoko | Kasunko Chiefdom | Koinadugu District | Savannah Woodlands | 12 |
| 14 | Kasangban | Kasunko Chiefdom | Koinadugu District | Savannah Woodlands | 10 |
| 15 | Kathawuya | Wara Wara Yagala | Koinadugu District | Savannah Woodlands | 5 |
| 16 | Kathombo II | Wara Wara Yagala | Koinadugu District | Savannah Woodlands | 6 |
| 17 | Leicester | Mountain Rural Ward | Western Rural District | Coastal Plains | 9 |
| 18 | Levuma | Mandu Chiefdom | Kailahun District | Rain Forest | 12 |
| 19 | Madina | Kasunko Chiefdom | Koinadugu District | Savannah Woodlands | 13 |
| 20 | Mahaine | Koya Ward | Western Rural District | Coastal Plains | 25 |
| 21 | Malambay | Koya Ward | Western Rural District | Coastal Plains | 25 |
| 22 | Mobai | Mandu Chiefdom | Kailahun District | Rain Forest | 13 |
| 23 | Mokassie | Bagruwa Chiefdom | Moyamba District | Transitional zone | 25 |
| 24 | Njagbahun | Fakunya Chiefdom | Moyamba District | Transitional zone | 10 |
| 25 | Nyadehun | Luawa Chiefdom | Kailahun District | Rain Forest | 11 |
| 26 | Ogoo Farm | Mountain Rural Ward | Western Rural District | Coastal Plains | 10 |
| 27 | Regent | Mountain Rural Ward | Western Rural District | Coastal Plains | 10 |
| 28 | Sandeyalu | Luawa Chiefdom | Kailahun District | Rain Forest | 13 |
| 29 | Sembehun | Bagruwa Chiefdom | Moyamba District | Transitional zone | 25 |
| 30 | Senehun | Kamajei Chiefdom | Moyamba District | Transitional zone | 20 |
| 31 | Songo | Koya Ward | Western Rural District | Coastal Plains | 37 |
| 32 | Tombo | Waterloo Rural Ward | Western Rural District | Coastal Plains | 11 |
| 33 | Upper Jui | Waterloo Rural Ward | Western Rural District | Coastal Plains | 10 |
| 34 | Yataya | Wara Wara Yagala | Koinadugu District | Savannah Woodlands | 10 |
| **Total Number of Respondents** | | | | | **500** |

## Table 21: No. of deaths resulting from climate-related problems

| Diseases | No. of Deaths | Agro-Climatic Region | | | | |
|---|---|---|---|---|---|---|
| | | Coastal Plains | Rain Forest | Savannah Woodlands | Transitional Rainforest/ Savannah Woodlands | Total |
| Malaria deaths | 1 Persons | 2(1.6%) | 9(7.2%) | 19(15.2%) | 1(0.8%) | 31(6.2%) |
| | 2 Persons | 0(0.0%) | 15(12.0%) | 0(0.0%) | 0(0.0%) | 15(3.0%) |
| | 3 Persons | 1(0.8%) | 4(3.2%) | 1(0.8%) | 0(0.0%) | 6(1.2%) |
| | None | 122(97.6%) | 97(77.6%) | 105(84.0%) | 124(99.2%) | 448(89.6%) |
| Cholera deaths | 1 Person | 1(0.8%) | 9(7.2%) | 9(7.2%) | 3(2.4%) | 22(4.4%) |
| | 2 Persons | 0(0.0%) | 9(7.2%) | 0(0.0%) | 0(0.0%) | 9(1.8%) |
| | 3 Persons | 0(0.0%) | 0(0.0%) | 1(0.8%) | 0(0.0%) | 1(0.2%) |
| | None | 124(99.2%) | 107(85.6%) | 115(92.0%) | 122(97.6%) | 468(93.6%) |
| Diarrhoea deaths | 1 Person | 1(0.8%) | 9(7.2%) | 2(1.6%) | 1(0.8%) | 13(2.6%) |
| | 2 Persons | 0(0.0%) | 5(4.0%) | 0(0.0%) | 0(0.0%) | 5(1.0%) |
| | None | 124(99.2%) | 111(88.8%) | 123(98.4%) | 124(99.2%) | 482(96.4%) |
| Yellow Fever deaths | 1 Person | 0(0.0%) | 7(5.6%) | 3(2.4%) | 1(0.8%) | 11(2.2%) |
| | 2 Persons | 0(0.0%) | 1(0.8%) | 0(0.0%) | 0(0.0%) | 1(0.2%) |
| | 3 Persons | 1(0.8%) | 0(0.0%) | 0(0.0%) | 0(0.0%) | 1(0.2%) |
| | None | 124(99.2%) | 117(93.6%) | 122(97.6%) | 124(99.2%) | 487(97.4%) |
| Thunder shocks deaths | 1 Person | 0(0.0%) | 1(0.8%) | 0(0.0%) | 2(1.6%) | 3(0.6%) |
| | 2 Persons | 1(0.8%) | 6(4.8%) | 0(0.0%) | 0(0.0%) | 7(1.4%) |
| | Above 5 Persons | 0(0.0%) | 0(0.0%) | 2(1.6%) | 0(0.0%) | 2(0.4%) |
| | None | 124(99.2%) | 118(94.4%) | 123(98.4%) | 123(98.4%) | 488(97.6%) |
| Flood & displacement deaths | 2 Person | 0(0.0%) | 4(3.2%) | 0(0.0%) | 0(0.0%) | 4(0.8%) |
| | Above 5 Persons | 0(0.0%) | 0(0.0%) | 1(0.8%) | 0(0.0%) | 1(0.2%) |
| | None | 125(100.0%) | 121(96.8%) | 124(99.2%) | 125(100.0%) | 495(99.0%) |
| Drought & displacement deaths | 2 Persons | 0(0.0%) | 4(3.2%) | 0(0.0%) | 0(0.0%) | 4(0.8%) |
| | None | 125(100.0%) | 121(96.8%) | 125(100.0%) | 125(100.0%) | 496(99.2%) |
| Pest infections on animal deaths | 1-2 Animals | 0(0.0%) | 0(0.0%) | 2(1.6%) | 0(0.0%) | 2(0.4%) |
| | 3-4 Animals | 1(0.8%) | 2(1.6%) | 3(2.4%) | 1(0.8%) | 7(1.4%) |
| | 5-6 Animals | 6(4.8%) | 0(0.0%) | 4(3.2%) | 1(0.8%) | 11(2.2%) |
| | 7-8 Animals | 2(1.6%) | 0(0.0%) | 3(2.4%) | 0(0.0%) | 5(1.0%) |
| | 9-10 Animals | 3(2.4%) | 0(0.0%) | 1(0.8%) | 1(0.8%) | 5(1.0%) |
| | Above 10 Animals | 26(20.8%) | 0(0.0%) | 22(17.6%) | 2(1.6%) | 50(10.0%) |
| | None | 87(69.6%) | 123(98.4%) | 90(72.0%) | 120(96.0%) | 420(84.0%) |
| No. Crops destroyed from pest infestation | 2 Acres | 0(0.0%) | 3(2.4%) | 0(0.0%) | 1(0.8%) | 4(0.8%) |
| | 3 Acres | 0(0.0%) | 0(0.0%) | 1(0.8%) | 0(0.0%) | 1(0.2%) |
| | Above 5 Acres | 2(1.6%) | 0(0.0%) | 0(0.0%) | 0(0.0%) | 2(0.4%) |
| | None | 123(98.4%) | 122(97.6%) | 124(99.2%) | 124(99.2%) | 493(98.6%) |
| Malnutrition/ Kwashiorkor deaths | 1 Person | 0(0.0%) | 0(0.0%) | 0(0.0%) | 2(1.6%) | 2(0.4%) |
| | None | 125(100.0%) | 125(100.0%) | 125(100.0%) | 123(98.4%) | 498(99.6%) |

## Table 22: Comparative range of expenditure on farming and sickness and returns from yields

| | Agro-Climatic Region | | | | |
|---|---|---|---|---|---|
| **Income Range** | **Coastal Plains** | **Rain Forest** | **Savannah Woodlands** | **Transitional Rainforest/ Savannah Woodlands** | **Total** |
| **Highest amount spent on sickness in the past five years** | | | | | |
| <Le100,000 | 84(67.2%) | 58(46.4%) | 29(23.2%) | 67(53.6%) | 238(46.8%) |
| Le100,000-399,000 | 33(26.4%) | 60(48.0%) | 77(61.6%) | 43(34.4%) | 213(42.6%) |
| Le400,000-699,000 | 6(4.8%) | 7(5.6%) | 9(7.2%) | 14(11.2%) | 36(7.2%) |
| Le700,000-999,000 | 0(0.0%) | 0(0.0%) | 7(5.6%) | 0(0.0%) | 7(1.4%) |
| Le1000,000-1,399,000 | 2(1.6%) | 0(0.0%) | 3(2.4%) | 1(0.8%) | 6(1.2%) |
| **Expenditure on farming activities during the year of highest expenditure on sickness** | | | | | |
| <Le100,000 | 7(5.6%) | 93(74.4%) | 3(2.4%) | 35(28.0%) | 138(27.6%) |
| Le100,000-399,000 | 85(68.0%) | 28(22.4%) | 87(69.6%) | 40(32.0%) | 240(52.1%) |
| Le400,000-699,000 | 25(20.0%) | 4(3.2%) | 27(21.6%) | 38(30.4%) | 94(18.8%) |
| Le700,000-999,000 | 7(5.6%) | 0(0.0%) | 6(4.8%) | 8(6.4%) | 21(4.2%) |
| Le1000,000-1,399,000 | 0(0.0%) | 0(0.0%) | 2(1.6%) | 1(0.8%) | 3(0.6%) |
| >=Le1,400,000 | 1(0.8%) | 0(0.0%) | 0(0.0%) | 3(2.4%) | 4(0.8%) |
| **Amount received from farming activities during the year of highest expenditure on sickness** | | | | | |
| <Le100,000 | 50(40.0%) | 14(11.2%) | 5(4.0%) | 10(8.0%) | 79(15.8%) |
| Le100,000-399,000 | 74(59.2%) | 75(60.0%) | 44(35.2%) | 79(63.2%) | 272(54.4%) |
| Le400,000-699,000 | 1(0.8%) | 36(7.2%) | 47(9.5%) | 27(5.4%) | 111(22.2%) |
| Le700,000-999,000 | 0(0.0%) | 0(0.0%) | 19(15.2%) | 7(5.6%) | 26(5.2%) |
| Le1000,000-1,399,000 | 0(0.0%) | 0(0.0%) | 7(5.6%) | 1(0.8%) | 8(1.6%) |
| >=Le1,400,000 | 0(0.0%) | 0(0.0%) | 3(2.4%) | 1(0.8%) | 4(0.8%) |

## Table 23: Module 1- Household Questionnaire for Small-holder Farmers

## Introduction:

Hello. My name is ______________________________

I am collecting information on farm practices and the influence of climate on your production level in the past couple of years. Your sincere responses to these questions will help the government and development donors to better understand and develop solutions/strategies to reverse any difficulty you are facing with climate-related problems in your farming activities

| | | | | | |
|---|---|---|---|---|---|
| Locality Name | ............................. | Chiefdom | ............................. | District | .................................... |
| Agro-climatic Region | ........................................................ | Start time:_ _:_ _ | | Finish time:_ _:_ _ | |

Respondent's Name and address:............................................................ ..........................................
.............................................................................. ..........................................................................
Interviewer/Enumerator:.......................................... ...........................................................................

| SECTION A. SOCIO-ECONOMIC STATUS OF INDEGINOUS PEOPLE, THEIR KNOWLEDGE, PERCEPTIONS AND BEHAVIOUR TOWARDS CLIMATE CHANGE | | Responses | Code |
|---|---|---|---|
| A1. | What is the sex of the respondent? | 1. Male/ 2. Female | |
| A2. | What is your age? | 1. 10-17yrs<br>2. 18-25yrs<br>3. 26-33yrs<br>4. 34-41yrs<br>5. 42-49yrs<br>6. 49-56yrs<br>7. Above 56yrs | |
| A3. | What is your marital status? | 1. Never married<br>2. Engaged<br>3. Separated<br>4. Married polygamous<br>5. Married monogamous<br>6. Divorced<br>7. Widowed | |
| A4. | When did you come to settle in this locality? | 1. From birth<br>2. Above 5 yrs, but not from birth<br>3. 5 years ago<br>4. 4 years ago<br>5. 1-3 years ago<br>6. Less than 1 year ago | |
| A6. | How many dependants are presently with you? | 1. 1-3<br>2. 4-5<br>3. Above 5 | |
| A7. | What type(s) of farming practice have you been engaged in since your stay at this place?(Choose All that Apply) 1. YES 2. NO | 1. Upland shifting cult. | |
| | | 2. Upland bush fallow | |
| | | 3. Upland cash cropping | |
| | | 4. Swamp rice farming | |
| | | 5. Market gardening | |
| | | 6. Dairy/pastoral/livestock farming | |
| | | 7. Fisheries | |
| A8. | What type(s) of crop(s)/animals do you cultivate/rear? (Choose All that Apply) 1. YES 2. NO | 1. Rice | |
| | | 2. Cassava | |
| | | 3. Yams | |
| | | 4. Sweet Potato | |
| | | 5. Millet | |
| | | 6. maize(corn) | |
| | | 7. Lettuce | |
| | | 8. Cabbage | |
| | | 9. Carrot | |
| | | 10. Wheat | |
| | | 11. Oil palm | |
| | | 12. Cocoa | |
| | | 13. Coffee | |
| | | 14. Orange | |
| | | 15. Cattle | |
| | | 16. Goat | |
| | | 17. Sheep | |
| | | 18. Groundnut | |
| | | 19. Oil Palm | |

| | | |
|---|---|---|
| A8. | | 20. Banana |
| | | 21. Beans |
| | | 22. Pepper |
| | | 23. Sorghum |
| | | 24. Fresh water/sea fish |
| | | 25. Irish Potato |
| | | 26. Others(specify………………) |
| A9. | What is your land ownership status for Farming? | 1. Farm on own land |
| | | 2. Farm on loan |
| | | 3. Farm on family land |
| | | 4. Farm on community land |
| | | 5. Farm on government land |
| | | 6. Farm on free range |

A10. Could you please reflect and tell me the rates of your agricultural yields as compared to what was ploughed in the past four years.

| Crop/Animal | Rates of Yields/Year | | | | | | |
|---|---|---|---|---|---|---|---|
| | 2005/06 | | 2006/07 | | 2007/08 | | 2008/09 |
| | 1. High | 2. Low | 1. High | 2. Low | 1. High | 2. Low | 1. High |
| 1. Rice | | | | | | | |
| 2. Cassava | | | | | | | |
| 3. Yams | | | | | | | |
| 4. Sweet Potato | | | | | | | |
| 5. Millet | | | | | | | |
| 6. Corn maize | | | | | | | |
| 7. Lettuce | | | | | | | |
| 8. Cabbage | | | | | | | |
| 9. Carrot | | | | | | | |
| 10. Wheat | | | | | | | |
| 11. Oil palm | | | | | | | |
| 12. Cocoa | | | | | | | |
| 13. Coffee | | | | | | | |
| 14. Orange | | | | | | | |
| 15. Cattle | | | | | | | |
| 16. Goat | | | | | | | |
| 17. Sheep | | | | | | | |
| 18. Groundnut | | | | | | | |
| 19. Oil Palm | | | | | | | |
| 20. Banana | | | | | | | |
| 21. Beans | | | | | | | |
| 22. Pepper | | | | | | | |
| 23. Sorghum | | | | | | | |
| 24. Fresh water/sea fish | | | | | | | |
| 25. Irish Potato | | | | | | | |
| 26. Others(specify…………) | | | | | | | |

| | | |
|---|---|---|
| A11. | Have you ever experienced any seasonal change in rainfall, temperature, heat or extreme cold during your farming season? (If No, Go To QUESTION A14 )<br>1. Yes/ 2. No | |
| | 1. Rainfall | |
| | 2. Temperature/heat | |
| | 3. Extreme Cold | |
| A12. | If Yes to Q. A11, when did you start experiencing any of these ? | 1. One year ago(2009)<br>2. Two years ago(2008) |

| | | |
|---|---|---|
| A12. | If Yes to Q. A11, when did you start experiencing any of these ? | 1. One year ago(2009)<br>2. Two years ago(2008)<br>3. Three years ago(2007)<br>4. Four years ago(2006)<br>5. Over four years ago(yrs<'06) |
| A13. | If Yes to Q. A11, what changes have you observed in your farming season? (Choose All that Apply) 1. Yes 2. No) | 1. Long rainfall duration |
| | | 2. Short & heavy rainfall |
| | | 3. Short drying season |
| | | 4. Long drying season |
| | | 5. Late start of farming |
| | | 6. Early start of farming |
| | | 7. High temperature |
| | | 8. Others(specify……………) |
| A14. | Have you ever suffered from any climate -related problems in your farming activities?(If No, Go To QUESTION 17) | 1. Yes/ 2. No |
| A15. | If Yes to Q. A14, what are these problems? (Choose All that Apply) 1. Yes 2. No | 1. Prevalence of pests& disease |
| | | 2. Low crop yields |
| | | 3. Hunger |
| | | 4. Flooding |
| | | 5. Land sliding |
| | | 6. Thunderstorm |
| | | 7. Extreme drought condition |
| | | 8. Displacement from homes/ farm sites |
| | | 9. Less fish catches |
| | | 10. Soil erosion |
| | | 11. Others (specify…………………………………………………..) |
| A16. | If Yes to Q. A14, which strategies have you been adopting to solve climate -related problems to have high yields? (Choose All that Apply) *Please provide in your Note Pads, descriptions/explanations of the strategies* 1. Yes 2. No | 1. Application of salt dung |
| | | 2. Irrigation of garden/farm |
| | | 3. Change of crop varieties |
| | | 4. Using of kerosene and soap on plants |
| | | 5. Using crushed grasshoppers as pesticides |
| | | 6. Fencing farm and setting rodent traps |
| | | 7. Hunting |
| | | 8. Tree planting |
| | | 9. Mulching |
| | | 10. Harvest of bush yams |
| | | 11. Clearing around farm |
| | | 12. Performance of ancestral ceremony/ spiritual invocation |
| | | 13. Physical clearing of un-burnt vegetation |
| | | 14. Applying animal dung to the soil |
| | | 15. Green manure application |
| | | 16. Applying mixed animal feed, capsule & powdered tobacco |
| | | 17. Creating fish ponds |
| | | 18. Using small-meshed fishing nets |
| | | 19. Using chemicals to catch fish |
| | | 20. Use of indigenous weather predictions |
| | | 21. Use of scientific weather forecasts |
| | | 22. Change of farming dates |
| | | 23. Use of rain water harvesting for farm irrigation |
| | | 24. Use of underground water for farm irrigation |
| | | 25. Construction of small dams for irrigation |
| | | 26. Change from farming to trading/other occupation |
| | | 27. Shift from crop production to animal production |
| | | 28. Shift from animal production to crop production |
| | | 29. Move from climate-risk/ unproductive zone/ farmland |
| | | 30. Adoption of agro-forestry |
| | | 31. Others (specify…………………………………………………… ) |
| | | |
| A17. | Do you have any way of predicting when rains will start or when you will be expecting hot drying season? | 1. Yes/ 2. No |

| | | | | | |
|---|---|---|---|---|---|
| A18. | If yes to Q. A17, how do you predict when t he following climatic conditions are about to occur? | | | | |
| | 1. Rainfall | 2. Hot drying season | 3. Thunderstorm | Flood | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| A19. | If Yes to Q. A17, has any of the predictions ever worked? | | | | 1. Yes, very frequentl y<br>2. Yes, not frequently<br>3. No, in recent years<br>4. No, at all times |
| A21. | Has any institution assisted you with ways to respond to climate -related risks in your locality/farming activities?(If No, Go To QUESTION A24) | | | | 1. Yes/ 2. No |
| A22. | If Yes to Q.A21 , what type of institution? (Choose All that Apply) | 1. Government (specify…………………….................................)<br>2. NGO/CBO (specify……………………………………………...)<br>3. Private Company(specify………………………………………)<br>4. Community Members | | | |
| A23. | If Yes to Q.A21 , what were the nature of assistance rendered? (Choose All that Apply) 1. Yes/ 2. No | 1. Provision of seed rice for farming<br>2. Provisions of chemicals/pesticides<br>3. Provision of credit /loan facilities<br>4. Training on farm practices<br>5. Traini ng on weather forecasts<br>6. Distribution of farming calendars<br>7. Provision of fertilizers<br>8. Construction of small irrigation dams<br>9. Provision of farm tools/ machinery<br>10. Provision of fast -growing seed varieties<br>11. Provision of p ost-harvest facilities<br>12. Provision of food<br>13. Provision of settlements/farm lands<br>14. Construction of fish ponds<br>15. Provision of fishing nets/ boats<br>16. Others(specify……………………………) | | | |
| A24. | Have you ever received weather/climate infor mation? (If No, Go to Q.B1) | | | | 1. Yes/ 2. No |
| A25. | If Yes to Q.A24, what type of information? | 1. Rainfall/weather information/forecast<br>2. Importance of tree planting<br>3. Impact of deforestation<br>4. Planting dates<br>5. Others (specify…………………………..) | | | |
| A26. | If Yes to Q.A24, was the information useful? | 1. Yes/ 2. No | | | |
| A27. | If Yes to Q.A26, what are the sources of information? | 1. Radio<br>2. Government<br>3. Friends<br>4. News Paper<br>5. Television<br>6. NGOs/CBOs<br>7. Community members<br>8. Others(specify……………………………) | | | |
| SECTION B. LINKING HUMAN HEALTH, NATURAL DISASTER, TO FOOD SECURITY AND LOCAL ECONOMY | | Responses | | | |

| | | | |
|---|---|---|---|
| B1. | Have you or anyone in your family been affected by any one of the following diseases/occurrences during your fa rming activities in the past five years? (Choose All that Apply) 1. Yes/ 2. No (If No, to all, please Go To Question Section C) | 1. Malaria | |
| | | 2. Cholera | |
| | | 3. Diarrhoea | |
| | | 4. Yellow Fever | |
| | | 5. Thunder shocks | |
| | | 6. Flood & displacement | |
| | | 7. Drought & displacement | |
| | | 8. Pest infections on animal | |
| | | 9. Pest infestations on crops | |
| | | 10. Malnutrition/kwashiorkor | |
| | | 11. Disability caused by weather events | |
| B2. | If Yes to B1, how many were affected in the worst cases by: | No. of sickness/acres destroye d/displacement | No. of deaths |
| | 1. Malaria | | |
| | 2. Cholera | | |
| | 3. Diarrhea | | |
| | 4. Yellow Fever | | |
| | 5. Thunder shocks | | |
| | 6. Flood & displacement | | |
| | 7. Drought & displacement | | |
| | 8. Pest infections on animal | | |
| | 9. Pest infestations on crops | | |
| | 10. Malnutrition/kwashiorkor | | |
| | 11. Disability caused by weather events | | |
| B3. | If Yes to any in Q. B1, what was the longest duration you or a family took to recover in the past five years? | Duration/No. of days | |
| | | 1. Less than 7 days | |
| | | 2. 7-14 days | |
| | | 3. 15-21 days | |
| | | 4. 22-28 days | |
| | | 5. Above 28 days | |
| B4. | If Yes to any in Q. B1, what was the highest amount spent on sickness in the past five years? | 1.<Le100,000 | |
| | | 2. Le100,000-399,000 | |
| | | 3. Le400,000-699,000 | |
| | | 4. Le700,000-999,000 | |
| | | 5. Le1000,000-1,399,000 | |
| | | 6.≥Le1,400,000 | |
| B5. | In response to B3 & B4, did it affect your farming activities? | 1. Yes, very seriously | |
| | | 2. Yes, somewhat seriously | |
| | | 3. Not affected at all | |
| B6. | In response to B3 & B4, how could you rate your total no. of yields? | 1. Extremely Low | |
| | | 2. Somehow low | |
| | | 3. Low | |
| | | 4. High | |
| | | 5. Somehow high | |
| | | 6. Extremely high | |
| B7. | In response to B3 & B4, did you have any reserve from your yields? | 1. Yes/ 2. No | |
| B8. | If Yes to B7, what was the purpose of the reserve? (Choose All that Apply) 1. Yes/ 2.No | 1. Farming | |
| | | 2. Feeding | |
| | | 3. Unexpected shocks | |
| | | 4. Marketing | |
| | | 6. Others (specify……………………) | |
| B9. | If you reserved food for feeding, was it enough for the whole year? | 1.Yes, was sufficient for whole year | |
| | | 2. No, was sufficient for 9-11 months only | |
| | | 3. No, was sufficient for 6-8 months only | |
| | | 4. No, was sufficient for 3-5 months only | |
| | | 5. No, was sufficient for only less than 3 months | |
| B10. | If you marketed any of the yields, how much did you receive in cash as compared to amount spent on farming in the year of highest spending on sickness? | Expenditure on farming | Amount from sales |
| | | 1.<Le100,000 | 1.<Le100,000 |
| | | 2. Le100,000-399,000 | 2. Le100,000-399,000 |
| | | 3. Le400,000-699,000 | 3. Le400,000-699,000 |
| | | 4. Le700,000-999,000 | 4. Le700,000-999,000 |
| | | 5. Le1000,000-1,399,000 | 5. Le1000,000-1,399,000 |
| | | 6. >=Le1,400,000 | 6. >=Le1,400,000 |
| SECTION C: BEHAVIOURIAL RESPONSES TO CLIMATE CHANGE ADAPTATION MEASURES AT INDIVIDUAL AND INSTITUTIONAL LEVELS | | | |

i. If the following adaptation measures are in troduced by the government/ partners, how will you rate them in terms of importance?
5. Very important 4. Somehow important 3. Important 2. Somehow not important 1. Not Important

a. ____ Formation of an early warning system/forecasting tables to inform fa rmers about temperature, rainfall patterns, flood, health and start -of-farming seasons
b. ____ Replacing old crop varieties that are no longer striving well with newly genetically modified strains that cope with present climatic conditio ns.
c. ____ Provision of professional training for local farmers on practical use of agro -meteorological information
d. ____ Construction of embankments/Watergates to prevent floods
e. ____ Construction of drains to evacuate surface water flows from sens itive areas.
f. ____ Constant monitoring of water quality for protection against pollution
g. ____ Increased production of energy saving technologies ( Local ovens, cookers and kerosene stoves)
h. ____ Construction of a number of small dams for agriculture
i. ____ Provision of a number of ponds and shallow wells for raising livestock (cattle, sheep, goat).
j. ____ Construction of discharge control dams on permanently flowing water courses
k. ____ Value addition to locally produced agricultural products and improved access to markets and finance for local farmers
l. ____ Encourage rain harvesting
m. ____ Provide a number of food storage facilities for local farmer
n. ____ Development of aqua -culture farming/ fisheries

ii. In your opinion, please rate how well each of the follo wing measures would work well in your farming community for better production and food self-sufficiency (please circle selected options)

| Measure | (N/A) | Work extremely well | Generally work well | Somehow work well | Slightly work well | Cannot Work Well |
|---|---|---|---|---|---|---|
| Formation of an early warning system/forecasts | (0) | (5) | (4) | (3) | (2) | (1) |
| Introducing genetically modified crops/animals | (0) | (5) | (4) | (3) | (2) | (1) |
| Training farmers on agro -climatic data collection | (0) | (5) | (4) | (3) | (2) | (1) |
| Construction of embankments/Watergates | (0) | (5) | (4) | (3) | (2) | (1) |
| Construction of drains | (0) | (5) | (4) | (3) | (2) | (1) |
| Constant monitoring of water quality | (0) | (5) | (4) | (3) | (2) | (1) |
| Increased production of energy -saving technologies | (0) | (5) | (4) | (3) | (2) | (1) |
| Construction of small dams for crop production | (0) | (5) | (4) | (3) | (2) | (1) |
| Provision of ponds/shallow wells for livestock | (0) | (5) | (4) | (3) | (2) | (1) |
| Construction of discharge control dams | (0) | (5) | (4) | (3) | (2) | (1) |
| Value addition & improved access to markets/finance | (0) | (5) | (4) | (3) | (2) | (1) |
| Introducing Rain harvest technology | (0) | (5) | (4) | (3) | (2) | (1) |
| Provision of food storage facilities | (0) | (5) | (4) | (3) | (2) | (1) |
| Development of aqua -culture farming/ fisheries | (0) | (5) | (4) | (3) | (2) | (1) |

Thanks for your patience

Thanks for your patience

----END---

Supervisor:…………………………………………

Signature:……………………………………………

Date:…………………………………………………….

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