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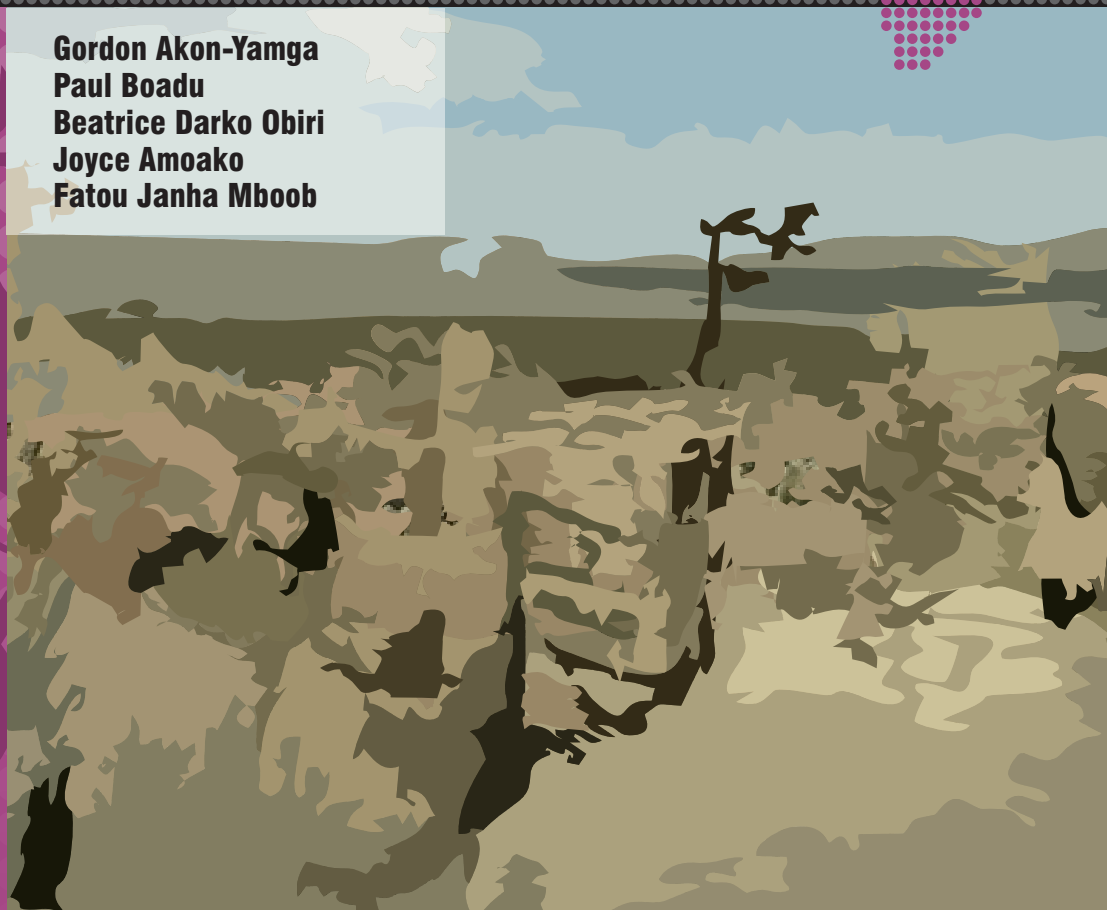

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Gordon Akon-Yamga Beatrice Darko Obiri

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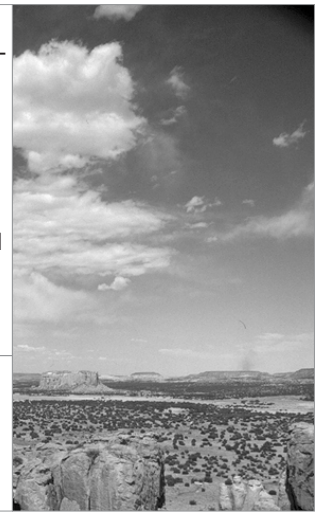
The African Technology Policy Studies Network (ATPS) is a multi-disciplinary network of researchers, private sector actors and policy makers promoting the generation, dissemination, use and mastery of science, technology and innovation (ST&I) for African development, environmental sustainability and 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

Introduction

Reports by the Intergovernmental Panel on Climate Change (IPCC) suggest that agricultural yields will suffer negative consequences of climate change if no serious intervention is carried out (IPCC, 2007). Studies have shown that Ghana's climatic conditions have changed in the past four decades (Agyeman-Bonsu et. al, 2008). In The Gambia, the Government (2003) used forty years (1951-1990). It is projected that by 2075, average mean temperature of The Gambia will increase by a margin of between 3°C to 4.5°C depending on the model used. On the impact of such change on food availability, The Government of Gambia (2003) predicts that all crop growth parameters (kg dm/ha) for the maize crop would undergo significant reductions under climate change.

The main objective of the study is to support the ATPS Agricultural Innovations Programme on Agricultural Innovations for Climate Change Adaptation and Food Security in Africa by achieving the following specific objectives: Identify and document indigenous innovations and good practices by climate change vulnerable communities for improved food security in Ghana and The Gambia; provide information on agricultural practices and activities of farmers towards food security and climate change adaptation in Ghana and Gambia; identify and document emerging innovations suitable for climate change adaptation in Ghana and The Gambia; promote some selected agricultural innovations through targeted training and field demonstrations with selected agriculture extension officers and farmers in Ghana and The Gambia; establish collaborative network involving researchers, ministry of food and agriculture or its equivalent and farmers to enhance agricultural innovations for increased productivity in the face of climate change; and to provide baseline information to support agricultural innovation programmes and the implementation of the NEPAD CAADEP programme in the West Africa region through popularization and policy advocacy.

The concept of innovation system provides many opportunities for learning about how a country's agricultural sector can make optimum use of new knowledge and to design new interventions that go beyond research and investments (World Bank, 2007). Innovation is an interactive process involving various critical actors working in a given socio-economic and cultural system to bring about improvements or advances in the production of goods and services.

The Intergovernmental Panel on Climate Change (IPCC, 2007) defines climate change as “a

change in the state of the climate that can be identified (for example, by using statistical tests) by changes in the mean and/or variability of its properties, and that persists for an extended period, typically decades or longer". Climate change may be due to natural internal processes or external influences, or to persistent anthropogenic changes in the composition of the atmosphere or land use. On the other hand, the United Nations Framework Convention on Climate Change (UNFCCC) defines climate change as "change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods" (UN 1992).

The IPCC defines adaptation as "adjustments in ecological, social or economic systems in response to actual or expected stimuli and their effects or impacts. This term refers to changes in processes, practices and structures to moderate potential damages or to benefit from opportunities associated with climate change" (IPCC 2001).

Study Area and Method

The study was carried out in Ghana and The Gambia. Ghana lies on the south-central coast of West Africa between latitudes 4°5'N and 11°5'N and longitude 3°5'W and 1°3'E. The Gambia is the smallest of the two countries (approximately11,000 km^2), lying between latitude 13° and 14° North, and 17° and 12° West. It consists of a narrow strip of land some 400 km long and 30 km wide on both sides of The Gambia River.

Two methods were employed for this study. These were field survey and desk research. These methods yielded both primary and secondary data. To allocate the number of household heads for the field survey between Ghana and the Gambia the ratio of the populations of the two countries was used. Therefore relying on the ratio of the population of Ghana (23,350,927[1]) to the Gambia (1,660,200[2]) as the basis for allocating the number of households to be selected from each country, 747 households were allocated to Ghana and 53 households were allocated to the Gambia to complete the proposed overall sample size of 800. However it was realized 53 households was too low a sample and therefore during the survey 100 households were selected from the Gambia and 746 from Ghana.

Results

The survey in Ghana covered 77.5% male farmer-respondents against 22.5% female farmer-respondents. In the Gambia, the respondents were dominated by male farmers represented by 91.9% whiles female respondents were 8.1%. The survey results from Ghana showed that majority of the respondents (64.7%) had some level of formal education. The results from the Gambia show that all the respondents had some level of formal education.

Majority of the farmers interviewed were mainly engaged in crop cultivation. The survey results show majority of the famers in Ghana finance their agricultural activities from their own pockets. All the finances that go into farming the activities of respondents in the Gambia were self-generated. The results from Ghana show that 54% of respondents had never benefit from the services of

[1] *World Bank Data, 2008*
[2] *World Bank Data, 2008*

agricultural extension agents whereas 46% of respondents said they have had some interaction with agricultural extension agents In the Gambia however, 95% of the respondents reported that they had receive visits from Agricultural Extension Agents whereas 5% reported they do not receive any visit from extension officers.

The term climate change was translated into the local dialect before asking farmers. The results from Ghana show that many of the farmers interviewed (60%) knew and were able to describe climate change, albeit many times they were describing the changing rainfall season. In the Gambia of climate change issues was very encouraging. About 91% of the farmers interviewed said they were aware of climate change. Farmers perceived the loss of forest resources as the major impact of climate change in their localities. The results further indicate that the trend of forest loss has consistently increased between 2005 and 2009; additionally the results show that flooding, long period of the dry season, soil infertility, drying of rivers, long period of rains, decrease in farm yields and delays in the onset of rainfall during the rainy season were some perceived impacts of climate change.

As an indicator of household food security in the study area in Ghana, famers were asked about the frequency with which they had problems meeting their household feeding. The results from Ghana show that majority of the respondents (45.3%) said they sometimes experienced problems with feeding in their households. Furthermore, 6.3% said they often faced problem with household feeding, 5.4% said they always faced problems, whiles 14.6% said they seldom encountered problems. Therefore overall 72.6% of the respondents have in some form experienced problems with meeting household feeding. In the Gambia, majority of the farmers (75%) sometimes find it difficult meeting the food needs of their family. Very few of the farmers (11%) never faced any challenge in meeting the food needs of their households. Respondents who seldom faced problems of meeting their household food needs accounted for 10%. However those who regularly faced the problem of meeting food needs was not noticeable as that accounted for only 1%.

Farmers' adaptive responses to erratic rainfall patterns were examined. The relative majority of the framers interviewed during the survey in Ghana (29.8%) said they did nothing in seasons where they had little rainfall. Other farmers said they regularly weeded their farms (22.7%); applied fertilizer (10.2%); irrigated their farms (8.7%); early cultivation; spraying with agro-chemicals (2.1%); and the application of manure (1.8%).The situation was no different in the Gambia as majority of the respondents there (33%) also did nothing. About 17% of them said they provide water to their livestock whereas 7% consult with the agricultural extension officers and 4% pray to God for relief. When it comes to farmers' response to excessive rainfall, the results show a similar trend in both countries.

The results from Ghana show that not many farmers had introduced innovations on their farms. Indeed about 79% of the respondents said they have not introduced any innovations whereas about 22% of the respondents said they had. Similarly, in the Gambia, 72% of the respondents said they have not introduced any innovations whereas 28% said they had introduced some innovations in the farming activities.

With respect to institutions, about 109 technologies and innovations were identified among 13

research institutions in Ghana. Most of the technologies were crop production related technologies/innovations. In the Gambia, five institutions were covered. The institutions were mostly engaged in the extension or information dissemination activities, production, and research and development of agricultural innovations and technologies. Other activities undertaken by the institutions in include teaching, policy advocacy and quality assurance of technologies

List of Acronyms & Abbreviations

AAEAs	Agricultural Extension Agents
ARI	Animal Research Institute
ASD	Animal Science Department
ATPS	African technology Policy Studies Network
CAADEP	Comprehensive Africa Agricultural Development Programme
CRI	Crop Research Institute
CSD	Crop Science Department
CSIR	Council for Scientific and Industrial Research
FAO	Food and Agriculture Organisation
FORIG	Forestry Research Institute of Ghana
FRI	Food Research Institute
GHGs	Greenhouse Gases
IFPRI	International Food Policy Research Institute
IIR	Institute of Industrial Research
IPCC	Intergovernmental Panel on Climate Change
KNUST	Kwame Nkrumah University of Science and Technology
MAT	Mean Air Temperatures
ND	Nutrition Department
NEPAD	New Partnership for Africa's Development
OPRI	Oil Palm Research Institute
PGRI	Plant Genetic Research Institute
R&D	Research and Development
SARI	Savannah Agricultural Research Institute
SRI	Soil Research Institute
SSA	Sub-Saharan Africa
SST	Sea Surface Temperatures
STEPRI	Science and Technology Policy Research Institute
SWAC	Sahel and West Africa Club
TAR	Third Assessment Report
UDS	University for Development Studies
UNFCCC	United Nations Framework Convention on Climate Change
WMO	World Meteorological Organisation
WRI	Water Research Institute

1. Introduction

1.1. Background

The critical role of science and technology in promoting agricultural growth, food security, poverty reduction and particularly improvement in the livelihood of farmers in the developing world is documented and universally acknowledged. With the ever decreasing per capita land and water, productivity gains have become the main source of growth in agriculture and the primary means to satisfy increasing demand for food and agricultural products. Fast population growth and ill-effects of climate change call for sustainable agricultural systems in which food security is of paramount concern. Projected consequences of climate change means that sub-Saharan Africa (SSA) would be drier, and rainfall patterns unreliable. However, most of the best lands are already under cultivation, meaning that expansion in the food production would require agricultural technologies such as high yielding disease tolerant seed, irrigation technology, better agronomic practices, biotechnology, etc. to withstand harsh ecological conditions. Increasing population, competing demand for and reducing per capita land, among others, require intensification of use of research technologies in agricultural production systems.

Many efforts to achieve food security in totality continue to be a great challenge not only for developing countries but the developed countries as well. The difference lies in the magnitude of the problem in terms of its severity and proportion of the population affected. In developed nations the problem is alleviated by providing targeted food security interventions, including food aid in the form of direct food relief, food stamps, or indirectly through subsidized food production. These efforts have significantly reduced food insecurity in these regions. Similar approaches are employed in developing countries but with less success. The difference in the results may be due to insufficient resource base, shorter duration of intervention, or different systems most of which are inherently heterogeneous among other factors. Through the process of research and development, the last four decades have seen a remarkable growth in agricultural production with per capita world food production growing. Modern agricultural methods have brought spectacular increase in productivity. They have resulted in more cereals and animals per hectare, more meat and milk per animal, and more food output per person employed. Farmers with access to sufficient inputs, knowledge and skills produce large amount of food. However, the majority of the chronic hungry are small farmers in developing countries who produce much of what they eat and often lack access to inputs, productive markets, and especially lack of storage facilities.

1.2. Research problem statement

Reports by the Intergovernmental Panel on Climate Change (IPCC) suggest that agricultural yields will suffer negative consequences if no serious intervention is carried out (IPCC, 2007). Therefore the impacts of climate change and variability will outweigh economic and population growth factors, yet these factors may intensify the impacts. Studies have shown that Ghana's climatic conditions have changed in the past four decades (Agyeman-Bonsu et. al, 2008). Analysis by Agyeman-Bonsu et. al. (2008) showed that both maximum and minimum air temperatures increased by 2.5 and 2.2°C respectively between 1961 and 2001. Thus maximum, minimum and mean air temperatures (MAT) on land also increased by 0.9°C, and a positive autocorrelation with a significant lag of one year was observed. The highest MAT was recorded in 1998 (27.8°C) and the lowest in 1975 (26.3°C). Apart from the marked decreases between 1972 and 1975, variability was generally low. The sea surface temperatures (SST) showed a higher variability with more frequent and greater inter-annual changes than the MAT. Cooling periods seemed to alternate with warm periods at an average cycle of 2-4 years but the most significant inter-annual change occurred between 1983-84 and 1986-87.

On the impact of climate change and food security in Ghana, the impact of climate change on cereal production in Ghana was assessed using the CERES model. CERES MAIZE and CERES MILLET models were used to generate growth and yield of maize and millet, respectively. The model output showed that there was a consistent decrease in the yield of maize in the Transition Zone due to an increase in temperature and solar radiation and a decrease in rainfall. However, the decreases in the projected yields were not significantly different from the baseline yields. The percentage decrease in the projected maize yield ranged from 0.5 percent in the year 2000 to 6.9 percent in the year 2020. With respect to millet, however, the changes in the climatic variables did not effect any change in the projected yield of millet. This could be ascribed to the drought tolerant nature of millet (Government of Ghana, 2003).

In The Gambia, the Government (2003) used forty years (1951-1990) of current climate data to develop the baseline climate scenarios with the analysis showing that in the 1951-1990 period, the behaviour of the climate of the country showed almost equal distribution of wet/cool and dry/warm years. Thus, the 1951-1980 period was wetter and relatively warmer while the 1961-1990 period was drier and cooler. However between the two periods, the rainfall for the months of July and September significantly decreased. Furthermore, it is projected that by 2075, average mean temperature of The Gambia will increase by a margin of between 3°C to 4.5°C depending the model used, and by 2100 a decrease of 59% (HCGG), 17% (HCGS) and 15% (GFDL equilibrium model), and an increase of about 15% (GFDL01) and 29% (CCCM) about the 1951-1990 average rainfall amount are projected in The Gambia (The Government of Gambia, 2003). On the impact of such change on food availability, The Government of Gambia (2003) predicts that all crop growth parameters (kg dm/ha) for the maize crop would undergo significant reductions under climate change. Furthermore, grain weight is estimated reduce lower than current climate values; leaf and stem weights are also expected to be lower than current climate values by amounts ranging from 18 – 35% and 17 – 34%, respectively; and the nutritional value of the biomass products from maize will also be decreased due to decrease in nitrogen content, a situation that is similar for millet.

The impact of such changes and outcomes on society has often been seen as normal and part of

life. This is because livelihood options have turned into adaptation strategies, where there is no clear transition, adaptation to extreme events are considered as part of livelihoods. The riots and protest due to food shortage and prices in 2007-2008 point to some of the signs of increasing food insecurity in many countries in sub-Sahara Africa, yet there exist innovations that can be used to stem the tide of food insecurity. A recent study conducted by CSIR-STEPRI of Ghana (Obirih-Opareh et al., 2008) shows that there exists numerous agricultural innovations that have not been used and yet they hold potential for improving food production in Ghana and Africa. However it is not known which of these innovations are most suitable for climate change adaptation. It is in this light that this research is founded; to document indigenous and emerging innovations and good practices for climate change adaptation and food security in Ghana and the Gambia.

1.3. Objective of the Study

The main objective of the study is to support the ATPS Agricultural Innovations Programme on Agricultural Innovations for Climate Change Adaptation and Food Security in Africa by achieving the following specific objectives:

- Identify and document indigenous innovations and good practices by climate change vulnerable communities for improved food security in Ghana and The Gambia;
- Provide information on agricultural practices and activities of farmers towards food security and climate change adaptation in Ghana and Gambia;
- Identify and document emerging innovations suitable for climate change adaptation in Ghana and The Gambia;
- Promote some selected agricultural innovations through targeted training and field demonstrations with selected agriculture extension officers and farmers in Ghana and The Gambia;
- Establish collaborative network involving researchers, ministry of food and agriculture or its equivalent and farmers to enhance agricultural innovations for increased productivity in the face of climate change; and
- To provide baseline information to support agricultural innovation programmes and the implementation of the NEPAD CAADEP programme in the West Africa region through popularization and policy advocacy.

2. Literature Review

2.1. Innovation System

The concept of innovation system provides many opportunities for learning about how a country's agricultural sector can make optimum use of new knowledge and to design new interventions that go beyond research and investments (World Bank, 2007). Therefore agricultural innovation system can be seen as the best approach to ensure food security in Africa. Innovation system thinking represents a significant change from the conventional linear approach to research and development. It provides analytical framework that explore complex relationships among heterogeneous agents, social and economic institutions, and endogenously determined technological and institutional opportunities. It demonstrates the importance of studying innovation as a process in which knowledge is accumulated and applied by heterogeneous agents, through complex interactions that are conditioned by social and economic institutions (Agwu et. al., 2008).

Innovation is an interactive process involving various critical actors working in a given socio-economic and cultural system to bring about improvements or advances in the production of goods and services. It is a dynamic process and it implies specific behaviours and performances, with obvious implications for outcomes. The concept of Innovation System has become an important framework for understanding technology development and diffusion in recent times (Nelson, 1993; Mytelka, 2000; World Bank, 2007). The framework stresses that innovation is neither research nor science and technology, but rather the application of knowledge (of all types) in production to achieve desired social or economic outcomes. This knowledge might be acquired through learning, research or experience, but until applied it cannot be considered innovation. While this knowledge can be brand new innovation often involves the reworking of the existing stock of knowledge, making new combinations or new uses (Edquist, 1997).

The origin of this framework is the concept of a national system of innovation (Freeman1988, and Lundval 1991). It emerged as a response to the limited explanatory power of conventional economic models that view innovation as a linear process driven by the supply of research and development (R&D). Instead the innovation systems framework conceptualised innovation in more systemic, interactive and evolutionary terms whereby networks of organisations, together with the institutions and policies that affect their innovative behaviour and performance, bring new products, new processes and new forms of organization into economic use (Nelson and Winter 1982, Freeman 1988, Lundval 1992; Edquist 1997).

Different approaches to promoting agricultural innovation have emerged since the 1980s. The period before the mid-1980s emphasised the creation of National Agricultural Research Systems to strengthen research at the national level and to encourage technology transfer and invention. In the 1990s, this approach changed to the pluralistic agricultural knowledge and information systems which emphasised greater client participation and financing, technology adoption and adaptation, and knowledge exchange mechanisms. More recently, the agricultural innovation system approach incorporates major agents such as universities, firms and other organisations that can tap into the growing stock of global knowledge to local needs, and create new technology and products. Within the changing agricultural context, agricultural innovation system emphasises technology and knowledge generation and adoption rather than strengthening research systems and their outputs (Kim et. al., 2007).

The innovation concept has been used by SWAC (2005) in a broad sense, integrating institutional, policy and organisational innovations. It includes:

i. Physical innovation (example: crop varieties, animal breeds, etc.);
ii. Institutional, social, organisational innovations (example: setting up producers' networks, better organisation of input distribution networks, etc.);
iii. Innovations in terms of information and practices (example: cultural practices).

For each type of innovation, endogenous innovations (farmer innovations) can be distinguished from exogenous innovations (innovations derived from research, extension, private companies, and agribusiness, etc.).

2.2. Climate Change

Climate change in recent times has assumed the top list of major public issues, especially since 2006 because the evidence of its manifestation is very overwhelming. However, there are recognised uncertainties in the science. There is debate and recognition of limits to knowledge about the times and ways in which the risk will manifest itself. At the same time, progress in understanding how climate is changing in space and time has been gained through improvements and extensions of numerous datasets and data analyses, broader geographical coverage, better understanding of uncertainties and a wider variety of measurements.

The climate is a system involving highly complex interactions between the atmosphere, the oceans, the water cycle, ice, snow and frozen ground, the land surface and living organisms. This system changes over time in response to internal dynamics and variations in external influences such as volcanic eruptions and solar radiation.

The atmospheric component is the most unstable and rapidly changing part of the climate system. The atmosphere is divided into five layers with different temperature characteristics. The lower two—the troposphere and the stratosphere—have the most influence on the climate system. The troposphere extends from the surface of the earth to an altitude of between 10 and 16 km. Clouds and weather phenomena occur in the troposphere, and greenhouse gases absorb heat radiated from the earth. The stratosphere, which extends from the boundary of the troposphere to an altitude of around 50 km, is the second layer of the atmosphere. The stratosphere holds a natural layer of high ozone concentrations, which absorb ultraviolet radiation from the sun. The balance of energy

between the layers of the atmosphere is a major driver of atmospheric and ocean circulation, which leads to weather and climate patterns (IPCC 2007).

The Earth's climate has always changed and evolved. Some of these changes have been due to natural causes but others can be attributed to human activities such as deforestation and to atmospheric emissions, from, for example, industry and transport, which have led to gases and aerosols being stored in the atmosphere. These gases are known as greenhouse gases (GHGs) because they trap heat and raise air temperatures near the ground, acting like a greenhouse on the surface of the planet.

The Intergovernmental Panel on Climate Change (IPCC, 2007) defines climate change as "a change in the state of the climate that can be identified (for example, by using statistical tests) by changes in the mean and/or variability of its properties, and that persists for an extended period, typically decades or longer". Climate change may be due to natural internal processes or external influences, or to persistent anthropogenic changes in the composition of the atmosphere or land use. On the other hand, the United Nations Framework Convention on Climate Change (UNFCCC) defines climate change as "change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods" (UN 1992).

It is important to distinguish between climate change and climate variability. According to the World Meteorological organisation (WMO, 2010) climate variability refers to "variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the climate on all temporal and spatial scales beyond that of individual weather events. Variability may be due to natural internal processes within the climate system (internal variability), or to variations in natural or anthropogenic external forcing (external variability)". The UNFCCC makes a distinction between "climate change" which is attributable to human activities altering the atmospheric composition, and "climate variability" attributable to natural internal climate system process. However, in the context of this study there is no distinction between the two. Making a distinction between climate change and variability will entail careful comparison between observed changes and those that are expected to result from external forcing. These expectations are based on physical understanding of the climate system, which is based on physical principles. This understanding can take the form of conceptual models or it might be quantified with climate models (IPCCC, 2007), but the respondents we envisaged to talk to mostly do not have such understanding and therefore it would be difficult to them to make such a distinction.

The warming of the climate system evident in the last half century is a result of the cumulative effect of all the natural and human drivers that influence the amount of warming or cooling in the system. The dominant influence since 1750 has been an increase in concentrations of carbon dioxide. Aerosols have had a net cooling influence, although this effect is poorly understood. Natural variability in solar radiation has had a small warming influence, but there is a high level of uncertainty in the magnitude of the effect (IPCC 2007).

According to the IPCC (2007), Observational evidence from all continents and most oceans shows that many natural systems are being affected by regional climate changes, particularly temperature

increases. It accordingly states that a global assessment of data since 1970 has shown it is likely that anthropogenic warming has had a discernible influence on many physical and biological systems.

There are many forecasts and indeed recorded cases of dire consequences or impacts of climate change. These, amongst many include:

> A general reduction in potential crop yields in most tropical and sub-tropical regions – for most projected increases in temperature;
> A general reduction in potential crop yields in most regions in mid-latitudes, with some variations, for increases in annual average temperatures of more than a few degrees Celsius;
> Less water in many water-scarce regions, particularly in the sub-tropics;
> Greater exposure to heat stress, vector-borne diseases such as malaria and water-borne diseases such as cholera;
> Increased risk of flooding of human settlements because of heavy precipitation and sea-level rises – tens of millions of people will be affected;
> Increased demand for energy for space cooling because of higher summer temperatures.
> Increased demand for energy for space heating during sever winters.

2.3. Adaptation to Climate Change

Two main responses have been identified by which societies can respond to climate change. These are adapting to its impacts and reducing the green house gas (GHG) emissions (mitigation), thus reducing the rate and magnitude of change. However, there is tension between these two-adaptation and mitigation (Henson, 2008). While mitigation seeks to limit climate change by reducing the emissions of GHG and by enhancing 'sink' opportunities, adaptation aims to alleviate the adverse impacts through a wide-range of system-specific actions (Fussel and Klein, 2002).

The IPCC defines adaptation as “adjustments in ecological, social or economic systems in response to actual or expected stimuli and their effects or impacts. This term refers to changes in processes, practices and structures to moderate potential damages or to benefit from opportunities associated with climate change” (IPCC 2001). Albeit both mitigation and adaptation measures must be pursued to tackle the climate change problem and to create an effective and inclusive international climate change regime, more attention has been devoted to mitigation in the past, both in scientific research and policy debate. Sensitivity to the issue of adaptation has grown over the last couple of years, particularly after the IPCC Third Assessment Report (TAR). Adaptation has now emerged as an urgent policy priority, prompting action both within and outside the climate change negotiations (Parry et al. 2005). According to Cohen et. al. (1998), one plausible reason for the focus on adaptation could be that climate change emerged as a problem related to the long-term disturbance of the global geo-biochemical cycles and associated effects on the climate system.

The United Nations Framework Convention on Climate Change (UNFCCC) provides that all Parties must formulate and implement national or regional programmes containing measures to facilitate adequate adaptation to climate change (Art. 4.1. b). It lists specific domains in particular need of adaptation, namely coastal zones, water resources, agriculture, and areas affected by drought and desertification, as well as floods.

2.4. Food security

Given that it has been projected and in some cases observed impacts of climate change in the general reduction in potential crop yields in most tropical and sub-tropical regions, there is clear indication that food security will be adversely affected by climate change. Indeed the IPCC (2007) projects that by 2020, some countries in Africa could experience up to 50% reduction in rain-fed agriculture. The report further adds that productivity of some important crops is projected to decrease and livestock productivity to decline, with adverse consequences for food security.

Climate change is likely to affect food production for the following reasons:

> Increased temperatures could reduce crop yields by shortening growing seasons and accelerating grain sterility in crops.
> Marine ecosystems could experience major migratory changes in fish stocks and mortality events in response to rising temperatures. Fish is the primary source of protein for more than one billion people in Asia.
> Shifts in rainfall patterns could disrupt flows in rivers used for irrigation, accelerate erosion and desertification and reduce crop and livestock yields.
> Rising sea levels could inundate and make unusable fertile coastal land.
> An increase in the intensity or frequency of severe weather events could disrupt agriculture.

Food security has been defined by Cook and Frank (2008) as "Access by all people at all times to enough food for an active, healthy life. Food security includes at a minimum:

(I) The ready availability of nutritionally adequate and safe foods, and
(ii) An assured ability to acquire acceptable foods in socially acceptable ways (e.g., without resorting to emergency food supplies, scavenging, stealing, or other coping strategies)".
The World Food Summit Plan of Action defines food security in the following terms: "Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (FAO, 1996). Food security comprises four dimensions:

(i) Adequacy of food availability;
(ii) Stability of supply;
(iii) Physical and economic accessibility of food; and
(iv) Quality and safety of food.

The standard definition of food security according to the World Bank (1986) is "access by all peoples at all times to enough food for an active, healthy life". Statistics of food security are usually computed for individual nation states. These may be aggregated for the world's major regions to demonstrate interregional disparities at global scales. National food security is a derivative of a balance sheet in which the population nutritional requirements are balanced by supply either from production or through international trade. Computed in per capita terms, national food security, usually assumes equitable sharing of available food stock between regions, between social classes, and between members of the same household.

A food secured world cannot be adequately represented at either the regional or the national level. The security envisaged should be at all levels of human organization, including the individual, the

household and the community. At the individual household level, appropriate and sufficient food could be secured with income available for food purchases, from farmland harvests, or from a combination of these and other sources. Therefore basically, food security is a function of agricultural production, which may be constrained by physical, biological and economic factors. However, a total failure of agricultural production to provide the required food will not automatically result in food insecurity provided the household can earn enough from employment and other engagements to purchase from the market.

FAO's methodology for evaluating the number of undernourished persons, which takes into account the amount of food available per person in a given country and the extent of inequality of access to food. This approach is reinforced by the emerging consensus that food insecurity in SSA is a product of both limited food availability and restricted access to food (FAO, 2006). Therefore, in this study food security was analysed mostly from the point of view of availability and accessibility.

3. Study Area

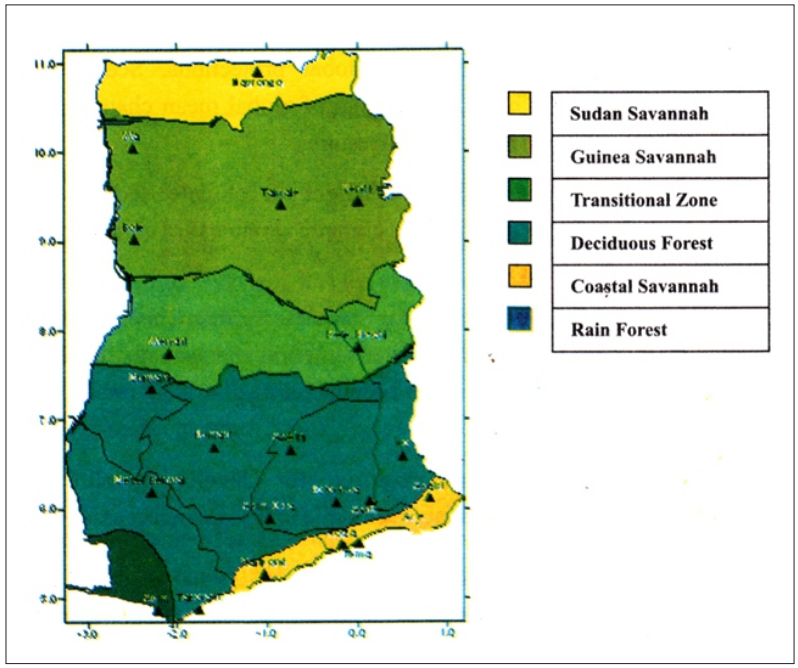
The study was carried out in Ghana and The Gambia. Ghana lies on the south-central coast of West Africa between latitudes 4°5'N and 11°5'N and longitude 3°5'W and 1°3'E. It shares a common border with the Republic of Togo on the east, Burkina Faso on the north and la Cote d'Ivoire on the west. Ghana covers an average area of 238,539 square kilometers. In 2008 the population was estimated to at 23,350,927 (World Bank, 2008. In Ghana, the respondents were spread across ten districts distributed among the ten administrative regions of the country and among six agro-ecological zones (see Figure 1).

Ghana is divided into six agro-ecological zones, namely Sudan, Guinea and Coastal Savannah zones, the Forest-Savannah Transitional zone, the Semi-deciduous Forest and the High Rainforest Zones. The Sudan Savannah covers an estimated area of 1,900 km^2 and consists of short drought and fire resistant deciduous trees interspersed with open Savannah grassland. Grass cover is very sparse and in most areas the land is bare and severely eroded. The Guinea Savannah covers almost the northern two-thirds of the country with an area of 147,900 km^2. The vegetation consists typically of a ground cover of grasses of varying heights interspersed with fire resistant, deciduous, broad-leaved trees at the forest margins. This grades into a more open grassland with widely spaced shorter trees towards the north. The Coastal Savannah covers an estimated area of 4500 km^2. It consists of mainly grassland interspersed with dense thickets often less than 5m high with a few trees. Short and medium grasses are the dominant species. The Forest-Savannah Transitional Zone (Derived Savannah) covers about 8,300 km^2. Most of the trees species, similar to those in the forest zone, occur in association with tall to medium tall grasses (EPA, 2003).

The Gambia is the smallest of the two countries (approximately11,000 km^2), lying between latitude 13° and 14° North, and 17° and 12° West. It consists of a narrow strip of land some 400 km long and 30 km wide on both sides of The Gambia River. The population is estimated at 1,660,200 (World Bank, 2008). The study in the Gambia was conducted in the Central Baddibou District in Northern Bank Region and Jara West in the Lower River Regions (see Figures 2).

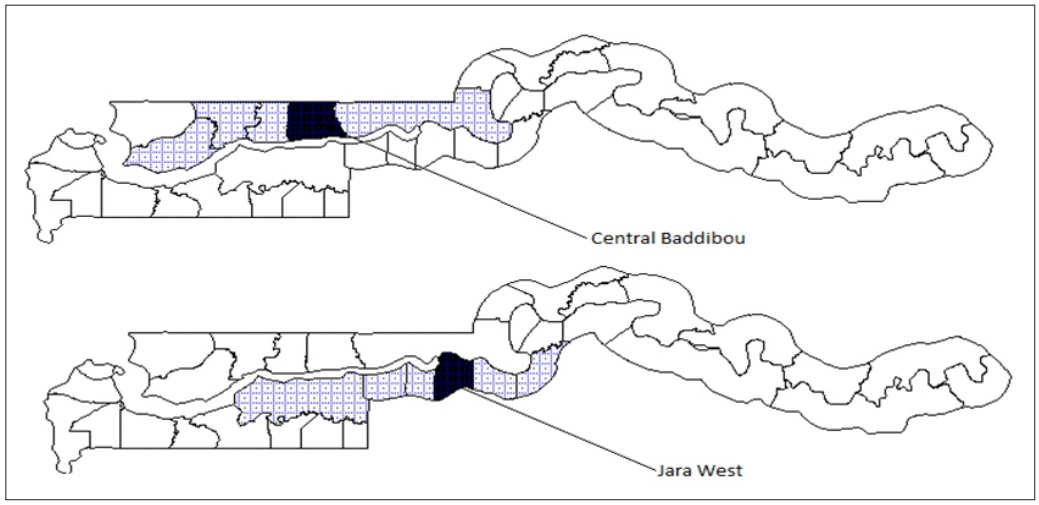
The climate of The Gambia is typically “Sudano Sahelian” characterized by a short monomodal rainy season (June to October) followed by a long-dry season (November to May) characterized by the harmattan wind (Ceesay, 2008). However agricultural production systems in The Gambia follow three types of agro-ecological zones existent in the country (Ceesay, 2006): The Sudano-Sahelian Zone or Riverine Zone which covers a great part of the country (Central River Region-South), Upper

River Region, North Bank Region and Lower River Region) and has moderate to high rainfall of approximately 900-1000mm per annum; the Sahel-Savanna Zone or Semi-Arid Zone covers mainly the Central River Region-North and has relatively low rainfall, below 900mm; and the Guinea-Savannah Zone or Humid zone is located around the coastline (i.e. Western Region and North Bank Region). It has high and moderately reliable rainfall (1000mm and above).



Source: Agyeman Bonsu et. al. (2008)

Figure 1: The Ecological Zones of Ghana



Source: Adapted from Government of the Gambia, 2003

Figure 2: Study area in the Gambia

4. Methodology

Two methods were employed for this study. These were field survey and desk research. These methods yielded both primary and secondary data.

4.1. Desk Study

The desk study was undertaken to review the literature and examine reports, papers, official documents that exist prior to the commencement of our study. It was also done with the intention to discover data that already exist, which could be used as background for our study. The documents were mainly obtained from ministries, departments and agencies in Ghana and the Gambia. The World Wide Web was relied on as a source of secondary data to complement what was obtained.

4.2. Field Survey

The field survey entailed the administration of questionnaires to heads of farming households or their representatives on one hand and the administration of questionnaires to heads of institutions conducting agricultural research. The administration of questionnaires at the household level was complemented by focus group discussions organized at the district level with farmers.

4.2.1. Survey of Households

The survey covered farmer-household heads or their representative, in their absence. The purpose was to interview farmers about their experiences and perceptions of climate change and their adaptation practices. In view of this it is important to describe the process through which the respondents were picked.

4.2.1.1. Sample Frame

The unit of analysis was the household and therefore the sample frame comprised households in the six ecological zones in Ghana. For The Gambia, the sampling frame was households in the four ecological zones of the country. A sample of 846 household heads was selected from Ghana and Gambia in order to achieve the purpose of this survey. This means that the study exceeded the 800 households stipulated in the proposal.

4.2.1.2. Sample Selection

To allocate the number of household heads to interview between Ghana and the Gambia the ratio of the populations of the two countries was used. Therefore relying on the ratio of the population of

Ghana (23,350,927) to the Gambia (1,660,200) as the basis for allocating the number of households to be selected from each country, 747 households were allocated to Ghana and 53 households were allocated to the Gambia to complete the proposed overall sample size of 800. However it was realized 53 households was too low a sample and therefore during the survey 100 households were selected from the Gambia and 746 from Ghana. Table 1 shows the distribution of the sample between Ghana and the Gambia, and across district and ecological zones.

In order to increase precision and reliability of the data and results of the survey, stratification was employed. This was done by taking into consideration the geographical distribution, ecological zones and population distribution as the main control. In both countries, districts were grouped according to their administrative regions. In Ghana, one district was selected within each region using the simple random sampling technique. In the Gambia, however, two regions were randomly selected initially and within these two regions, one district each was selected using the simple random sampling.

Once a district was selected, within the selected districts a list of five major food producing communities was obtained from the state ministry or department responsible for agriculture. From this list some communities were randomly selected. The number of communities selected per ecological zone or district depended on the total population per community and the total sample per ecological zone. Within each of the identified communities, the survey team entered and met with the leader/head of the community to introduce themselves, explain their mission to the leadership of the community, seek the permission of the community to carry out the survey, and to request for the assistance of someone who knows the community very well.

At the community level, an enlistment of the households was conducted with the assistance of a member of the community who knows it very well. This provided the sampling frame of households at the community level from which the households interviewed were randomly selected.

[3] *World Bank Data, 2008*
[4] *World Bank Data, 2008*

Table 1: Distribution of sample per ecological zone and district in Ghana and Gambia

Ecological Zone	Sample proportion (%) of total sample	Sample	District
Sudan Savannah	8.1	60	Bongo
Guinea Savannah	10.1	75	West Gonja and Wa East
Transitional zone	9.9	74	Tano North
Deciduous forest	37.6	280	Amansie Central, South Dayi and Yilo Krobo
Rain forest	10	75	Jomoro
Coastal Savannah	24.4	182	Ewutu-Efutu and Ga South
Sub-Total	100	746	
GAMBIA			
Sudan Sahelian Savannah	100	100	Jara West and Central Baddibou
Sub-Total	100	100	
Grand Total		**846**	

4.2.1.3 Household Questionnaire Administration

At the household, the whereabouts of the head as sought after exchanges of pleasantries. In the absence of the head, the next most responsible person in the household who must also be a farmer was selected and the questionnaire administered to him or her. The questionnaire covered the demographic characteristics of the respondent, agricultural activities of the household, farmers' level of awareness of climate change, the household's access to food, the adaptation measures taken by farmers, the innovations of farmers and the extent to which they network with others.

4.2.2. Focus Group Discussions

In each of the districts selected, one focus group discussion was organized. Members of the groups were made up of farmers selected from the communities in the districts and each group did not exceed 12 in number. The groups were composed of mixed gender; male and female, young and the elderly. The discussions were facilitated by the field team leader who led discussions on issues such as agricultural practices of the farmers, how these practices have contributed to food production, reasons why some practices are no longer in use, communities' responses to environmental disasters, and the identification of beliefs that are inimical to women's participation in decision making in their communities.

4.2.3 Survey of Research Institutions

A survey of heads of institutions was conducted with institutions engaged in agricultural research in Ghana and The Gambia. The research institutions and or departments in the universities in Ghana and the Gambia were identified and sent copies of the questionnaire to respond to.

The questionnaire was designed to capture primary data bordering demographic characteristics of the head of institution, the type of institution it is, i.e. whether international or national/government or non-governmental, etc.… The questionnaire also sought to capture the main area of focus of the institutions, their human resource base, source of funding and the institutions' activities with respect to networking and collaborations.

However, the responses from Ghana were not encouraging. The explanation is that there appear to have been a somewhat survey-fatigue among the institutions especially bordering on innovations since within the same year of the survey, CSIR-STEPRI had conducted a survey of agricultural innovations. Therefore in the case of Ghana the analysis relied on secondary data comprising CSIR-STEPRI's previous survey. In the case of the Gambia, five institutions responded.

5. Results

5.1. Demographic Characteristics of Respondents

The demographic characteristics of respondents in surveys are vital in analyzing and interpreting the complete data collected about the respondents. It is in this light that the demographic characteristics such as the sex, age and educational level of the respondents were obtained. These are presented as follows.

5.1.1. Gender of respondents

The survey in Ghana covered 77.5% male farmer-respondents against 22.5% female farmer-respondents. The distribution of the respondents among the ecological zones shows that majority of the respondents were from the Deciduous Forest ecological zone (40.5%) followed by the Coastal Savannah ecological zone(23.2%), the Sudan Savannah zone (11.0%), the Guinea Savannah (9.4%), the Transition zone (9.0%), the Rain Forest ecological zone had the least representation with 7.0% of the respondents. Table 2 gives the gender distribution of the respondents according to ecological zones by country. It is evident that the Coastal Savannah and Deciduous Forest ecological zones recorded higher numbers of female respondents than the other ecological zones, nonetheless, no ecological zone recorded more female respondents than male. It is important to note that inference from the gender distribution must be done with proper caveat.

Table 2: Gender distribution by country

Ecological Zone	Male		Female		Total	
	No.	Percent	No.	Percent	No.	Percent
Ghana						
Coastal Savannah	108	18.8	65	38.0	173	23.2
Deciduous forest	244	42.4	58	33.9	302	40.5
Guinea Savannah	55	9.6	15	8.8	70	9.4
Rain forest	38	6.6	14	8.2	52	7.0
Sudan Savannah	71	12.4	11	6.4	82	11.0
Transition Zone	59	10.3	8	4.7	67	9.0
Total	575	100	171	100	746	100
The Gambia						
Lower River	43	46.7	7	87.5	50	50
North Bank	49	53.3	1	12.5	50	50
Total	**92**	**100**	**8**	**100**	**100**	**100**

Source: ATPS Survey, 2010

IIn the Gambia, the respondents were dominated by male farmers represented by 92% whiles female respondents were 8%. Table 2 shows that 46.7% of the male respondents were from the Lower River Region whilst 53.3% were from the North Bank Region of the Gambia. On the other hand, 87.5% of the female respondents were from Lower River Region whereas 12.5% were from North Bank.

5.1.2 Age of Respondents

The age of distribution of the respondents in Ghana was skewed towards the youthful population as about 63% of the respondents were less than 50 years old, however a sizeable percentage of the respondents (37%) were over 50 years old. Furthermore, the survey showed that a relative majority of the respondents (29.8%) belonged to the 40-49 age group, followed by the 30-39 age group (23%), 50-59 age group (20.2%), above 60 age group (16.9%), 20-29 age group (9.8%) and below 20 years (0.1%).

Table 3 shows the age distribution of the respondents according by country. The results from the Gambia indicate that farmers in the study area were not in the active labour force group. This is because only about 16% of the respondents were in the age group below 40 years (which can be considered as the active labour force group) whereas 84% of them were in the age groups above 40 years. The daunting part of it is the fact that 37% of the respondents are above age 60. The implication for the agricultural sector in the Gambia is that the country is not realising its potential in agricultural productivity as the active age groups may not be engaged in agriculture.
Age distribution of respondents by country

5.1.3. Age distribution of respondents by country

Table 3: Age of respondents

Age Group	The Gambia		Ghana		All	
	No.	Percent	No.	Percent	No.	Percent
<20	1	1.0	2	0.3	3	0.4
20-29	5	5.0	74	10.0	79	9.4
30-39	10	10.0	174	23.6	184	22.0
40-49	22	22.0	221	30.0	243	29.0
50-59	25	25.0	144	19.5	169	20.2
60+	37	37.0	122	16.6	159	19.0
All	**100**	**100**	**737**	**100**	**837**	**100**

Source: ATPS Survey, 2010

5.1.4 Educational Level of Respondents

The survey results from Ghana show that majority of the respondents (61.5%) had some level of formal education. Table 4 shows that many of them (34.3%) said they had attempted primary school followed by those who have secondary level of education (13.0%), Junior secondary school (9.5%), diplomas (3.1%), certificates course (112%). and bachelor degrees (0.3%). On the other hand, 38.5% of the respondents had no formal education whiles 0.3% said they had attempted "other" form of education, mainly the Arabic.

The results from the Gambia show that all the respondents had some level of formal education. About 30.0% of the respondents had primary level education; 7.0% had up to secondary level education; none of them were certificate and diploma holders. The category of education that recorded the highest was Arabic (62%), however, one of the respondents had a bachelor degree. Therefore the most of the farmers interviewed in the Gambia were more educated than their Ghanaian counterparts.

Table 4: Educational level by country

Educational level	The Gambia		Ghana		All	
	No.	Percent	No.	Percent	No.	Percent
Primary School	30	30	256	34.3	286	33.81
Secondary School	7	7	97	13 .0	104	12.29
C ertificate Course	-	-	8	1. 1	8	0.95
Diploma	-	-	23	3. 1	23	2.72
B.Sc./Degree	-	-	2	0. 3	2	0.24
None	-	-	287	38. 5	349	41.25
Other(Arabic, Dara)	62	62	2	0.3	2	0.24
JSS/MSLC	1	1	71	9.5	72	8.51
Total	**100**	**100**	**746**	**100**	**846**	**100**

Source: ATPS Survey, 2010

In addition to the acquisition of formal education, farmers were asked whether they had participated in any form of training on climate change adaptation and or food security issues. The responses from Ghana show that an overwhelming majority of farmers (97.4%) said they have never participated in any form of training whereas 2.6% responded that they have the opportunity to participate in such training, which was mainly provided by non-governmental organizations. Similarly, the responses from the Gambia show that only 4% of the farming household heads were reported to have attended some training on climate change adaptation and/or food security issues whilst the remaining 96% have never had.

5.2 Farm Characteristics

Majority of the farmers interviewed in Ghana were mainly engaged in crop cultivation. Indeed 99.9% of the respondents were into crops cultivation as their main farming activity, whiles 0.1% was engaged mainly in livestock rearing. It should, however, be added that many of those engaged in crop production as their main farming activity were also engaged in subsistence livestock farming. Table 5 shows that most of the farms (81.5%) were small farms; being less than five hectares under cultivation. On the other hand about a quarter of the farmers cultivated medium sized farms of between five and twenty hectares, and only 0.4% of the respondents cultivated farms categorized as large, that is of size more than 20 hectares. There were no large scale farmers among the respondents from the Gambia. About 49% of the respondents had small-scaled farm lands (less than 5ha) whereas 51% had medium-scaled farm lands (5-20ha). In terms ownership of the farms, many of the respondents (99.1%) worked on their own farms although this number includes farms that belong to families. About 0.7% of the respondents in Ghana said the ownership of their farms was joint ownership whiles 0.3% of the respondents said their farms had foreign ownership (Table 6).

The main areas of farming focus of respondents in the Gambia were crops and livestock. About 54% of the respondents were engaged in the cultivation of various crops whereas 46% of them were in livestock. Farm lands used for agricultural purposes by respondents in the Gambia were all family/privately owned.

Table 5: Farm size by country

Farm size	The Gambia		Ghana		All	
	No.	Percent	No.	Percent	No.	Percent
Small -size < 5ha	49	49.0	608	81.5	657	77.7
Medium -sized 5 -20ha	51	51.0	135	18.1	186	22.0
Large -size >20ha			3	0.4	3	0.4
Total	**100**	**100**	**746**	**100**	**846**	**100**

Source: ATPS Survey, 2010

Table 6: Farm ownership structure by country

Farm ownership	The Gambia		Ghana		All	
	No.	Percent	No.	Percent	No.	Percent
Family/privately owned	100	100	737	98. 8	837	98.9
Foreign owned			2	0. 3	2	0.2
Joint venture			7	0.9	7	0.8
Total	**100**	**100**	**746**	**100**	**846**	**100**

Source: ATPS Survey, 2010

5.3 Source of Finance for Agricultural Activities

The survey results show majority of the famers in Ghana finance their agricultural activities from their own pockets (98.4%) whiles 1.1% of the respondents relied on loans from family members and friends to finance their farming activities. Furthermore, 0.3% of the respondents said they have had some state support to finance their agricultural activities; and 0.3% also added that they had obtained funding from 'other' sources for their agricultural activities (see Table 7).

Table 7: Sources of finance for agriculture by country

Sources	The Gambia		Ghana		All	
	No.	Percent	No.	Percent	No.	Percent
Self generated	100	100	734	98.4	834	98.6
Government Subsidies	-	-	2	0.3	2	0.2
Private Sector (loans)	-	-	8	1.1	8	1.0
Other (venture capita)	-	-	2	0.3	2	0.2
All	**100**	**100**	**746**	**100**	**846**	**100**

Source: ATPS Survey, 2010

All finances that go into farming activities of respondents in the Gambia were self-generated and none got support from anywhere else. By implication, farmers support their own farming activities without relying on any financial institution or government to provide incentives or subsidies. Therefore if farmers rely mostly on their personal funds to operate their farms, it should be expected that the farms sizes will be small.

5.4. Farmers Interaction with Agricultural Extension Agents

The role of agricultural extension agents in providing farmers with information on best farming practices and introducing farmers to new technologies and innovations is very important. Knowledge of the extent to which farmers interact with agricultural extension agents is therefore very important to this survey. The results from Ghana show that 39.1% of respondents had never benefit from the services of agricultural extension agents whereas 60.9% of respondents said they have had some interaction with agricultural extension agents. In terms of ecological distribution, the responses, as illustrated in Table 8 show that farmers in the Decidious forest zone had more interactions with Agricultural Extension Agents (AEAs) than all the other ecological zones. On the other hand, farmers in the Rain Forest Ecological Zone seem to have little interaction with AEAs.

In the Gambia, however, 95% of the respondents reported that they had receive visits from Agricultural Extension Agents whereas 5% reported they do not receive any visit from extension officers. These were farmers from the North Bank region (Table 8).

Table 8: Visit of agricultural Extension agents by country.

Responses	Yes		No.		All	
	No.	Percent	No.	Percent	No.	Percent
Ghana						
Coastal Savannah	89	19.6	84	28.8	173	23.2
Deciduous forest	195	43.0	107	36.6	302	40.5
Guinea Savannah	60	13.2	10	3.4	70	9.4
Rain forest	21	4.6	31	10.6	52	7.0
Sudan Savannah	63	13.9	19	6.5	82	11.0
Transition Zone	26	5.7	41	14.0	67	9.0
Total	454	100	292	100	746	100
The Gambia						
Lower River	50	52.6	-	-	50	50
North Bank	45	52.6	5	100	50	50
Total	**95**	**100**	**297**	**100**	**846**	**100**

Source: ATPS Survey, 2010

For respondents who have had the benefits of visits from agricultural extension agents, Table 9 shows the type of activity that AEAs pursued with them as far as climate change and food security is concerned. The table shows that many of the farmers who had interacted with AEAs received advice on ways of managing their farms to reduce the impact of climate change followed by demonstrations on the use of adaptive measures to cushion the effects of climate change. Additionally the table shows that the least activity that AEAs undertook with farmers was visiting sites showing varying climate situations.

Table 9: Activities of extension agents in Ghana in relation to climate change and food security

Activity	The Gambia		Ghana		All	
	No.	Percent	No.	Percent	No.	Percent
Deminstration/training on the use of adoptive measures						
Yes	55	55	105	14.08	160	18.91
No	45	45	641	85.92	686	81.09
All	100	100	746	100	846	100
Visiting sites that are undergoing change due to climate change						
Yes	33	33	92	12.33	125	14.78
No	67	67	654	87.67	721	85.22
All	100	100	746	100	846	100
Advisory services on how to manage farm to reduce the effect of climate change						
Yes	24	24	124	16.62	148	17.49
No	76	76	622	83.38	698	82.51
All	100	100	746	100	846	100
Awareness creation on the effect of climate change						
Yes	71	71	97	13	168	19.86
No	29	29	649	87	678	80.14
All	100	100	746	100	846	100
Organizing public shows on climate change						
Yes	4	4	49	6.57	53	6.26
No	96	96	697	93.43	793	93.74
All	100	100	746	100	846	100
Excursing showing varying climate situations						
Yes	32	32	18	2.41	50	5.91
No	68	68	728	97.59	796	94.09
All	100	100	746	100	846	100
Field days where discussion on the effect of climate change is done						
Yes	49	49	50	6.7	99	11.7
No	51	51	696	93.3	747	88.3
All	100	100	746	100	846	100
Other activities organized by extension agents						
Yes			60	8.04	60	7.09
No	100	100	686	91.96	786	92.91
All	100	100	746	100	846	100

Source: ATPS Survey, 2010

In the Gambia, the major activities that have been undertaken by extension agents on climate change and food security issues include awareness creation on the issue, discussions on the effects of climate change with the farmers during field days and training on the use of adaptive measures. However, there are other activities which they undertook as listed in the table above but were not recognized by many of the farmers or perhaps very few of them benefit. About 71% of the farmers reported that extension officers have been creating awareness about the effects of climate change. Training on the use of adaptive measures by extension officers covered about 55% of the farmers whilst field days where discussions are done on climate change were 49% of the farmers.
One important area that is not usually covered by extension officers is that of advisory services on how to manage the farms. Only about 24% of the farmers reported they received such service from the officers (Table 9).

5.5. Farmers' Level of Awareness of Climate Change

The survey sought to gauge the level of knowledge of the climate change phenomenon among famers and the experiences of farmers with respect to the manifestation of climate change.

5.5.1. Farmers' Perception of Climate Change

Farmers were asked whether they knew what climate change was. The term climate change was translated into the local dialect before asking farmers. The results from Ghana show that many of the farmers interviewed (60%) knew and were able to describe climate change. However, 40% of the respondents did not know anything about climate change. The level of awareness of climate change issues among farmers in the Gambia was very encouraging. About 91% of the farmers interviewed revealed that they were aware of climate change whilst only 9% of them reported they know nothing about the issue. Farmers were further asked whether in their view the current state of the climate would change for a 'better' one than they knew some years back. To this, 74% of the respondents in Ghana said yes, 11.4% said no and 14.6% said they do not know. For the Gambia, a greater number (74%) of farmers believed there was the possibility for the climate change to reverse in the near future. On the other hand, 25% of them were uncertain about changes in the situation any time soon.

Additionally farmers were asked about their experiences with the onset of the last rainy season preceding the survey. About 57% of the respondents indicated that it did not rain at the right time at the last planting season to enable them farm. On the other hand, about 43% responded that the rains came at the right time in the last planting season. Table 10 shows the disaggregation of the responses according to the ecological zones in Ghana. It shows that farmers in the Deciduous Forest and Coastal Savannah zones mostly reported that the rains did not fall at the right time for them to start planting with 65% each answering "No". These ecological zones were followed by Transitional zones (12.9%), Guinea Savannah with (9.2%), Sudan Savannah (8.9%), and the Rain forest Zone(6.7%) responding that the rains did not fall at the right time of the planting season preceding the period of the survey (see Table 10). Majority (74%) of the farmers in the Gambia revealed that the rains occurred at the right time in the last planting season before the survey year. On the other hand, 26% of them, however, reported otherwise.

Table 10: Onset of rains during the planting season by ecological zone

Responses	Yes		No		All	
	No.	Percent	No.	Percent	No.	Percent
Ghana						
Coastal Savannah	63	18.42	110	27.23	173	23.19
Deciduous forest	160	46.78	142	35.15	302	40.48
Guinea Savannah	33	9.65	37	9.16	70	9.38
Rain forest	25	7.31	27	6.68	52	6.97
Sudan Savannah	46	13.45	36	8.91	82	10.99
Transition Zone	15	4.39	52	12.87	67	8.98
All	342	100	404	100	746	100
The Gambia						
Lower River	32	59.26	18	39.13	50	50
North Bank	22	40.74	28	60.87	50	50
All	**54**	**100**	**46**	**100**	**100**	**100**

Source: ATPS Survey, 2010

In addition to the farmers' perception about climate change, especially using rainfall and temperature as proxy indicators, farmers were asked if they have noticed other changes in their environment. The results indicate that losses of vegetation cover and wildlife dominated the responses from both Ghana and the Gambia. In Ghana, 78.7% mentioned loss of vegetation cover and wildlife whiles 4.8% responded that they have observed an increase in vegetation cover and wildlife. Farmers also responded that they have noticed an increase in the number of pests and diseases (1.7%), whiles some responded that they have noticed a decrease in the number of extreme weather events (1.2%)(See Table 11).

In the Gambia, some noticeable environmental changes that farmers have observed over the past years have been decrease in vegetation cover and wildlife and also decrease in the frequency of extreme weather conditions. On the contrary some farmers (14.4%) held it that there has been an increase in vegetation cover and wildlife numbers. Farmers who hold that vegetation cover and wildlife amount has been decreasing were 84.4% of the total number of respondents (Table 11).

Table 11: Other observed environmental changes by country

Observations	The Gambia		Ghana		All	
	No.	Percent	No.	Percent	No.	Percent
Vegetation cover and wildlife amount is decreasing	76	76	587	78.7	663	78.4
Vegetation cover and wildlife amount is increasing	13	13	36	4.8	49	5.8
Decrease in frequency of extreme weather events	1	1	9	1.2	10	1.2
Increase in the number of some pest/diseases	-	-	13	1.7	13	1.5
Other	10	10	101	13.5	111	13.1
All	**100**	**100**	**746**	**100**	**846**	**100**

Source: ATPS Survey, 2010

5.5.2 Perceived Causes of Climate Change

Table 12 shows that farmers in Ghana seem to strongly agree that cutting trees was a contributory factor to the incidence of climate change. However they strongly disagree that gas flaring can be a contributory factor. The farmers disagree that overgrazing can be a contributory factor to the incidence of climate change. Furthermore, majority of the farmers agree that high temperature due to the depletion of ozone layer can contribute to climate change (Table 12). In the opinion of farmers in the Gambia, the changing pattern of rainfall can be attributed to a number of factors. These include loss of vegetation cover (63%), drought (12%), and changes in weather (15%). A handful of farmers attributed the changes in rainfall pattern and amount to desertification (1%), bush burning (2%), greenhouse gas emission (1%) and natural cause (1%) (See Table 12).

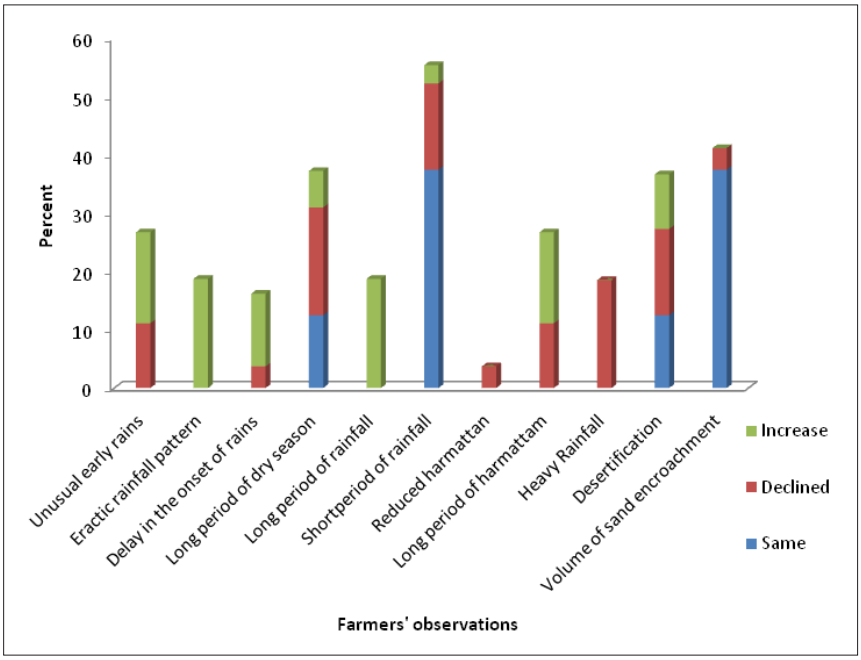
Table 12: Farmers perception about the causes of climate change (percentage)

Causes	The Gambia	Ghana	The Gambia	Ghana	The Gambia	Ghana	The Gambia	Ghana
	Agree		*Strongly Agree*		*Disagree*		*Strongly disagree*	
Burning of fossil fuel by industries	11.11	8.99	0	7.73	5.88	4.65	7.14	6.67
Use of generator to generate electricity for household use	11.11	13.76	0	3.18	0	3.26	14.29	11.11
Gas flaring from oil companies	18.52	4.23	0	7.73	0	6.05	0	4.44
Burning of firewood for cooking	0	3.7	4	5	11.76	10.23	14.29	4.44
Bush burning	0	2.65	20	16.82	0	1.86	0	0
Burning of fossil fuel from vehicles, machines(motorcycles)	11.11	8.99	4	4.09	0	2.79	7.14	4.44
High use of irrigation which changes the amount of water going into and out o a given location	14.81	13.23	0	2.73	5.88	2.79	0	8.89
Cutting down of trees	0	0	20	18.18	0	2.33	0	0
Over grazing of farm by livestock	7.41	5.82	0	1.36	17.65	10.7	0	2.22
Gases released from industries	7.41	7.94	8	5.91	0	4.19	0	0
High temperature due to depletion of Ozone layer	3.7	5.29	16	10	5.88	2.79	0	2.22
Use of excess chemicals in farmlands	3.7	5.82	0	1.36	23.53	9.77	7.14	15.56
Emission of green house gases	7.41	7.94	16	6.82	0	3.72	0	4.44
Swamp reclamation	0	3.17	0	0	11.76	13.95	28.57	15.56
Swamp rice production	3.7	2.65	0	1.36	5.88	14.42	21.43	15.56
Crude oil spillage	0	5.82	12	7.73	11.76	6.51	0	4.44
Total	**100**	**100**		**100**	**100**	**100**	**100**	**100**

Source: ATPS Survey, 2010

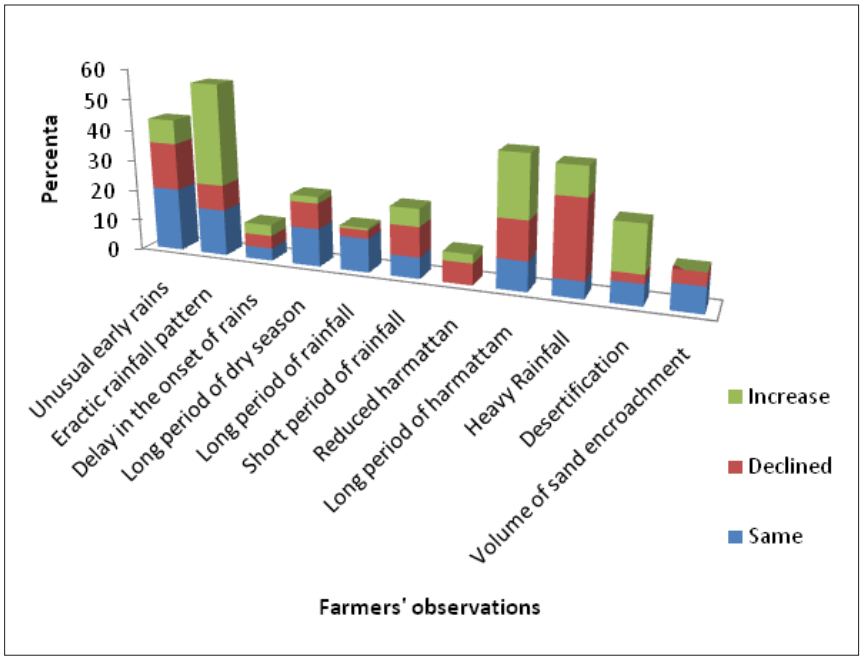
5.5.3 Perceived Impact of Climate Change

Figure 3 shows that farmers in Ghana perceived the eractic rainfall pattern and long period of dry harmattan with its acssociated loss of forest resources as the major impact of climate change in their localities. They indicated that the trend of forest loss has consistently increased between 2005 and 2009. Furthermore, the figure shows that flooding, long period of the dry season, soil infertility, drying of rivers, long period of rains, decrease in farm yields and delays in the onset of rainfall during the rainy season.



Source: ATPS Survey, 2010

Figure 3: Farmers' perception of the impact of climate change in The Gambia



Source, ATPS Survey, 2010

Figure 4: Farmers' perception of the impact of climate change in Ghana

5.6 Farmers' Source of Information on the Climate

Farmers were asked if they get information about the weather and climate or not. About 63% of the respondents from Ghana said they received climatic information whereas 37% responded in the negative. In terms of the specific type of information, most of the respondents said they received weather forecasts (59.5%), whiles some said they received information on causes of climate change (1.7%) and good agronomic practices (1.5%), see Table 13.

In the Gambia, 62% of the farmers reported that they have ever received weather information whiles 38% of them were of a contrary opinion. In terms of the specific type of information they received, farmers mentioned weather forecast (56.0%); the effects of bush burning (2.0%); climate change (2.0%); forest protection and land degradation (1%), see Table 13

Table 13: Type of information received by farmers in relations to climate change

Information type	The Gambia		Ghana		All	
	No.	Percent	No.	Percent	No.	Percent
Agronomic practice; food security	-	-	11	1.5	11	1.3
Causes of climate change	-	-	13	1.7	13	1.5
Weather forecast	56	56.0	444	59.5	500	59.1
Effects of bush burning	2	2.0	-	-	2	0.2
Land degradation	1	1.0	-	-	1	0.1
On forest protection	1	1.0	-	-	1	0.1
Climate change	2	2.0	-	-	2	0.2
No response	38	38.0	278	37.3	316	37.4
All	**100**	**100**	**746**	**100**	**846**	**100.0**

Source: ATPS Survey, 2010

The radio was a major source of information to famers interviewed in Ghana. Indeed 50.4% of the respondents said the radio was their main source of climatic and agricultural information. The next source was Agricultural Extension Officers (AEAs) who accounted for 5.4% of the respondents. Other sources included their colleague farmers, the television, farmers' own personal observations and private companies (Table 14).

Table 14: Sources of information on climate change phenomena

Sources	The Gambia		Ghana		All	
	No.	Percent	No.	Percent	No.	Percent
Agric Extension Officers	31	31	40	5.4	71	8.4
Agric extension office, farmers and radio	-	-	1	0.1	1	0.1
Agric extension officers and radio	-	-	2	0.3	2	0.2
Millennium Development Authority	-	-	2	0.3	2	0.2
Other farmers			9	1.2	9	1.1
Personal observations	-	-	8	1.1	8	0.9
Print media	19	19	1	0.1	20	2.4
Radio	12	12	376	50.4	388	45.9
Radio and newspaper	-	-	2	0.3	2	0.2
Radio and other farmers	-	-	8	1.1	8	0.9
Radio and personal observation	-	-	1	0.1	1	0.1
Radio and television	-	-	10	1.3	10	1.2
Radio and farmer organization	-	-	1	0.1	1	0.1
Television	-	-	5	0.7	5	0.6
WIENCO	-	-	1	0.1	1	0.1
Forestry commi ssion	-	-	1	0.1	1	0.1
No response	38	38	278	37.3	316	37.4
Total	**100**	**100**	**746**	**100**	**846**	**100**

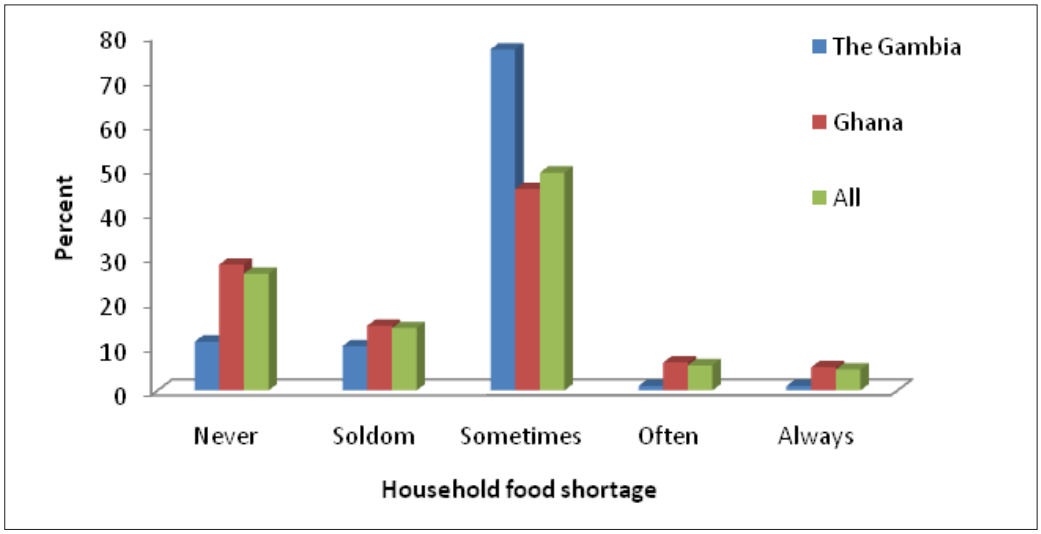
Source, ATPS Survey, 2010

Gambian farmers' major source of information on the weather and climate was AEAs (31 %.). This goes to confirm the invaluable nature of the services from Agricultural Extension Officers. Farmers trust the agricultural extension officers since they are the closest to them and probably the most reliable in terms of information. The next most important source of information to farmers in the Gambia was through the print media (19%) and the radio (12%) (See Table 14).

5.7 Farmers' Household Access to Food

As an indicator of household food security in the study areas in Ghana, famers were asked about the frequency with which they had problems meeting their household feeding. Figure 4 shows that majority of the respondents (45.3%) said they sometimes experienced problems with feeding in their households. Furthermore, 6.3% said they often faced problem with household feeding, 5.4% said they always faced problems, whiles 14.6% said they seldom encountered problems. Therefore overall, this means that 72.6% of the respondents have in some form experienced problems with meeting household feeding. In The Gambia, however, about 78% or the respondents sometimes experience household food shortages, but the much less percentage of farmers always experience

household food shortage as compared to the their Ghanaian countapart. Very few of the farmers (11%) never faced any challenge in meeting the food needs of their households. Respondents who seldom faced problems of meeting their household food needs accounted for 10%. However those who regularly faced the problem of meeting their food needs accounted for only 1% (Figure 5).



Source, ATPS Survey, 2010

Figure 5: Frequency of household feeding challenges within the years preceding the survey

When considered along ecological zones, the indication is that the problem of meeting household feeding is more pronounced in the Coastal Savannah Ecological Zone where only 16% of the respondents said they have never experienced problems with meeting their household food needs, followed by the Rain Forest Zone with 22.4%; the Sudan Savannah Zone with 32.4%; the Guinea Savannah Zone 32.7%; Deciduous Forest Zone with 33.5%; and the Transition Zone with 45% of the respondents saying they have never experienced problems meeting their household feeding requirements (see Table 15).

Table 15: Frequency of household feeding by ecological zones within the year preceding the survey(percent)

Ecological Zone	Never	Seldom	Sometimes	Often	Always	Total
Ghana						
Coastal Savannah	17.3	13.9	59.0	5.8	4.1	100
Deciduous forest	32.1	16.6	38.1	5.6	7.6	100
Guinea Savannah	32.9	7.1	45.7	7.1	7.1	100
Rain Forest	19.2	3.9	65.4	5.8	5.8	100
Sudan Savann ah	26.8	13.4	45.1	13.4	1.2	100
Transition Zone	44.8	25.4	28.4	1.5	0.0	100
Total	28.4	14.6	45.4	6.3	5.2	100
The Gambia						
Lower River	20	18	60	2	0	100
North Bank	2	2	94	0	2	100
Total	**11**	**10**	**77**	**1**	**1**	**100**

In terms of the severity of the problem with meeting household feeding requirements, respondents in the Deciduous Forest Zone recorded the highest responses for those who always faced problems with meeting household feeding, followed by the Guinea Savannah, Forest and the Sudan Savannah Ecological Zones (see Table 15). In The Gambia, however, farmers in the North Bank Region experience food shortages in their tousehold as 94% of them sometimes experience food shotage as compared with their 60% of their counterpart in the Lower Rover Region.

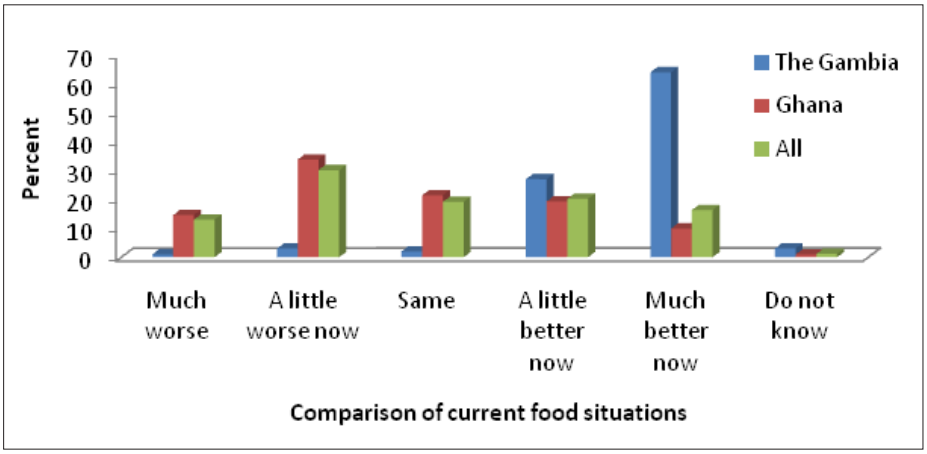


Figure 6: Farmers' comparison of current food situation of household to previous year

Notwithstanding the status of food availability in the household of the respondents, a relative majority (43%) of the famers indicated that the household food situation at the time of the survey was a little worse than the previous year; 21% responded that the situation has not changed for them; 19% said the situation has improved a little for them; 15% said the situation is much worse; 10% said the situation is much better; and 1% said they cannot tell whether their household food situation has changed between the two periods (see Figure 6).

Gambian farmers' food situation in the year the survey was conducted was generally much better than the year before the survey. This is asserted by the number of farmers (64%) who responded positively to the fact that their food situation in the year of the survey was much better than that of the previous year. About 27% of the farmers agreed that their food situation currently is a little better than the previous year. Therefore, 91% of the respondents in the Gambia say their food situation currently has improved over the previous year. On the other hand, only 4% of the respondents gave indication that their food needs have become worse (Figure 6).

5.8. Famers Adaptive Responses to Climate Change

5.8.1. Farmers' Adaptive Responses to Erratic Rainfall Pattern

Farmers' adaptive responses to erratic rainfall patterns were examined. Table 15, it is illustrates that the relative majority of the framers interviewed during the survey in Ghana (29.8%) said they did nothing in seasons where they had little rainfall. Other farmers said they regularly weeded their farms (22.7%); applied fertilizer (10.2%); irrigated their farms (8.7%); early cultivation; spraying with agro-chemicals (2.1%); and the application of manure (1.8%). It is interesting to note that the use of irrigation as an adaptive response to low rainfall has not caught on with farmer respondents in Ghana.

The situation was no different in the Gambia as majority of the respondents there (33%) also did nothing. About 17% of them said they provide water to their livestock whereas 7% consult with the agricultural extension agents and 4% pray to God for relief (Table 16).

Table 16: Farmers' adaptive response to low/little rainfall

Adaptive measure	The Gambia		Ghana		All	
	No.	Percent	No.	Percent	No.	Percent
No response	36	36	99	13.3	135	16.0
Application of fertilizer	-	-	76	10.2	76	9.0
Application of manure	-	-	14	1.8	14	1.7
Create mounds	-	-	2	0.3	2	0.2
Cultivate drought resistant varieties	-	-	2	0.3	2	0.2
Early cultivation	-	-	41	5.5	41	4.8
Early harvesting	-	-	1	0.1	1	0.1
Good spacing	-	-	3	4	3	0.4
Inter cropping	-	-	2	0.3	2	0.2
Irrigation	-	-	65	8.7	65	7.7
Mulching	-	-	12	1.6	12	1.4
Nothing	33	33	222	29.8	255	30.1
Planting in rows	-	-	2	0.3	2	0.2
Pray for God's intervention	4	4	2	0.3	6	0.7
Provide water for livestock	20	20	6	0.8	26	3.1
Pruning	-	-	1	0.1	1	0.1
Regular weeding	-	-	169	22.7	169	20.0
Replanting	-	-	7	0.9	7	0.8
Shifting cultivation			3	0.4	3	0.4
Spraying of agro chemicals	7	7	16	2.1	23	2.7
Treating seeds before planting	-	-	1	0.1	1	0.1
Total	**100**	**100**	**746**	**100**	**846**	**100**

Source, ATPS Survey, 2010

When it comes to farmers' response to excessive rainfall, the results show the same trend in both countries. In Ghana most the respondents (49.9%) said they did nothing when their farms and livestock come under excessive rainfall; followed by 18.1 who said they usually construct trenches and drains on their farms for the excess water to flow away. Other responses of Ghanaian respondents included frequent weeding of the farms (4.7%), early harvesting (1.6%) and replanting of drowned crops (1.3%). On the other, 21.3% of the respondents said they do not experience heavy rains (Table 17).

For the Gambia, most of the respondents did not answer this question, whiles 32% of them said they report to the Veterinary Officers; an indication that during such occasions the livestock frequently get sick. Additionally, 23% said they usually do nothing about the excess rainfall (Table 17).

Table 17: Farmers' adaptive response to excessive rainfall

Adaptive measure	The Gambia		Ghana		All	
	No.	Percent	No.	Percent	No.	Percent
Apply cow dung	-	-	2	0.3	2	0.2
Construct trenches	5	5	135	18.1	140	16.5
Early harvesting	-	-	12	1.6	12	1.4
Feed animals	-	-	2	0.3	2	0.2
Frequent weeding	-	-	35	4.7	35	4.1
Green belt	-	-	1	0.1	1	0.1
House livestock	5	5	7	0.9	12	1.4
Mulching	-	-	2	0.3	2	0.2
Nothing	23	23	372	49.9	395	46.7
Pruning	-	-	3	0.4	3	0.4
Relocate	-	-	1	0.1	1	0.1
Replanting	-	-	10	1.3	10	1.2
Set fire to provide warmth	-	-	1	0.1	1	0.1
Invoke the spirit of our ancestors	-	-	2	0.3	2	0.2
Creates terrace on the field	-	-	2	0.3	2	0.2
Expand farm area	1	1			1	0.1
Never experienced such events	-	-	159	21.3	159	18.8
Consult veterinary officers	32	32	-	-	32	3.8
No response	34	34	-	-	34	4.0
Total	**100**	**100**	**746**	**100**	**846**	**100**

Source, ATPS Survey, 2010

5.8.2 Farmers' Adaptive Responses to Diseases and Pests Attacks

Table 18 shows the responses of farmers to the attack of diseases and pests on their farms and livestock in Ghana and the Gambia respectively. In Ghana, most of the farmers reported that they usually spray their crops with agrochemicals (60.2%) whiles 15.8% said they did nothing when their farms are infested with diseases and pests. Other adaptive responses alluded to by the respondents included pruning the crops (7.2%), and reporting to agriculture extension agents (5.6%) see Table 18.

Table 18: Farmers' adaptive response to diseases and pest attack

Adaptive measures	The Gambia		Ghana		All	
	No.	Percent	No.	Percent	No.	Percent
Application of agrochemicals	48	48	449	60.2	497	58.7
Burn old vehicl e tyre to drive away pest	4	4	-	-	4	0.5
Applies crop residue like cassava and	-	-	1	0.1	1	0.1
Burn cow dang to drive insect away	1	1	-	-	1	0.1
Manually remove pests	1	1			1	0.1
Apply mixture of ash and water on effected parts	-	-	1	0.1	1	0.1
Nothing	-	-	118	15.8	118	13.9
Prune affected parts	-	-	54	7.2	54	6.4
Report to the agric officers	39	39	42	5.6	81	9.6
Spray with neem tree extract			4	0.5	4	0.5
Use power from the back of mahogany tree	1	1	-	-	1	0.1
Never Experience such events			77	10.3	77	9.1
No response	6	6			6	0.7
Total	**100**	**100**	**746**	**100**	**846**	**100**

Source, ATPS Survey, 2010

5.8.3 Farmers' Expenditure on Climate Change

In terms of the proportion of farmers' expenditure that is directed towards addressing climate change, the survey results indicate that 15.2% of the respondents allocate some of their expenditure for addressing problems created by climate change, whiles 82.8% of the respondents said their expenditures on agricultural activities have never covered addressing problems of climate change (see Table 19).

Table 19: Proportion of farmers' budget directed towards solving problems caused by climater change

Responses	The Gambia		Ghana		All	
	No.	Percent	No.	Percent	No.	Percent
None (0%)	50	50	618	82.8	668	79.0
Less than 15%	22	22	87	11.7	109	12.9
Between 16 and 30%	17	17	22	3	39	4.6
Between 31 and 45%	6	6	3	0.4	9	1.1
Between 46 and 60%	5	5	1	0.1	6	0.7
Don't Know			15	2	15	1.8
Total	**100**	**100**	**746**	**100**	**849**	**100**

Source, ATPS Survey, 2010

In the case of the Gambia, 50% of the respondents do not channel any portion of their farm budget to respond to solving climate change related problems. The remaining percentage spends at least some portion of their budget to solving problems caused by climate change. Those who spend less than 15% of their budget on climate change related problems were 22%; those who spend between 16-30%, 31- 45% and 46-60% of their budget were 17%, 6% and 5% respectively (Table 19).

5.9. Agricultural Innovation

5.9.1. Famers' Innovations

The results from Ghana show that not many farmers had introduced innovations on their farms as a response to climate change. Indeed about 79% of the respondents said they have not introduced any innovations whereas about 21% of the respondents said they had. Table 15 a shows that majority of the those who introduced innovations got some new improved crop varieties and or livestock breeds. Other innovations included new information about agricultural activities and introduced improved farm tools and practices (Table 20).

Similarly, in the Gambia, 72% of the respondents said they have not introduced any innovations whereas 28% said they had introduced some innovations in their farming activities. Table 20 shows the specific types of innovations they have introduced over the past three to five years. The table shows that the most introduced innovations have been on improved crops and livestock breeds, improved farm tools or practices and new information on agricultural activities.

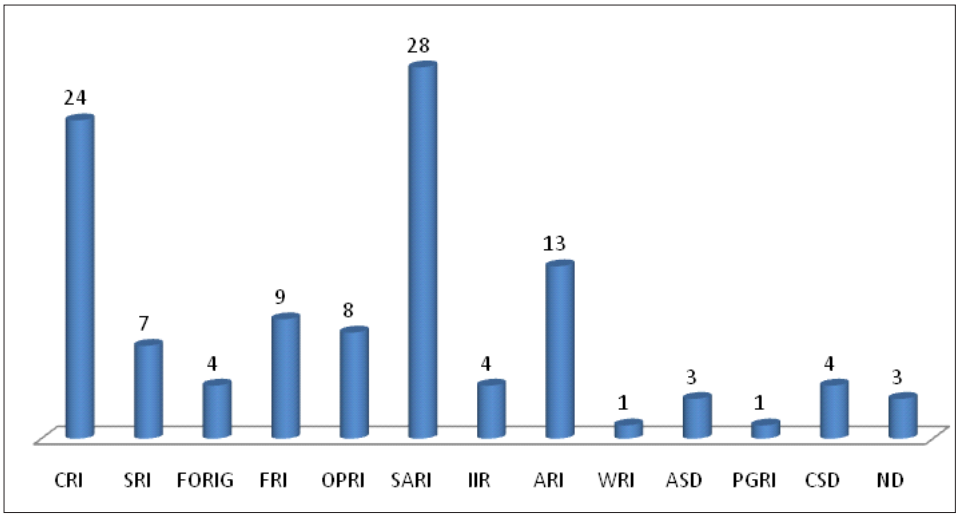
.Table 20: Farmers' innovation in products and services within the past three to five years in relation to climate change

Innovations	The Gambia		Ghana	
	No	Yes	No	Yes
New or improved crop/livestock breed	87	13	44.8	55.2
New or improved farm tool/practice	24	76	18.2	81.8
New Information	24	76	18.6	81.4
New mark et products	2	98	12.5	87.5
Upgraded machinery or equipment on your farm within the past years	4	96	11.8	88.2

Source, ATPS Survey, 2010

5.9.2 Research Institutions' Innovations

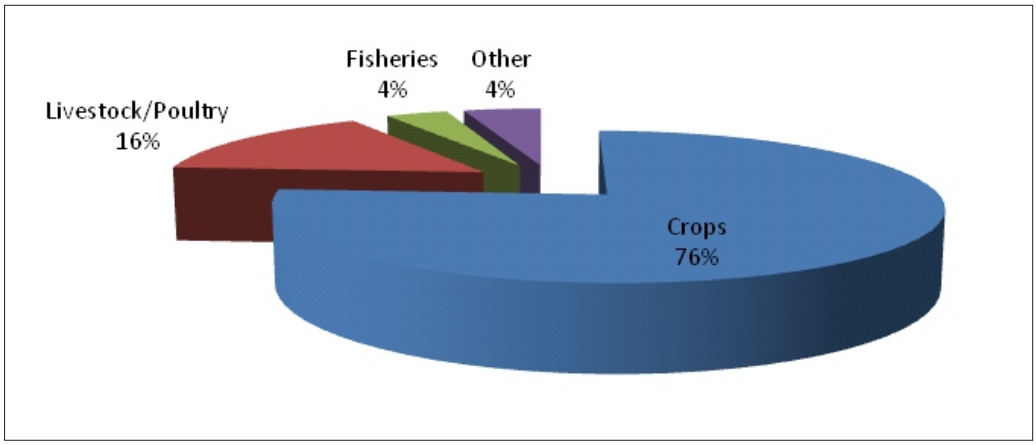
The results for Ghana were drawn mainly from a survey that was conducted by STEPRI and IFPRI on agricultural technologies and innovations in Ghana. The survey covered a total of 109 agricultural technologies and innovations developed by the agricultural research systems in Ghana (see Figure 7).



Source: IFPRI-STEPRI survey, 2010. Where: CRI-Crop Research Institute; SRI-Soil Research Institute; FORIG- Forestry Research Institute of Ghana; FRI-Food Research Institute; OPRI-Oil Palm Research Institute; SARI-Savannah Agricultural Research Institute; IIR-Institute of Industrial Research; ARI-Animal Research Institute; WRI-Water Research Institute; ASD-Animal Science Department; PGRI-Plant Genetic Research Institute; CSD- Crop Science Department; ND-Nutrition Department

Figure 7: Number of technologies developed by research insitutes in Ghana

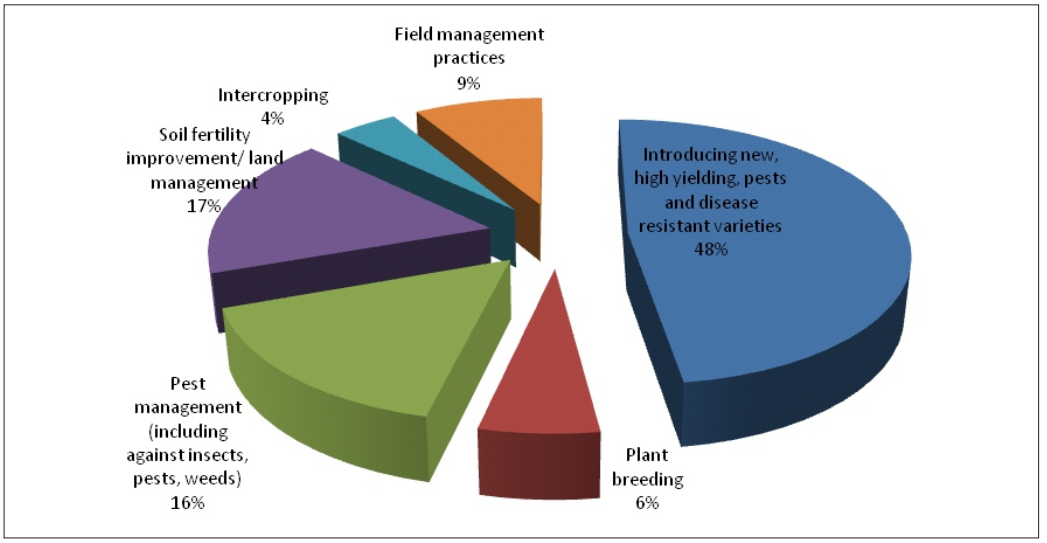
Figure 7 provides details on the departments that generated the various agricultural technologies in Ghana. As illustrated in the figure, out of 109 technologies identified, the Savannah Agriculture Research Institute (SARI) produced the highest number of technologies of 25.7%. This number is followed closely by the Crop Research Institute (CRI), with 22.0% of the technologies. Two stations of the Animal Research Institute (ARI) Accra and Nyankpala combined effort and produced 11.9% of the technologies. Food Research Institute (FRI), Oil Palm Research Institute (OPRI), Soil Research Institute (SRI) had 8.3%, 7.3%, and 6.4% of the technologies respectively to their credits. The Forest Research Institute of Ghana (FORIG) and Institute of Industrial Research (IIR) generated four 3.7% of the technologies, each. Five (5) of the technologies were generated at the University of Ghana (Legon); 1.8% from the Crop Science Department and 2.8% from the Nutrition Department. The Kwame Nkrumah University of Science and Technology (KNUST) produced 1.8%; both technologies came from the Animal Science Department. The University for Development Studies (UDS) generated two technologies; each of the technologies came from the Animal Science and Crop Departments, respectively. One technology, representing about 0.9 percent each came from the Water Research Institute, Plant Genetic Research Institute and the Crop Science Department of the University College of Education, Mampong Campus. Figure 8 provides the distribution of the technologies by commodities applicable.



Source: IFPRI-STEPRI survey, 2010.

Figure 8: Technologies by type of commodity

As shown in Figure 8, about 76% of the technologies were crop production related technologies, this represents about three-quarters of the agricultural technologies that were gathered. About 16 % were technologies applicable to livestock and poultry production. While about 4 percent of the technologies applicable to fisheries, the same percentage of technologies were "other" such as sediment filter technology, development of mushroom seedlings, and Geo-spatial modeling for agro-ecological assessment.



Source: IFPRI-STEPRI survey, 2010

Figure 9: Crop-related technologies by type of research area/theme

Figure 9 shows that about 48% of the technologies were varieties introduced to improve yield and resist to pest and diseases. About 17% of the technologies were in the area of improving soil fertility and land management practices. About 16% of the technologies were pest management practices to guard against the invasion of pest, diseases and weed. Technologies on farmer field management practices constituted about 9% of the technologies covered under this study. While plant breeding constituted about 6%, intercropping took 4 % of the technologies.

In the Gambia, the study covered five institutions that were engaged in agricultural research or had programmes relating to climate change and/or food security. This section presents the results obtained from the analysis of the interviews of the heads of these organizations. Table 21 shows the type of organizations that were interviewed. Two of them were civil society organizations, and one each was from government, research and development, and the private sector.

Table 21: Type of organization of respondents

Responses	Frequency	Percentage
Government Ministry	1	20
Research & Development	1	20
Civil Society Organization (NGO, CBO, FBO)	2	40
Enterprise (eg. Input suppliers, processing)	1	20
Total	**5**	**100**

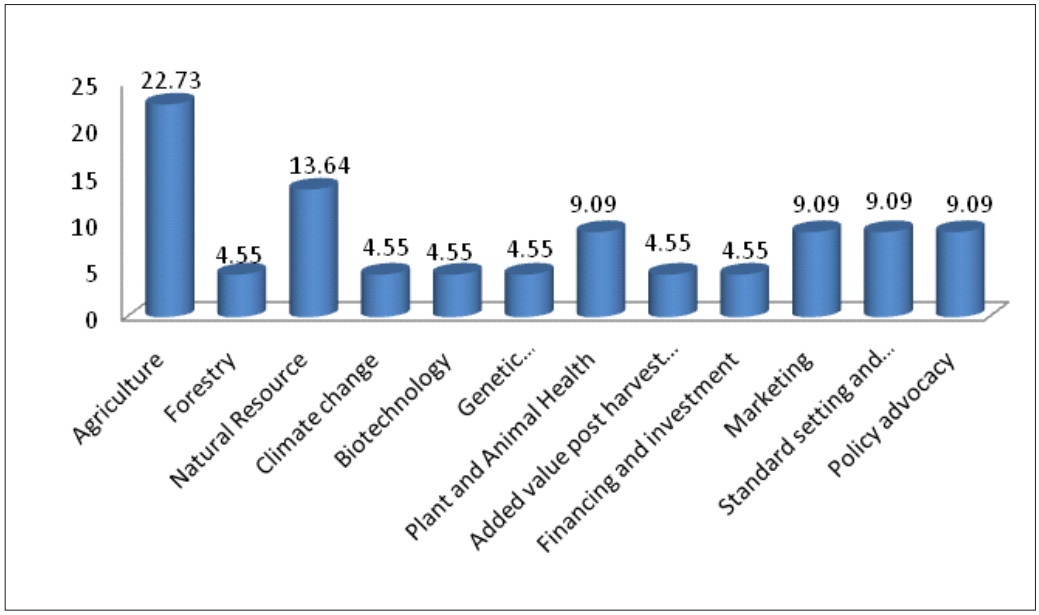
Table 22 shows that the organisations in the Gambia were mostly engaged in the extension or information dissemination activities, production, and research and development of agricultural innovations and technologies. Other activities engaged in include teaching, policy advocacy and quality assurance of technologies. The National Agricultural Research Institute of the Gambia was one organization that was engaged in several activities relating to agricultural innovations and technologies. The Institute was engaged in research and development, teaching, technology production, policy advocacy, quality control, consultancy, and extension, outreach and information dissemination. The National Women Farmers Association was also engaged in a number of activities including training, technology production, policy advocacy, commercialization, outreach and women empowerment.

Table 22: Main focus area of organizations in the Gambia

Main Focus Area	Organisations				
	ACTIONAID	National Agricultural Research Institute (NAR)I	PROGEB Gambia	National Women Farmers Association	Animal Health and Production Services
Research and development	1	1	1		
Teaching/training		1		1	
Production		1	1	1	1
Policy advocacy		1		1	
Quality assurance/control-standard setting		1			1
Consultancy		1			
Added value/Commercialization				1	
Extension/Outreach, information dissemination		1	1	1	1
Fighting poverty and injustice	1				
Women empowerment				1	

Source: ATPS Survey, 2010

In terms of the specific areas of that these organizations work in, Figure 9 shows that they were mostly in general agricultural activities (22.7%), i.e. crops and animal husbandry. About 14% was engaged in natural resources management and 9.1% each was in plant and animal health, marketing, standard setting and monitoring, and policy advocacy. Climate change was not among the top thematic areas that the organisations were working. Indeed the percentage response was the same for biotechnology, post harvest processing, financing, and investment with 4.6% each (Figure 10).



Source, ATPS Survey, 2010

Figure 10: Thematic areas of the organisations

6 Conclusion & Recommendations

From the foregoing, it can be concluded that farmers in Ghana and the Gambia have perceived that the climate is changing; manifested in the form of erratic rainfall patterns and rising temperatures. In addition, farmers have identified other symptoms such as loss of vegetation cover and wildlife in their communities although it may difficult to ascribe these to the effects of climate change rather than the impact of unsustainable use of forest resources, urbanisation and other factors.

Furthermore, although farmers reckon the impacts of climate change on their farming activities, many of them did nothing to respond when their farms receive little rainfall, excessive rainfall, or when their crops and livestock are attacked by diseases and pests. Even for many of those farmers who did something, they have many times reported to the Agriculture Extension Agents or bought and applied fertilizer and agrochemicals.

The Study has shown that farmers do not see the impact of climate change as a threat that will prevail for a long time and thus may be the reason for them doing nothing when they are affected but hoping that the situation will change for the better.

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