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

Teddy Amara Morlai
Chris Bobo Squire
Kelleh Gbawuru Mansaray
Gibril Vandy

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Teddy Amara Morlai
Leonard Cheshire Disability,
West Africa

Kelleh Gbawuru Mansaray
Fourah Bay College,
University of Sierra Leone

Chris Bobo Squire
Fourah Bay College,
University of Sierra Leone

Gibril Vandy
St. Joseph's Convent,
Sierra Leone.

The African Technology Policy Studies Network (ATPS) is a multi-disciplinary network of researchers, private sector actors and policy makers promoting the generation, dissemination, use and mastery of science, technology and innovation (ST&I) for African development, environmental sustainability and global inclusion. ATPS intends to achieve its mandate through research, capacity building and training, science communication/dissemination and sensitization, participatory multi-stakeholder dialogue, knowledge brokerage, and policy advocacy.

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Executive Summary

Climate change impacts according to global estimates seem to be at the threshold of human tolerance; a result of anthropogenic activities such as massive deforestation, industrial and destructive land use practices, etc that lead to sporadic emissions of Greenhouse gases (GHGs). Climate change is especially affecting poorer communities in developing countries. In particular, indigenous/small-holder farmers are highly likely to be affected. They form over half of the farming population and thus can contribute greatly to economic growth in developing countries where over 70% of the population are farmers and agriculture contributes significantly to GDP shares. But in spite of all these potentials, they are given less attention in the climate change mitigation and adaptation interventions and research. They lack the coping capacity to tackle climate change problems. This situation is likely to have negative repercussions on developing countries like Sierra Leone. It is estimated that any 2-30C rise in temperature will potentially place about 20-300 million people at risk of hunger and that worldwide cereal production will decline by 5% for a 20C rise in temperature and 10% for a 100C rise in temperature. Climate change will also reduce the sources of protein, and already it is responsible for about 150,000 deaths globally.

Response to climate change impacts in Sierra Leone is too low, despite the emerging evidence in recent years. Climatic variables such as rainfall and temperature which have shown normal routine of occurrence now give a different picture. There has been heavy and short rainfall fluctuation, either early or late- causing farmers to stand in start-of-farming and start-of-seasons dilemmas. Yet little research has been done on the extent of climate change influence on the farming population, and what assistance or indigenous adaptation strategies/technologies they are adopting for self-sustenance and economic growth. This research therefore was proposed "to develop a comprehensive climate change adaptation policy through stakeholder participation for enhanced food production, food security at local and national levels in Sierra Leone". In particular it proposes to achieve this general aim by:

(i) identifying and documenting effective indigenous and emerging technologies and innovations for climate change adaptation in the study;
(ii) enhancing behavioural changes towards climate change adaptation measures at individual and institutional levels in the study area;
(iii) building the capacity of the farming communities in Sierra Leone to adapt to climate change impacts;
(iv) examining the state of climate change and climate variability across agro-climatic regions in Sierra Leone,
(v) building a model on how climate links health, natural disaster, to food security and the local economic growth, and

(vi) making policy recommendations for building climate change resilience at the state and nationals in Sierra Leone.

This report therefore presents the final findings and views of small-holder farmers on the state of climate change impacts on small-holder agriculture in the country. Methodologically, a multi-stage sampling technique was implored and 500 small-holder farmers were engaged using structured questionnaires to generate quality and quantitative results from across four agro-climatic regions. Ten (10) Focus Group Discussions were also held to build farmers capacity on the causes and impacts of climate change, as well as gain their views on the impacts of the changing climate and the indigenous/emerging technologies/innovations that farmers are presently adopting to respond to climate change impacts. Data analysis was carried out using SPSS and Excel spreadsheet, to generate descriptive statistical and simple bivariate excel-based presentations in the form of simple frequencies and charts. Cross-tabulations were also use for other presentations.

The findings revealed farmers still uphold to their indigenous farm practices and that certain agricultural products are already disappearing in terms of production. In addition, it was observed that small-holder farmers are already moving from an a priori situation to building a culture on an already observable changed climate. According to the farmers, phenomenal changes in rainfall, and temperature are already taking place in an uneven and erratic manner in the past two to three years. Farmers acknowledged that they have had indigenous meteorological predictions to determine their start-of-farming and start-of-seasons, but these no longer serve them well in recent years. As a result, crop failures, pest and disease proliferation and extreme hunger have been observed. Few indigenous innovations/ emerging technologies were also identified, but from limited locations. The capacity of small-holder farmers on climate change, it causes and impacts were also discovered to be very low. Information transfer is from a single source (radio); and assistance to tackle climate-related problems were concentrated in 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 proved 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 few farmers of an average proportion of 1% agreed on year-round feeding on reserved food.

Various recommendations were made to solve the impacting climatic influences on the agricultural production across the agro-climatic regions in Sierra Leone. In particular it was recommended that: (i) 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 collaborate and pool resources and promote research and development in the country, particularly to adopt agro-meteorological technology to periodically test the climatic requirements of crops across the country and identify crop suitability in each of the agro-climatic regions; (ii) a science and technology communications strategic framework be developed in the country- with expert institutions such as the National Council of Science and Technology, African Technology Policy Studies (ATPS) Network and the National Telecommunication Commission (NATCOM) playing a leading role in this process; (iii) farmers' recommendations/priorities on adaptation measures be recognized as stipulated in the report, using the Adzen's and Fishbein's attitude-toward-behaviour model; etc.

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
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 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 mitigation (e.g. Reduction of greenhouse gas emissions, and large-scale agricultural technology) seem to be given high priority, is likely to leave poverty-stricken indigenous farmers vulnerable and their climate change adaptation knowledge underutilized for sustainable food self-sufficiency and economic growth. This paper therefore 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) research method and procedures, and (iv) research results, from which conclusions and policy recommendations are suggested.

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 , 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 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 are main source of livelihoods (Bruisma, 2003). These conditions are likely to be exacerbated with any 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. This research has therefore been undertaken in order to fill these knowledge gaps.

1.2 Problem Statement

Sierra Leone is no exemption to the debilitating effects of climate change on developing countries as it is already experiencing de facto climatic hazards such as floods, changed rainfall patterns, strong winds, thunderstorm and seasonal droughts. However, the country, like other developing countries, lacks the coping mechanisms and financial capacity to reverse and/or adapt to the climate change and climate variability presently threatening humanity. .

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 mechanize 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 and are most likely to experience the strongest impact of climate change. 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. This might have pushed indigenous farmers to be making countless strides to adopt and come up with local innovations/technologies that can help improve on their agricultural yields. On the contrary, indigenous farmers are thought to lack the capacity of using scientific

predictions, high cost technologies as well as gaining access to credits that could help reduce future impacts of climatic shocks on their farming activities.

Information on how farmers cope with the changing climate, its impacts on yields and local economic growth are lacking due to low research interest. Consequently, there are little or no formalized documentations with regards to indigenous innovations and technologies to adapt to climate change impacts 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 and Justification for 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 patterns have become seasonally unreliable and unpredictable, 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 state of rainfall and its duration is a cause of concern for agricultural yields in Sierra Leone. A serious decline has been observed in recent years. There have been four agro-climatic regions in the country, but these might have been shifted considerably due to 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. In Sierra Leone, modern climate change adaptation techniques remain costly and unaffordable. However, one main asset that is often disregarded but yet highly essential to build on its 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, 2002). 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 a part of the African Ministerial Conference on Environment (AMCEN) and participated at the 2008 AMCEN meeting in Johannesburg, South Africa, where climate change adaptation was considered as the most immediate priority, considering the vulnerability of African countries. 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 supposed to be executed over a period of 9-month duration- 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.

2. Research Method & Procedures

2.1 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.

2.2 Description of 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. 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 (Statistics Sierra Leone 2004 census report). 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 1). 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.

Figure 1: Map of Agro-climatic regions in Sierra Leone

The Coastal Plains. Agro-climate of this region is dominated by proximity to the sea, strong temperature regimes, humidity and rainfall. The boundary of the region is approximated and taken to coincide with the specific drainage and edaphic characteristics. The coastal plains covers an area of some 11,000 km2 or about 15% of the land surface of Sierra Leone and is comprised of estuarine swamps, alluvial plains, beach ridges and coastal terraces. The dominant factor influencing the agricultural utilization of this region is the exceptionally high rainfall and an excess of precipitation over evapo-transpiration demands, exposing the region to excessive leaching, prolonged flooding and swampy conditions. An average water budget account for the region shows that there is some 2,100 mm of surplus rainfall which together with the seasonal flooding reflects the extreme conditions of humid environment. There are distinct contrasting periods of the year generally referred to the rainy and dry seasons. The average duration of rain-fed growing period averages some 260±10 days. The dry season therefore averages some 105 days, but for specific agricultural purposes it could be extended for several weeks to include comparatively dry periods of the rainy season in November and December. Temperature is however not a limiting factor for crop growth in this region.

The Rainforest. The ecologically important characteristic of the region is a unimodal distribution of annual rainfall resulting in the high reliability of moisture supply to vegetation. However, the receipt of annual rainfall is much in excess evapotranspiration demands and consequently about half of the annual precipitation (1460mm) finds its way to ground water or runoff resulting in stream and river flow. The distribution of rainfall is prolonged, lasting from the beginning of May to the end of November; a rise in the level of ground water table occurs and may adversely affect draining conditions particularly in the lower parts of the topography. Another agronomically important aspect of this large climatic water supply is its effect on soil nutrients and land management. The drainage is poor in some areas, especially where there is low elevation- nutrients are all taken away from the forest. The major crops grown here are both perennial and annual, but the most common types are perennials (plantation).

Savannah Woodlands. This covers about 30% of Sierra Leone, and extends from the interior lowland to the interior plateaus of the north and northwest. Rainfall and water surplus are slightly lower than the other agro-climatic regions. The region is characterized with unique less luxuriant savannah vegetation, and has a dry season that lasts for about 100-130 days. There is also a serious annual water deficit. Wild fire, crop cultivation and overgrazing were also identified as the major biotic influences producing this type of agro-climatic zone. Poor drainage, shallowness and infertility are the main edaphic influences. These two factors according to research, result in the establishment of savannah mosaic landscape, which consists mainly of deciduous woodland tree species and grasses. The rainy season starts about mid-April to January. This result is suitable for annual crop production. Average growing period is about 255 days. Rainfall is unimodal. There is large water surplus in humid condition resulting to environmental stress for the arable crops. This produces pests, diseases, weeds, leaching of nutrients, risk of flooding and soil erosion. Dry season experiences a high water deficit (about 500 ml). At times dry season prolongs between 160-170 days. Irrigation technology is therefore important. Since there is a marked water supply in the rainy season and water deficit in the dry season, there is a need to conserve water in the rainy season for use during the dry season.

Transitional Rainforest/Savannah Woodlands. This shares similar characteristics with the rainforest and savannah woodland agro-climatic regions.

2.3 Types of Data

Both Primary and Secondary data were collected during 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 were 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 collection on climatic parameters such as rainfall and temperature was done at 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 done.

2.4 Sample and Sampling Procedures

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 (i.e. 75% of 4.9 million). 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 carried out with selected farmers' groups in each of the regions.

Table 1: 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**

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.

2.5 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.

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:

$$AT_{Br} = \sum_{i=1}^{n} b_i a_r$$

Where 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; bi is strength of each group's response/belief (subjective probability) that the action or behavior will produce outcome i; a_r 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 (b_i and a_r) asked on the salient action outcome on climate change adaptation measures, etc; a_r 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.

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.

3. 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.

3.1 Socio-demographic Dynamics of Indigenous Farmers

The research did not intend testing hypotheses 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 2).

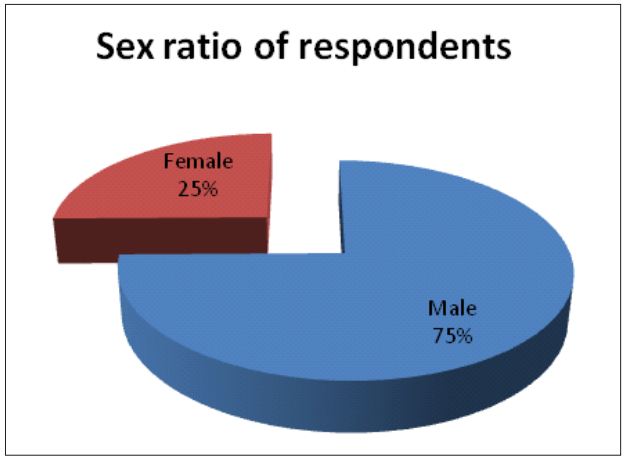


Figure 2: Sex composition of farmers

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 2). 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 2: 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 3). 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.

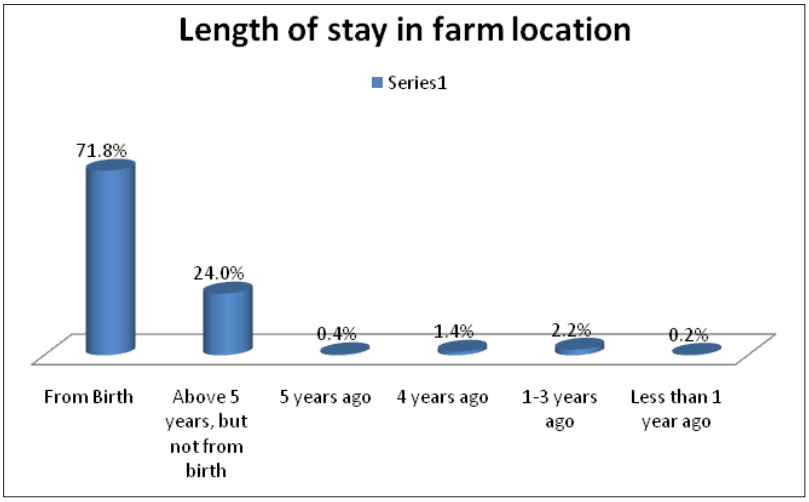


Figure 3: Length of stay of farmers in their farm locations

The major marital characteristics observed from the findings are polygamous and monogamous practices (see Table 3). 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 getting more yields.

Table 3: 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 4) 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.

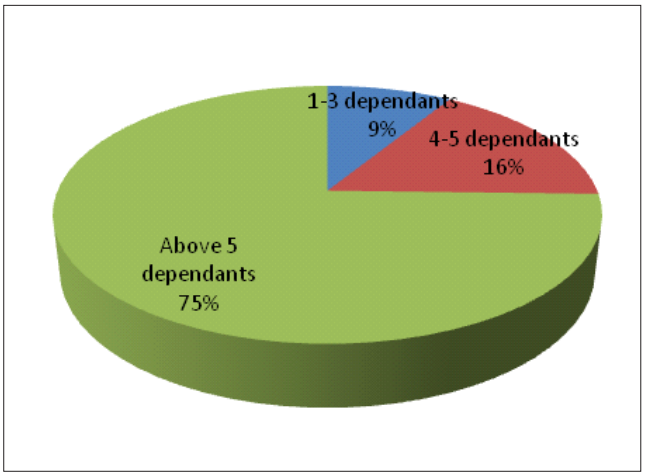


Figure 4: No. of dependents reported by farmers

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 5). 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.

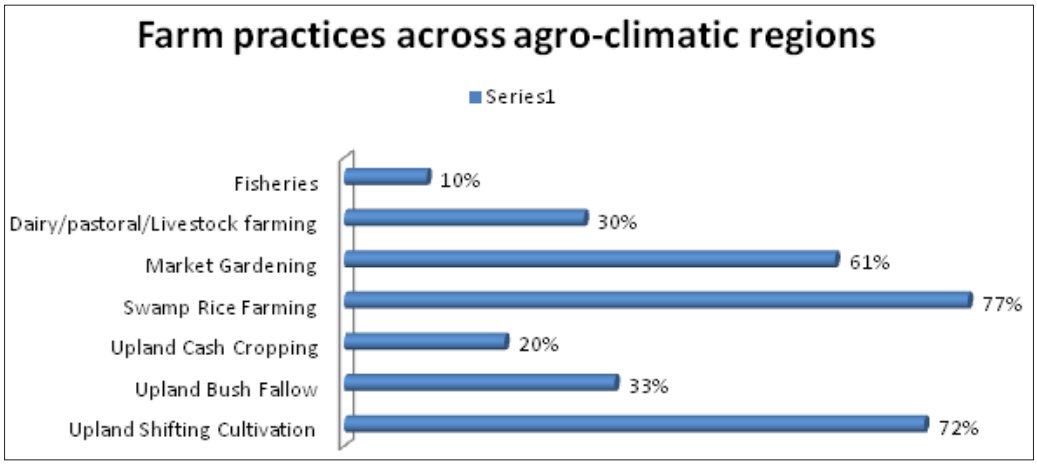


Figure 5: Farm practices across agro-climatic regions

3.2 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 farmers are the most widely hit. Their knowledge and perception would give future directives on solutions to this problem. Meanwhile Figure 6 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 6). 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.

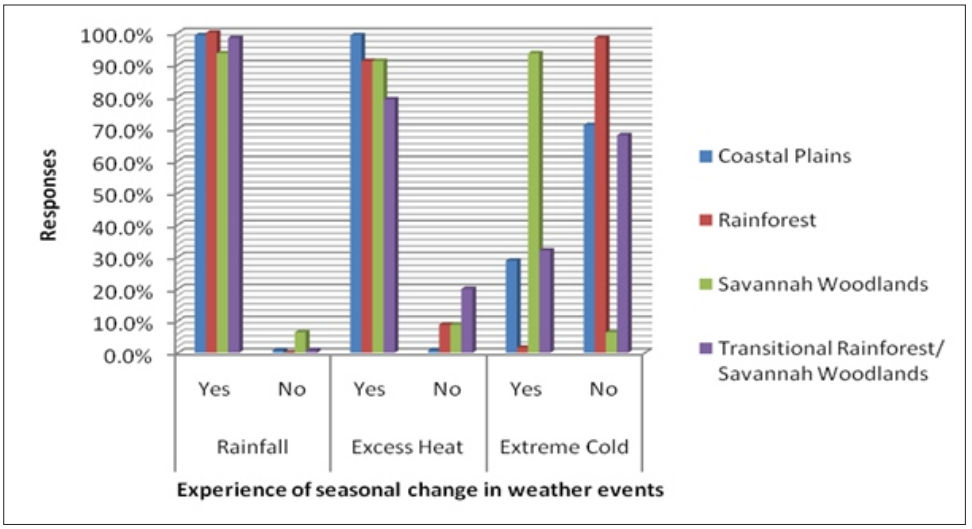


Figure 6: Farmers' experience of seasonal change in weather events

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 4: 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 7).

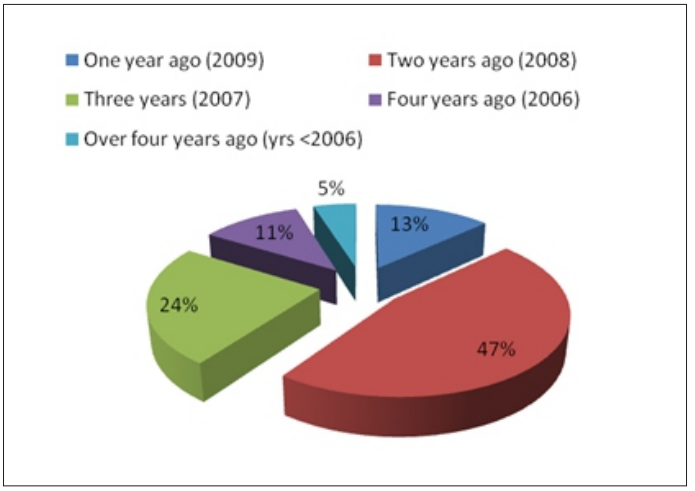


Figure 7: Years of experiencing changes in weather events

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 8. 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.

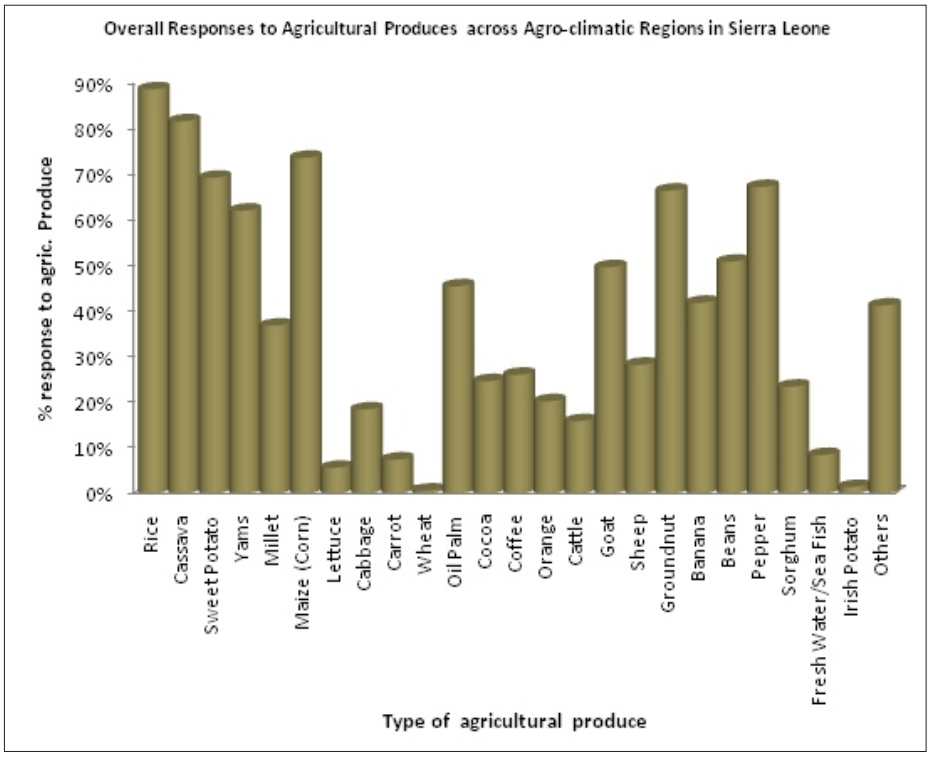


Figure 8: Farmers' responses to agricultural produces across agro-climatic regions in Sierra Leone

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 9) - 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 9: 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.

3.3 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 5). 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 5: Farmers' responses to types of climate-related problems

Type of climate-related problems	Agro-Climatic Region				Total N=500
	Coastal Plains N=125	Rain Forest N=125	Savannah Woodlands N=125	Transitional Rainforest/ Savannah Woodlands N=125	
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%)

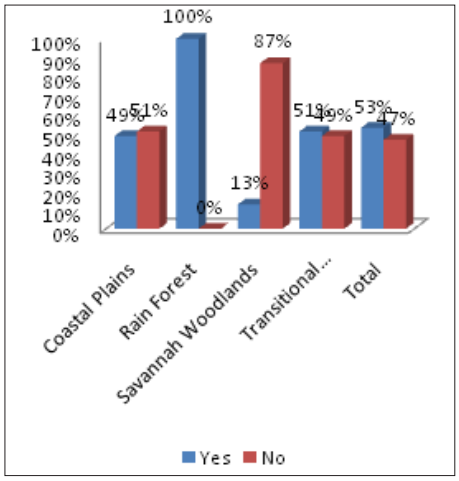
Adaptation practices to solve some of the impacting climate-related problems reported by farmers were also identified. Over twenty (20) ways in which farmers tend to respond to climate-related problems for agricultural production were noted in the findings. Meanwhile, findings show that farmers tend 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 6).

Table 6: 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[1]. But it was reportedly agreed that these predictions have failed them (44%) in many cases. (see Figure 10).

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



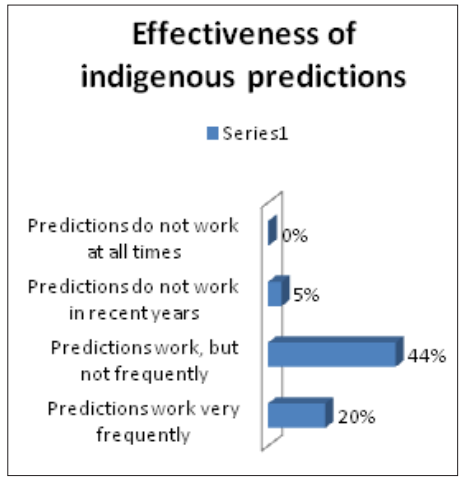


Figure 10: Responses to indigenous weather predictions and effectiveness

3.4 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 identified 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.

3.4.1 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 7.

Table 7: 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 occurring in previous years. The major problems they reported encountering are poor crop and animal yields which are 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 and are given in Table 8.

Table 8: Description of indigenous meteorological weather predictions in the Rainforest

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 Corprative-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 9).

Table 9: 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 10 presents some of these predictions.

Table 10: 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.

3.4.2 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 11 and 12). 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

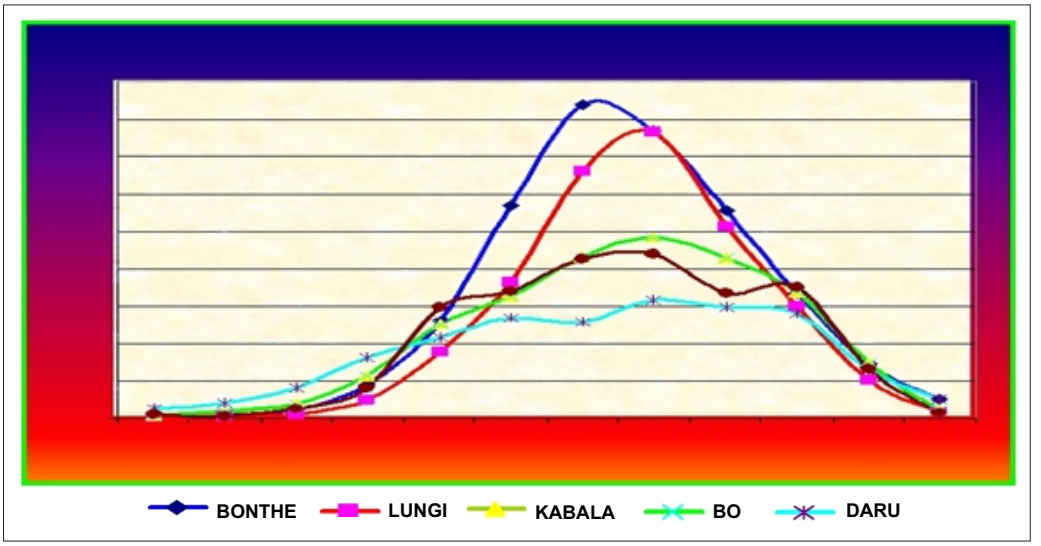


Figure 11: Rainfall estimates by available meteorological stations

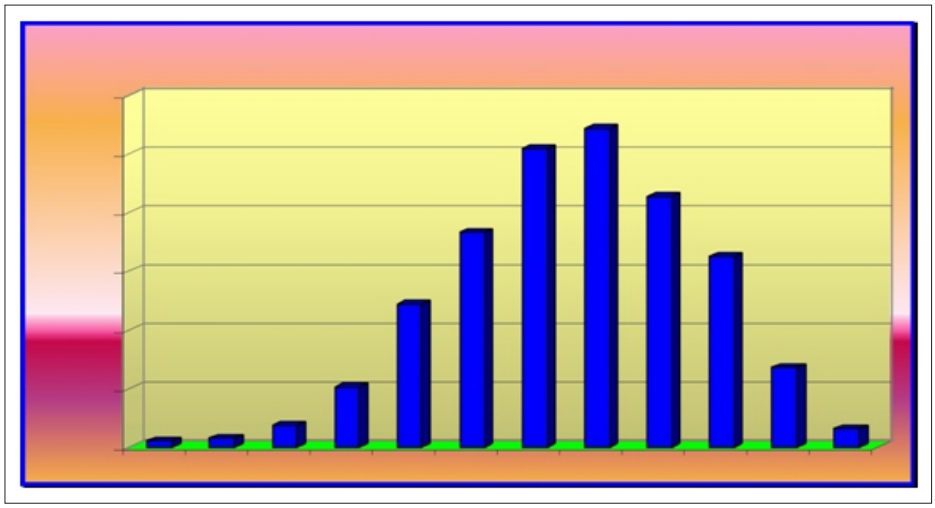


Figure 12: Mean monthly estimates of rainfall

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 13 & Table 11).

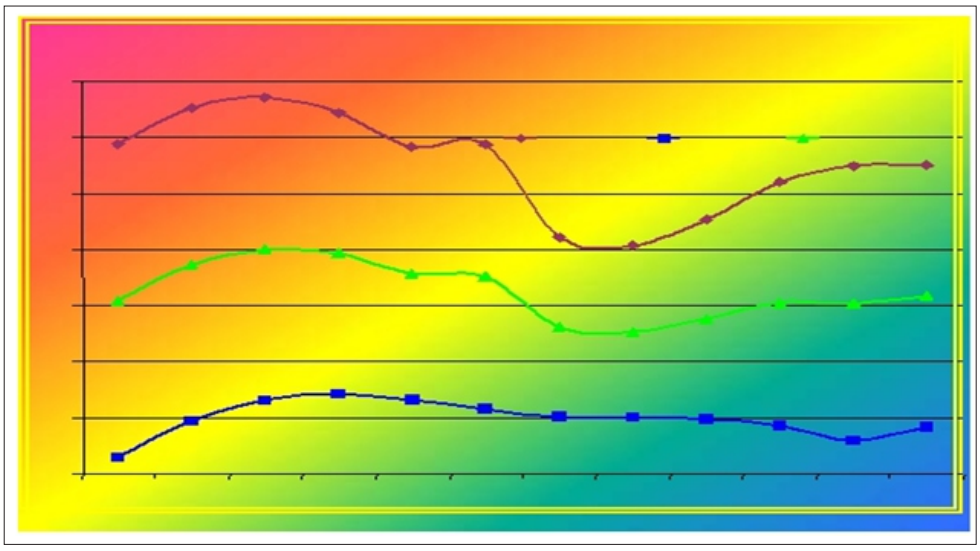


Figure 13: Average monthly temperatures of Sierra Leone for the period 1961-1990

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 14)

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 14 and 15)

Table 11: 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

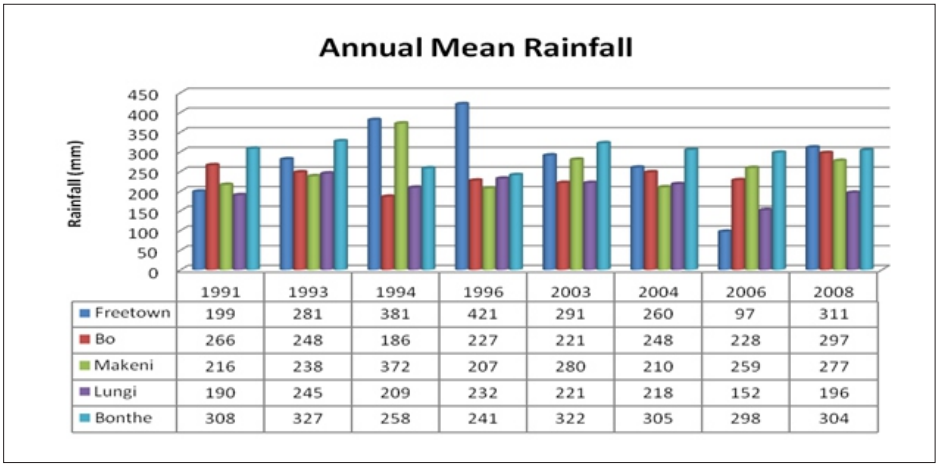
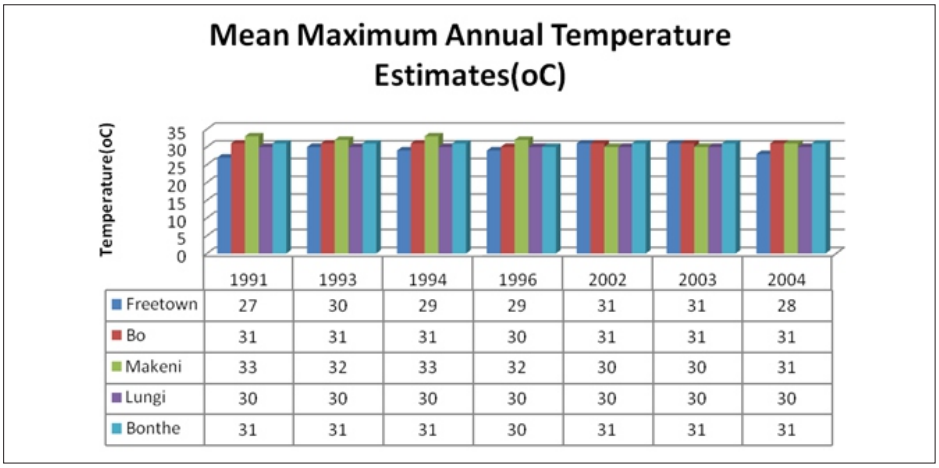


Figure 14: Annual Mean Rainfall



	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 15: 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 12). 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 12: Climate Varianility 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)

3.4.3 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 16).

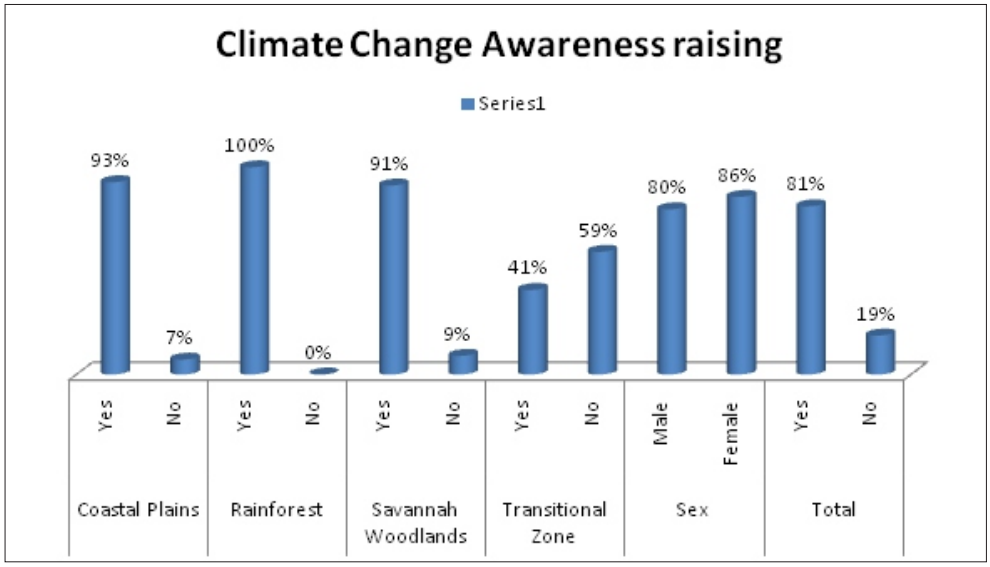


Figure 16: State of Climate Change Awareness raising by agro-climatic region and sex

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 great regional gaps in terms of accessing these information do 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 are 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 13).

Table 13: 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 facts that most farmers agreed on hearing 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 14)

Table 14: 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.

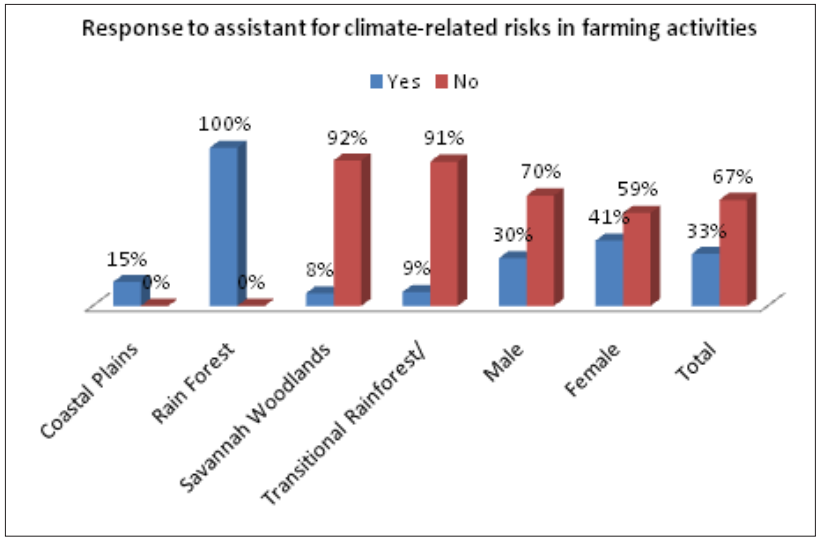


Figure 17: Responses to assistant for climate-related risks in farming activities

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 18).

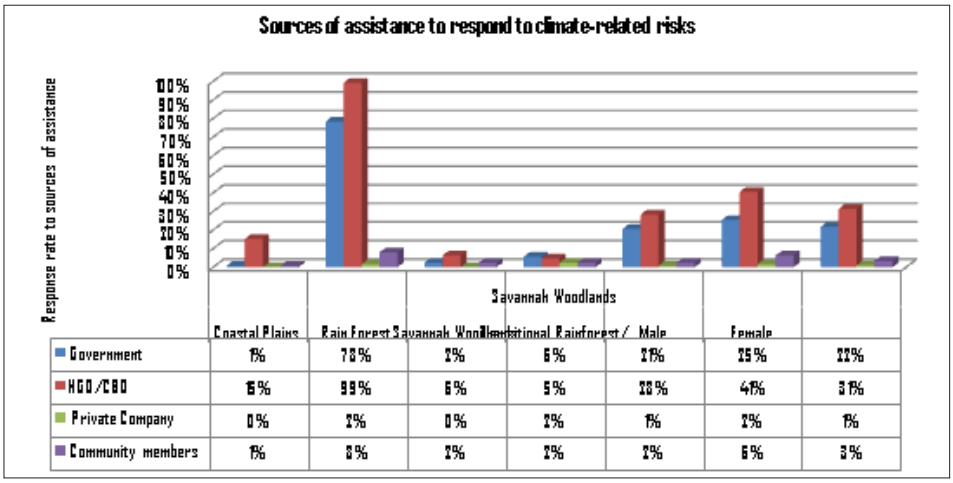


Figure 18: Sources of assistance to respond to climate-related risks

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 15: 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%)

3.4.4 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, diarrhoea and cholera (see Figure 19). 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.

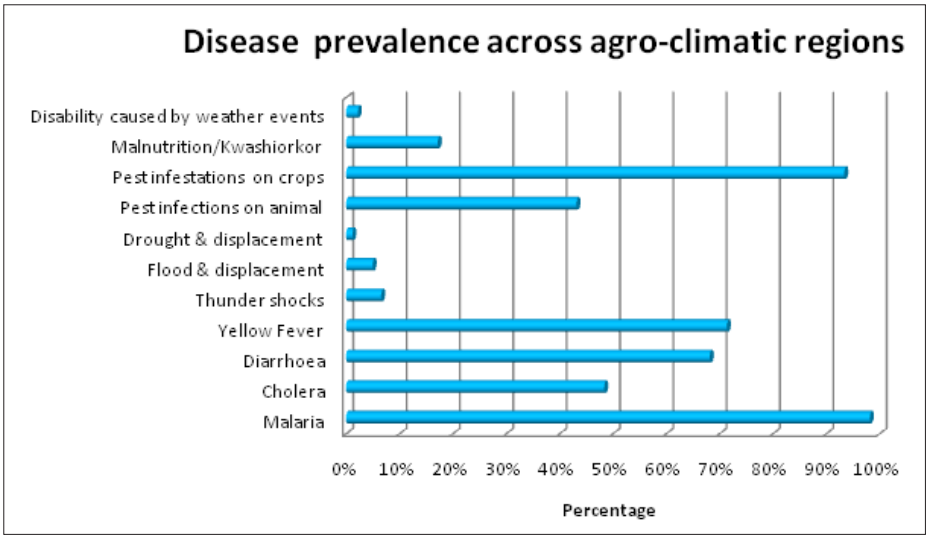


Figure 19: Disease prevalence across agro-climatic regions

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 losing 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 19 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 16.

Table 16: 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 20). 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 20b) 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 20a, 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.

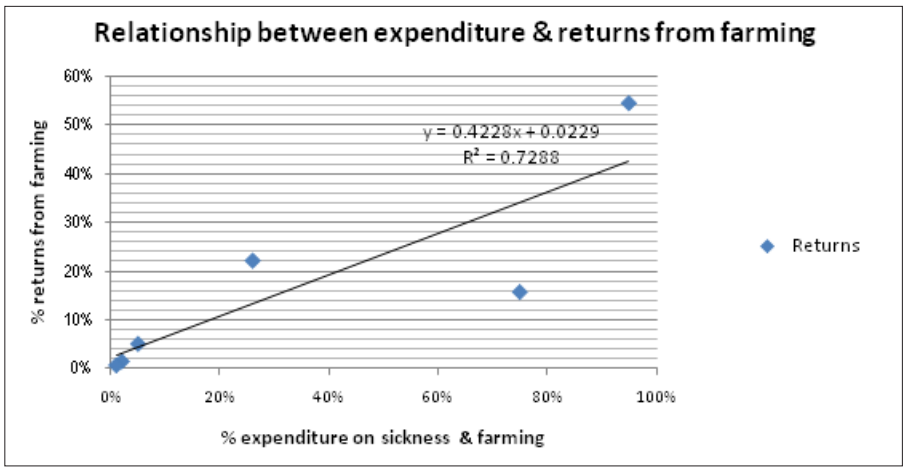
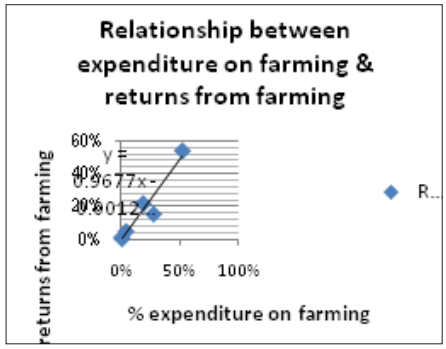
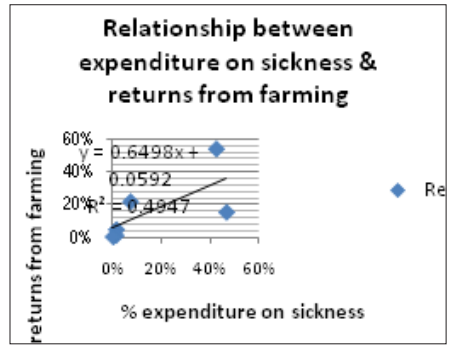


Figure 20: Expenditure on sickness versus returns from agricultural produces



20a. expenditure on farming vs. returns from farming



20b. expenditure on sickness vs. from returns 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 19 and 20 in the appendix).

Table 17: Nature of yields in the year of highest expenditure on sick bed

Yields in the year of longest time on sick bed/highest expenditure on sickness	Agro-climatic Regions				
	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 21).

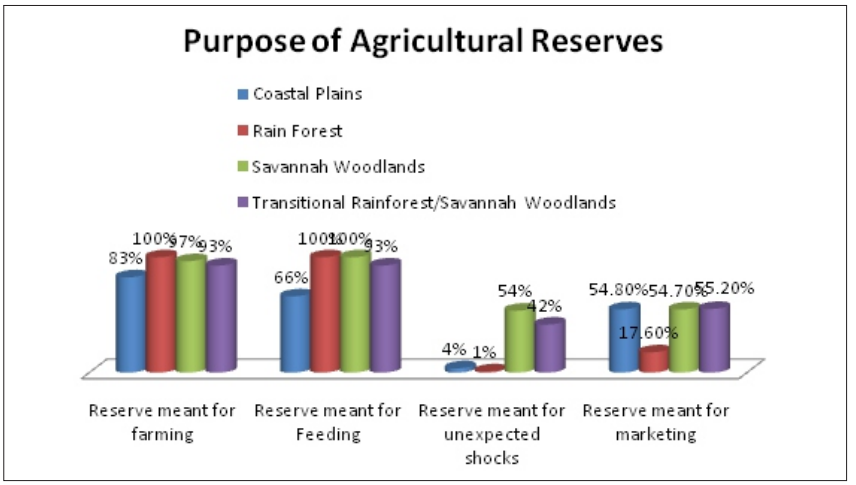


Figure 21: Agricultural reserves and purpose of reserves

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 22).

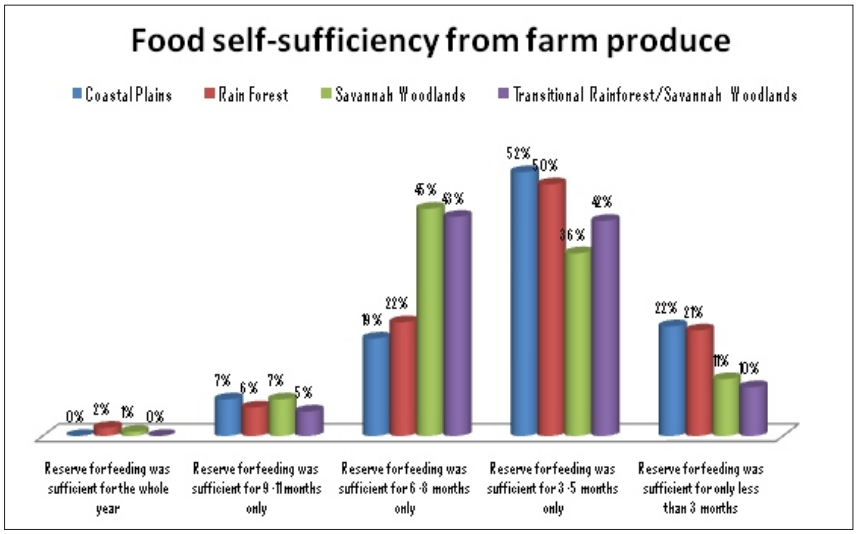


Figure 22: Perceived responses to food self-sufficiency

3.4.5 Responses and Behavioural Changes of Indigenous Farmers towards Climate Change Adaptation Measures

Local ownership of policies, projects and programmes is crucial in any development endeavours. 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 18). 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 18: 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	∑b/N	∑a/N	∑[(b)(a)]/N	x(13)	∑b/N	∑a/N	∑[(b)(a)]/N	x(13)	∑b/N	∑a/N	∑[(b)(a)]/N	x(13)	∑b/N	∑a/N	∑[(b)(a)]/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)

4. 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, temperature and cold is no longer normal as 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 injected by rainfall and mild temperatures, and not technology-driven. 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:

4.1

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:

4.1.1

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.

4.1.2

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 key, but has low technical and human capacities to carry out effective and efficient meteorological data collection; the institution's capacity there 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.

4.2

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 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. There following recommendations have therefore been made to address these issues:

4.2.1

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.

4.2.2

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.

4.2.3

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 other 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 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-bahaviour 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 priories are presented in table 20.

4.3

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.

4.4

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.

4.5

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.

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Appendices

Table 19: No. of deaths resulting from climate-related problems

Diseases	No. of Deaths	Agro-Climatic Region				Total
		Coastal Plains	Rain Forest	Savannah Woodlands	Transitional Rainforest/ Savannah Woodlands	
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 20: Comparative range of expenditure on farming and sickness and returns from yields

Income Range	Agro-Climatic Region				
	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 21: 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 2. 18-25yrs 3. 26-33yrs 4. 34-41yrs 5. 42-49yrs 6. 49-56yrs 7. Above 56yrs	
A3.	What is your marital status?	1. Never married 2. Engaged 3. Separated 4. Married polygamous 5. Married monogamous 6. Divorced 7. Widowed	
A4.	When did you come to settle in this locality?	1. From birth 2. Above 5 yrs, but not from birth 3. 5 years ago 4. 4 years ago 5. 1-3 years ago 6. Less than 1 year ago	
A6.	How many dependants are presently with you?	1. 1-3 2. 4-5 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) 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) 2. Two years ago(2008)

A12.	If Yes to Q. A11, when did you start experiencing any of these ?	1. One year ago(2009) 2. Two years ago(2008) 3. Three years ago(2007) 4. Four years ago(2006) 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 th ese 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 2. Yes, not frequently 3. No, in recent years 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…….....)		
		2. NGO/CBO (specify……...)		
		3. Private Company(specify……)		
		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	
			2. Provisions of chemicals/pesticides	
			3. Provision of credit /loan facilities	
			4. Training on farm practices	
			5. Training on weather forecasts	
			6. Distribution of farming calendars	
			7. Provision of fertilizers	
			8. Construction of small irrigation dams	
			9. Provision of farm tools/ machinery	
			10. Provision of fast -growing seed varieties	
			11. Provision of p ost-harvest facilities	
			12. Provision of food	
			13. Provision of settlements/farm lands	
			14. Construction of fish ponds	
			15. Provision of fishing nets/ boats	
			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	
			2. Importance of tree planting	
			3. Impact of deforestation	
			4. Planting dates	
			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	
			2. Government	
			3. Friends	
			4. News Paper	
			5. Television	
			6. NGOs/CBOs	
			7. Community members	
			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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African Technology Policy Studies Network
Contact the Executive Director at
The Chancery, 3rd Floor, Valley Rd.
P O Box 10081, 00100-Nairobi, Kenya
Tel: (254 020) 2714092, 2714168, 2714498, 2723800
Fax: (254 020) 2714028

http://www.atpsnet.org

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