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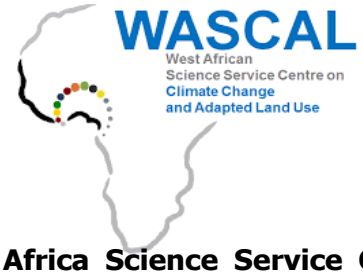

West Africa Science Service Centre on Climate Change and Adapted Land Use

FACULTY OF HUMANITIES AND SOCIAL SCIENCES
DEPARTMENT OF GEOGRAPHY

MASTER RESEARCH PROGRAM
CLIMATE CHANGE AND HUMAN SECURITY

EFFECTS OF CLIMATE VARIABILITY ON HOUSEHOLD FOOD SECURITY AMONG RURAL FARMERS IN CENTRAL RIVER REGION-SOUTH OF THE GAMBIA

FIELD: HUMANITY AND SOCIAL SCIENCE

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Thesis Submitted In Partial Fulfilment of the Requirements for the Award of Master of Science Degree in Climate Change and Human Security

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January 2018

DECLARATION

I, Mr. BADJIE Momodou, declare that this thesis entitled "**Effects of climate variability on household food security among rural farmers in Central River Region-South of The Gambia**" is my own work and that all sources of materials used for this thesis have been duly acknowledged and I have undertaken the research work independently with the guidance and support of my research supervisors. I solemnly declare that this thesis is not submitted to any other institution anywhere for the award of any academic degree.

SIGNATURE DATE

..... ……

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This thesis has been submitted for examination with our approval as supervisors

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DEDICATION

This Thesis is dedicated to my beloved wife Mrs. Jainaba SK Jammeh for her encouragement, patience, prayers and moral support.

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ABBREVIATIONS

CBA- Community Base adaptation strategies

FEWS. Famine and Early Warning Systems Network

FAO- Food and Agriculture Organization

WFP-World Food Programme

UN- United Nations

UNDP- United Nation Development Programme

HDI- Human Development Index

CFSVA -Comprehensive Food Security and Vulnerability Analysis

SDG- Sustainable Development Goals

GHGs- Green House Gases

GBOs- Gambia Bureau of Statistics

IPCC- Inter-governmental Panel on Climate Change

IICA- Inter-American Institute for Cooperation on Agriculture

UNFCCC- United Nations Framework Convention on Climate Change

GDA- Gambia Department of Agriculture

NAPA- National Adaptation Programme of Action

NEMA- National Land and Water Management Development Project

DWR- Department of Water Resources

NASS- National Agricultural Sample Survey

GoGT- Government of The Gambia

ABSTRACT

The Gambia's over-dependence on rain-fed agriculture for livelihoods is one of the major causes of vulnerability of communities' mostly rural areas to the effects of climate change. For farmers to increase crop production, there is the need for them to be aware of climate change and how they can sustainably respond to its effects. This study examines the effects of climate variability on household food security among rural farmers in Central River Region-South of The Gambia. Multi-stage sampling techniques were employed to collect data from 219 farmer household heads through a household survey, focus group discussions and key informant interviews. Descriptive statistics were used to summarize the household information on food security status. The study also used the Logistic regression model to analyze the various factors that are hypothesized to affect household food security status while Mann Kendal test was used to analyze the trend in climate factors such as rainfall and temperatures in the study area.

The findings indicated that 90% of the farmers obtained food from their own production. Moreover, an overwhelming majority of 75.5% % of the households responded that they faced food shortage and August is the most difficult month to obtain food. The study further revealed that factors that affect household food security are complex and multidimensional. As to coping strategies, the majority of the household resort to a combination of strategies to cope with food shortages. Therefore, the study recommends Government in collaboration with other stakeholders to clearly outline climate change adaption needs and implementation plans especially for smallholder farmers who depend on rain-fed to improve their climate change knowledge thereby enhancing their adaptive capacity to climate change effects, thus improving household food security status.

KEYWORDS: Climate Variability, Rural Household, Food Security, Vulnerability, Coping

CHAPTER ONE

INTRODUCTION

1.1 Background Information

The concept of climate change is probably the most debated phenomena of our time. There is consensus in the scientific field that the land and sea temperatures are warming under the influence of Green House Gases (GHG) and will continue to warm regardless of human interventions for, at least, the next two decades (Intergovernmental Panel on Climate Change, IPCC, 2007). However there is also a small but vocal number of scientist in climate change related fields who argued that there is no conclusive evidence that climate change is happening. As explained by Abid *et al.* (2015) and Asayehegn *et al.* (2017), climate change is one of the most widespread silent crisis in the recent decades affecting agricultural production and its consequences are not immediately visible and easy to prevent. Unfortunately, Africa is regarded as the most vulnerable continent to the impacts of climate change with West Africa being a key region of concern due to its poor adaptive capacities to climate extremes.

Africa's over-dependence on rain-fed agriculture for livelihoods, as discussed by Smit and Wandel (2006) and Ifeanyi-obi *et al.* (2012), are some of the causes of this vulnerability of communities mostly rural areas. Intergovernmental Panel on Climate Change IPCC (2007, p.30) defines climate change as "any change in climate over a long period of time mainly 30 years and above, whether due to natural variability or as a result of human activities". This usage differs from that in the United Nations Framework Convention on Climate Change (UNFCCC, 2007, p.30), where climate change refers to as "change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods".

Climate change is slow and gradual. Unlike year-to-year climate variability, climate change is very difficult to perceive without scientific records. On the other hand, climate variability—which is considered as a component of climate change—is defined as the way climate fluctuates yearly above or below a long-term average value. The most hardly affected by climate change

and variability are the developing countries, especially the rural people even though their contribution to Green House Gases (GHGs) emission is very low compared to industrialized countries (Lasco *et al*. 2011),Tariq *et al.* (2014) ; (Agbo *et al*. 2015) and Ali & Erenstein (2017),

Researchers, including Cgiar (2009) and Makate *et al.* (2017), predicted that farmers in developing countries who depend on rain-fed agriculture will face a very immediate and direct threat to food shortage as a result of irregular or erratic rainfalls, leading to low crop yields. Even without relying on rain-fed agriculture which is already threatened by climate variability, many agricultural systems in Africa are at a critical point (Agbo *et al*. 2015). As elaborated by Muller-Kuckelberg (2012), feeding rapid global population growth is becoming a major burden on agricultural lands, ecosystems and ecosystems services, fisheries, rivers and lakes.

Using climate models, Koohafkan (2008) predicted that agricultural yields by some farmers in Africa who depend on rain-fed agriculture will suffer a reduction of 50% by 2020. The prediction further demonstrates that by 2025, approximately 480 million people in Africa could be living in water-scarce or water-stressed areas. This could have severe consequences on farmers for food production, thus contributing to food shortage, conflicts, malnutrition and other related threats to human security. Slater *et al.* (2007) also projected that climate change and variability may retard the attainment of household food security if no adaptation strategies are put in place. The projection further indicated that by 2080, approximately 1,300 million people will face food risk as a result of climate change and variability: around 600 million more than in 1999. The high risk countries are those that depend on rain-fed agriculture with weak institutions and low capacities to adopt to climate change extremes such as flood, drought etc. (Kaushik and Sharma, 2015) and (Gregory *et al.* (2005).

A similar research by Morton (2007) revealed that smallholder farmers depending on rain-fed agriculture in both Latin America and Africa are likely to face a major decrease of about "~10% by 2055" in the yields of cereal crops like maize. In a research conducted by Bennett *et al.* (2015) citing IFPRI, (2004) explained that more than 90% of Africa's agricultural production depends on subsistence or local food production; 65% of the population are themselves smallholder farmers who depend on food and income from their farms.

Although the magnitude of food insecurity differs from one region to another, climate change and variability combined with other factors like environmental degradation, urbanization and globalization can exacerbate food insecurity in the world (Barron *et al.* 2013). In developing countries, the low coping ability and inadequate early warning systems are among the drivers to the adverse effects of climate change. Due to uncertainties of climate change and variability, the attainment of food security will remain a challenge to developing countries.

In The Gambia, climate change have had and will continue to have significant economic costs. The Gambia is highly vulnerable to any changes to its climate characteristics and it is evidently documented that there is an increase in average monthly minimum temperature by 0.40 degree centigrade over 40 years. Research conducted by Jaiteh (2010) and Yaffa (2013) revealed that there is an observed reduction in rainfall both in amount and in duration and increased frequency and length of dry spells in most part of the country. Yaffa further highlighted that for at least 29 years out of 40 years in the North Bank Region of The Gambia, rainfall had dropped below average. Citing Balk *et al.* (2007), Jaiteh (2011) stated that The Gambia is one of the most vulnerable countries to sea level rise. Mean temperatures are expected to increase between 3°C and 4.5°C by the year 2075. The Gambia's Greenhouse Gases (GHGs) emission may be relatively low, however, there are evidence of climate variability. The Gambia is a signatory to the United Nations Framework Convention on Climate Change (UNFCC) and is working towards the reduction of GHG emissions.

In order to address the threats of climate change, The Gambia has developed and implementing National Adaptation Programme of Action (NAPAs) and prioritized climate change resilience to withstand the shock. This focuses on thematic areas such as adaptability, susceptibility, and sustainability of a country. Good adaptation measures can minimize the negative impacts of global warming and climate change. These measures comprise the growing of alternative crops, intercropping different crop varieties, use of drought tolerant seed varieties, employing irrigation and water harvesting techniques, crop diversification, early warning and monitoring systems, construction of dykes, human migration, changing planting dates, diversifying in and out of agriculture, reliance on safety nets and social networks among others. One constraint to adaptation especially in agriculture has been that some of the adaptation technologies such as irrigation systems and dykes require huge capital investments.

1.2 Problem Statement and Justification

The current state of food insecurity in The Gambia is alarming, especially in rural areas. The country is regarded as a food deficit country with little or no natural resources and depends mainly on rain-fed agriculture as a main source of income and livelihood. The situation is impacting negatively the livelihoods of households and their well-being. Combined with climate change and variability impacts and other factors such as land use/land cover change, deforestation and depletion of the ecosystems and their services, among others, household food security is at risk and vulnerable. Climate change is regarded as a threat multiplier and its effects are felt across all the sectors. The most affected by the impacts of climate change and variability are the rural communities due to their low adaptive capacities to any shocks from climate change and variability. The situation is exacerbated by climate change because agriculture, which is the main source of livelihood of the rural people, is the most affected sector. Rainfall has dropped and farmers are only trying to feed their families from the little returns from the farmlands (Yaffa, 2013)

Although, research works have been conducted on food security in the some parts of rural areas of The Gambia, not much have been documented on the effects of climate change and variability on household food security among rural farmers. This research will, therefore, focus on the effects of climate change and variability on household food security in rural Gambia.

1.3 Main Research Objective

The main purpose of this research is to examine the effects of climate variability on household food security among rural farmers in central river region-south of The Gambia.

1.4 Specific Objectives

The specific objectives of this research are to:

1. identify the main source of food within the households in the Central River Region-South;
2. examine the variability and trends of climate elements in the study area;
3. examine the effects of climate variability on household food availability in the Central River Region-South;

4. identify factors affecting food security status among rural households in the study area; and
5. identify the coping strategies adopted by households in case of food shortages.

1.5 Research Questions

Research questions were designed to address the objectives of the study.

- What is the main source of food for the households?
- What are the main institutions supporting household food security status?
- What are the perceptions of community about climate change and variability?
- Which period of the year do rural dwellers face food shortage most?
- What are the factors affecting household food security status?
- What are the main coping mechanisms adopted by Households during food shortage?

1.6 Scope and Limitation of the Study

The research considered only one region of The Gambia. However, the research would have been more robust and detailed if the entire country was covered. Additionally, the region has only few functional meteorological stations with old measuring instruments. Therefore, accurate recording and measuring of climate parameters such as rainfall and temperature etc. is challenge.

1.7 Significance of the Study

The outcome of the research will be relevant to the local communities, WASCAL, government institutions (such as Ministry of Agriculture), agricultural projects, farmers, food chain stakeholders and other international organizations and research institutions working towards enhancing household food security and livelihood improvement in The Gambia. This would help the rural communities, government/policy-makers and food chain stakeholders in planning and implementing policies and activities that are geared towards strengthening rural areas with inputs, capacities and skills needed to attain household food security vis-à-vis improve coping strategies. Most importantly, the research will contribute to the body of knowledge by highlighting household food security gaps for more future research.

Organization of the Thesis

This research work is presented in five chapters. Chapter one deals with the general information about climate change and its related effects on human livelihood. It also shows the problem statement and justification of the study, main research objective(s), scope and limitation of the study, significance of the study and the conceptual framework used for this research work among others are discussed in this chapter.

Chapter two deals with the review of relevant related literature on the concept of climate change and food security, impacts of climate change on the fundamental pillars of food security among others. It also highlighted issues related to climate change and household food vulnerability. The chapter further illustrated household food production and food insecurity in The Gambia and household adaptation/coping strategies to food insecurity among other factors which affects household food security status in rural Gambia.

Chapter three described the methodology used for this research work. It highlighted the location and description of the study area, sampling and sampling procedures. In addition, data collection methods and analysis of data including the model used to analyzed household coping strategies to food insecurity are also presented in this chapter.

Chapter four illustrates the presentation and discussion of the results of the study.

The summary and the major findings together with resulting conclusions and policy recommendations from the study are presented in chapter.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter highlights some important issues such as; the concepts and fundamental pillars of food security, the impacts of climate change on household food security etc. The literature review further illustrates the potential effects of climate variability on household food production in The Gambia. The chapter also revealed the effects of climate variability and food vulnerability in The Gambia and the conceptual framework used for the study.

2.1 The Concept of Food Security

The fight for food security has been a global issue dating back to time immemorial. Pooled with climate change impacts, maintaining food security at national, household and individual levels is a serious challenge. The concept of food security has been undergoing an evolutionary change over the last 50 years. In the nineteen fifties (1950s), food security was considered essentially in terms of production. It was assumed that adequate production will assure adequate availability of food in the market as well as in the household. In the seventies (1970s), it became clear that availability alone does not lead to food security, since those who lack purchasing power will not be able to have access to balanced diets.

As outlined in the 1996 world food summit and FAO (2013), "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"., In this research work, the FAO 2013 definition of food security is adopted.

2.2 Climate Change and Food Security Status

Food security is one of the major concerns for developing countries, despite the efforts to improve food situation at national and household levels. Citing FAO (2012), Zakari *et al.*(2014) stated that approximately 870 million people globally are estimated to have been undernourished (in terms of dietary energy supply) in the period 2010–2012, representing 12.5% of the world population. A large proportion of these undernourished people live in developing countries, with sub-Saharan Africa having the highest prevalence of under-nourishment. There are scientific evidence that climate change is among the many factors affecting the achievement of food

security and Sustainable Development Goals (SDGs) across the world, especially in developing countries. Despite diverse adaptation efforts employed at all levels, the effects are adverse and are felt mostly in developing countries, especially in rural areas due to insufficient capacities to effectively adjust or adapt to the effects of climate variability (Ochieng *et al.* 2016). As illustrated by FAO (2009) and Ozor N. *et al.* (2015), the most affected sector by climate change in Sub-Saharan Africa countries is agriculture. This is due to its large dependency on rainfall for household food production.

Climate change extremes such as floods, drought, changes in temperature and precipitation, which in turn reduces vegetation cover, water resource availability, soil quality and changes in land-use practices, such as conversion of land use, pollution and depletion of soil nutrients which, in turn, reduce crop yields are among the factors affecting food production. Land degradation is considered as one of the most severe environmental and socio-economic problems of recent times in Sub-Saharan Africa Abdi *et al.* (2013). Meanwhile, if there are uncertainties concerning the direct effects of climate change on human well-being then, negative aspects are most likely to be pronounced.

2.3 Impacts of Climate Change on the Fundamental Pillars of Food Security

Due to the complexity and varieties of household in Africa, household in this study is considered as people who eat and work together in a family to ensure the production of food and welfare for the entire members of that particular family. Household food security status, as described by FAO (2013), is the capability of household members or individuals to secure food, either from its own production or through purchases, in adequate quantities to meet the dietary needs of all members of the household or individuals. Additionally, the United Nations (2014) affirmed that a household is considered food secured if it can constantly have access to enough food both in quantity and quality for all household members to live a healthy and active life. Regardless of the above perception, in this study, a household is regarded as food secured when it has year-round access to the amount and variety of safe foods for their members' needs to live active and healthy lives. One should note that household food security can be attained principally from the household's own production abilities to ensure that every member of the family has access to and utilize food to remain healthy and active.

The fundamentals of food security are based on the four main pillars—availability, accessibility, utilization and stability.

2.4 Fundamental Pillars of Food Security

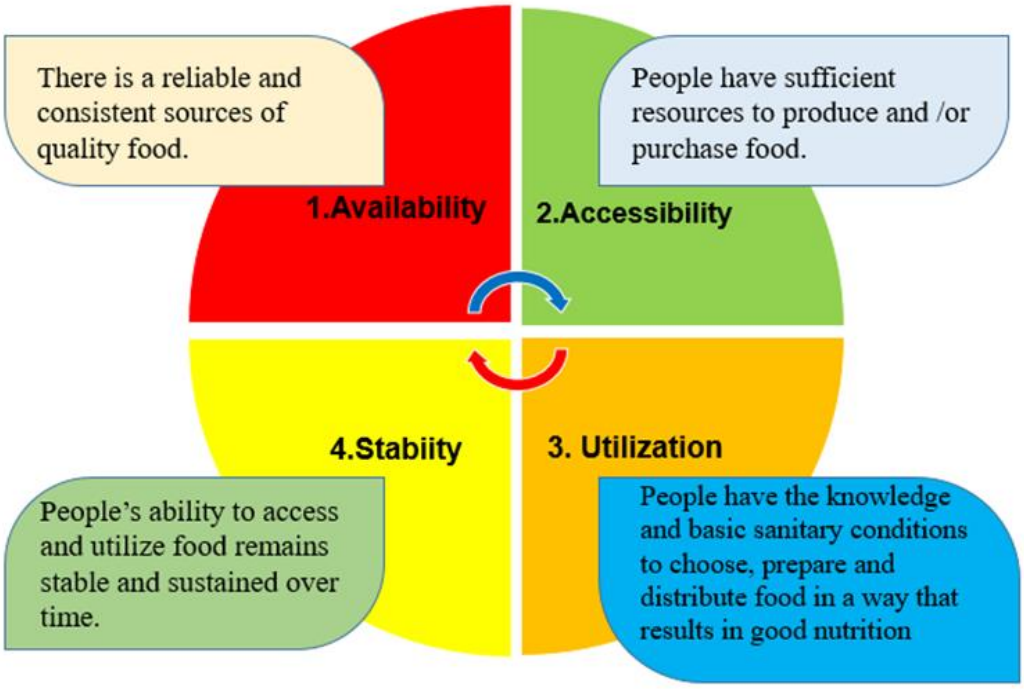

Figure 2: Fundamental pillars of Food Security

2.5 Household Food Production in The Gambia

Household food production in rural Gambia, as described by Loum and Fogarassy (2015), is mainly human labour combined with traditional methods of faming systems with low returns. Generally, The Gambian agriculture sector, as explained by Fafanding *et al.* (2011), is characterized by small-scale and subsistence crop production, traditional livestock rearing, artisanal fisheries and semi-commercial groundnut and horticultural production. The smallholder farmers cultivate less than 3 Ha with traditional and undeveloped farming techniques. Crop yields are generally low, with an average of about 1.5 tonnes/Ha compared to an estimated potential of 3-4 tonnes/Ha for cereals (NASS 2008). Access to and the use of farm inputs such as fertilizer and improved agricultural techniques is limited. The level of commercialization of the sector is also low to sustain the food needs of a growing population (Fatajo, 2010). Agro-industrial activity is mainly limited to groundnut milling, cereal processing, and cotton ginning

and sesame oil extraction. Furthermore, The Gambia agricultural sector is categorised by little diversification, mainly subsistence rain-fed agriculture with a self-food sufficiency ratio of about 50%. The Gambia has experienced numerous challenges from droughts and a severe crop failure that affect food production to successive flash floods. However, as domestic production even in a good year is not sufficient to cover consumption requirements, the country depends on food imports to make up for the gap which is why international price trends are usually felt in local markets (CFSVA The Gambia, 2016). Furthermore, agricultural intensification—increase in both production and productivity with good adaptation strategies to climate change and variability—has the potential to reduce rural poverty, enhance household food status, thus improving household livelihood by strengthening their human, financial, social, physical and natural assets, and more sustainable management of natural resources.

In their research, Girard *et al.* (2012) and IFRC (2015) opined that household home gardening and animal rearing can contribute greatly to improved household food security and nutrition, but these strategies are negatively impacted by climate change extremes such as floods and droughts, etc. Any strategies within the household level to improve food production will also contribute to food availability-Thus, increasing their purchasing power through increases in financial status and/or by directly increasing quantity and quality of foods produced and available for household consumption. Loum and Fogarassy (2015) further stated that The Gambia cereal production has been fluctuating along the years, with the level of performance varying among cultivars as a result of rainfall variability. This is due to the fact that farming in The Gambia is purely rain-fed and most farmers are unable to give a good prediction about the climate pattern, specifically onset and cessation of rainfall. The situation is caused by the absence of adequate number of agro-metrological stations to provide early warning systems to the farmers. In most situations, farmers are compelled to rely on local indicators which are sometimes not accurate regarding the rainfall duration and intensity. As a result, food production seriously affected, thus contributing to household food insecurity.

2.6 Climate Variability and Food Vulnerability Status in The Gambia

Socio-economically speaking, "The Gambia is categorized as a Least Developed Country, Low Income Food Deficit Country, and is ranked 155 out of 177 countries according to UNDP's Human Development Index (HDI)" (Fatajo, 2010, citing UNDP, 2007). In addition, domestic

food production only caters for 50 percent of consumption requirements; with the rest filled by imports, particularly of rice.

Agriculture, the principal source of occupation of approximately 70% of the population, is impacted by rainfall variability and climate extremes (Fatajo, 2010). The short wet season limits production to one crop per year and the main cash crop groundnut production continuously decreases over the years mainly due to adverse climate conditions. The research further stated that domestic food production in The Gambia provides little more than 50% of the consumption requirements. A large percentage of the population lives below the poverty line and suffer from food insecurity. There is sufficient reasons in The Gambia today to state that those who live in extreme poverty are mostly smallholder farmers mostly in the rural areas depending on agriculture for their survival.

Gaye and Gibba (2004) in their findings, reported that variability in rainfall and temperature in the last three decades in The Gambia has affected agricultural production. The effects are mostly felt by small-scale farmers who constitute approximately 70% of The Gambia population. Department of Agriculture (GDA, 2005) further reported that temperature and rainfall variations will have significant effects on local people. Consequently poor harvest as a result of crop failure will seriously threaten household food security and livelihoods. For example, low crop yields may result in higher food prices, which, in turn, affect food availability and the amounts that households consume.

To cope with household food insecurity, most farmers tend to sell the bulk of their farm produce immediately after harvesting, usually at give-away prices. During food shortage, they buy back at inflated prices the very produce they sold reasonably to the local merchants. For the purchase of food items during this period, farmers may lend money from neighbors or family members to meet the market prices. This practice is not sustainable and takes cruel advantage of the poor rural farmers, and this may even get worst combined with effects of climate change and variability. This has serious effects on their food stability and utilization, thus making them more vulnerable to health hazards and other socio-economic impacts. One of the possible solution to the above-cited problem faced by farmers is to have regional (localized) cereal bank where appropriate cereal stores are constructed and also making access to food easy at all times by all

means. The State can buy farm produce from the farmers and store them in their own areas, then sell them back to the communities during the lean period at affordable prices.

A Comprehensive Food Security and Vulnerability Analysis (CFSVA) report issued by WFP and FAO (2016) stated that the most vulnerable people in terms of food security are the rural dwellers due to their large dependency on rain-fed agriculture as a single main source of livelihood.

2.7 Conceptual Framework for Food Security in The Gambia

The conceptual framework describes the factors that directly or indirectly affect household food security. Kapande (2015) reported that rural household livelihoods are built within a diverse range of activities which include dependency upon both natural resources and non-natural resources, through which rural households meet their basic necessities, including food and non-food items. However, these livelihood activities, which rural households depend on, can be constrained by factors either within the system or environment where the livelihood activity is carried out or external conditions and factors. This includes factors like environment, political, social, economic, climate change and variability, demographic and policy settings, determining the ability of rural households to overcome the livelihood activity constraints. In light of the above, this research work focuses only on the effects of climate variability on household food security among rural farmers in Central River Region-South of The Gambia.

Furthermore, the study asserts that rural household food security status can be influenced by the interaction of the following variables at different levels. The direct and indirect relationship between variables makes the system very comprehensive and the weakness of one variable may influence the performance of the other variable.

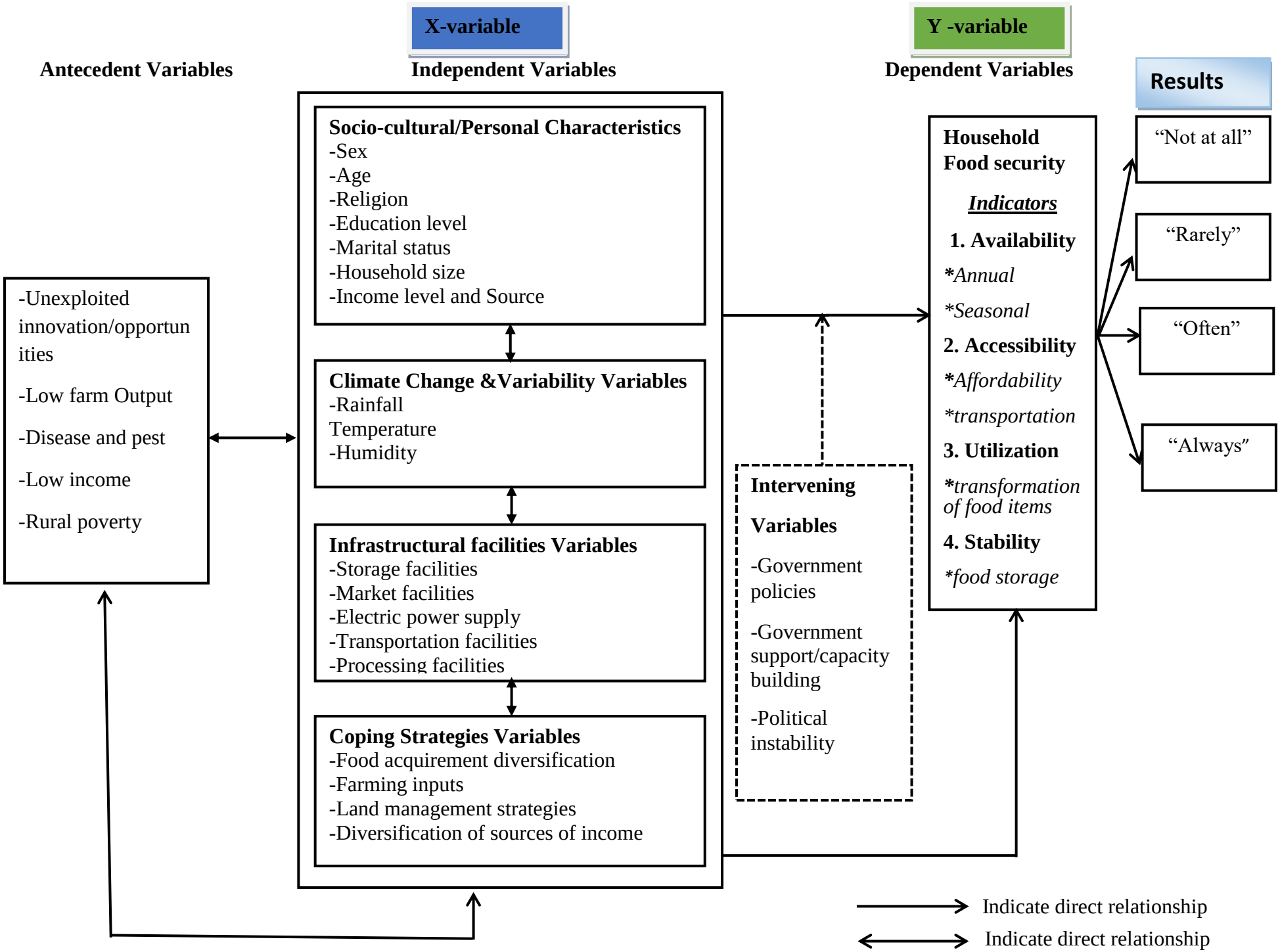

Figure 1.2: Conceptual Framework of Factors that affect Household Food Status in rural Gambia.

CHAPTER THREE

METHODOLOGY

3.0 Introduction

This chapter highlights the methods used for the study. It looks at the types of data and the procedures/tools adapted for data collection and analysis. It also looked at the location and description of the study area, socio-economic activities of the study area, research design, sampling procedures among others. It also described how reliability of data collection instruments were achieved through pilot testing, the logistic regression model used in the study to analyze factors influencing household food security status in the study area.

3.1 Location of Study Area

Occupying a total land area of 11,300 sq. km, with a population of 1,882,450 (GBOS, 2013) and population density of 176.1 inhabitants per square kilometers (456.1 inhabitants per square mile), The Gambia is one of the smallest countries in West Africa. The country lies between latitude 13° and 14° North, and 17° and 12° West, and consists of a narrow strip of land some 400 km long and 30 km wide on both sides of The Gambia River.

The study area is located in the Central the River Region-South of The Gambia. It lies on the southern part of River Gambia, stretching from Sofaa Naima Bolong (Pakaliba Bridge) in the West to Farato Village in the East. The study was conducted in three randomly selected districts of the Central River Region-South of The Gambia namely; Niamina West, Niamina East and Lower Fulladu West. Simple random sampling was employed to select three communities from each of the selected district. Kumbaney Buniadu, Sambang Mandinka Kunda and Katamina were the communities selected from Niamina West district. The villages selected from Niamina East were Sambel Kunda, Sotokoi and Kerewan Touray. In Lower Fulladu West, Sinchu Magai (Mara Magai), Medina Ceesay Kunda and Sankuleh Kunda were the communities selected for the study.

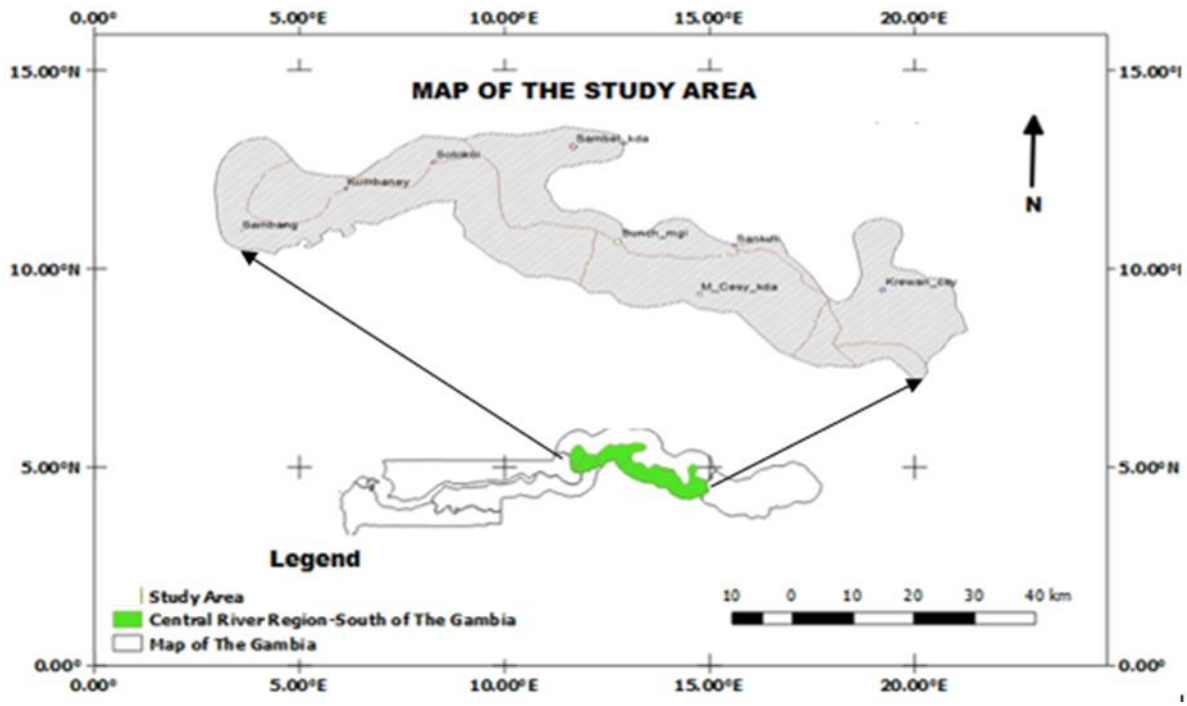

Figure 3.1 Map of the Study Area

3.2 Description of Study Area

Climate of the study area

The Gambia's climate is mainly semi-arid with one rainy season from May/June to October, followed by a seven month dry season from November to May. The region is characterized by a long dry season and a short wet season. The dry season commences in mid-October and lasts through May/June. The wet season is normally mid-June to mid-October with approximately 550 – 600mm of annual rainfall. The climate is "***Sudano-Sahelian",*** with a short rainy season from June to October and a long dry season from November to May.

3.3 Population of the Study Area

According to the 2013 Gambia population and housing census (GBOS), Central River Region-South of The Gambia had a total population of 126,910 people out of the total Gambian population of 1,882,450 people. The percentage of each selected district and communities for the study are illustrated in Table 3.1 below.

Table 3.1: Population of the study Area

Districts	Settlements/Villages	Population of Settlements	Male	Female	Male %	Female %
	Kumbaney Buniadu	184	88	96	48	52
Niamina	Sambang Mandinka Kunda	284	137	147	48	52
West	Katamina	512	237	275	46	54
	Sambel Kunda	680	369	311	54	46
Niamina	Sotokoi	978	463	515	47	53
East	Kerewan Touray	287	139	148	48	52
Lower	Sinchu Magai (Mara Magai)	648	295	353	46	54
Fulladu	Medina Ceesay Kunda	159	73	86	46	54
West	Sankuleh Kunda	615	313	302	51	49

Source: Gambia Bureau of Statistics (GBOS), 2013

3.4 Socio-Economic Activities of the Study Area

Like other regions of The Gambia, almost all the residents of the Central River Region-South depend directly or indirectly on agricultural activities (Loum and Fogarassy, 2015). The main crops grown include groundnut, maize, early millet, rice, sorghum, sesame, etc. Equally, they also depend on small livelihood means such as traditional souvenirs, basket making, bead making, petty trading, carving, fishing and household vegetable production. Among the main activities performed by rural households during the rainy season are food crop (cash and cereal crop productions). They are also involved in animal husbandry such as cattle, goat, sheep and poultry. These activities vary during the dry season, making them more vulnerable to food insecurity.

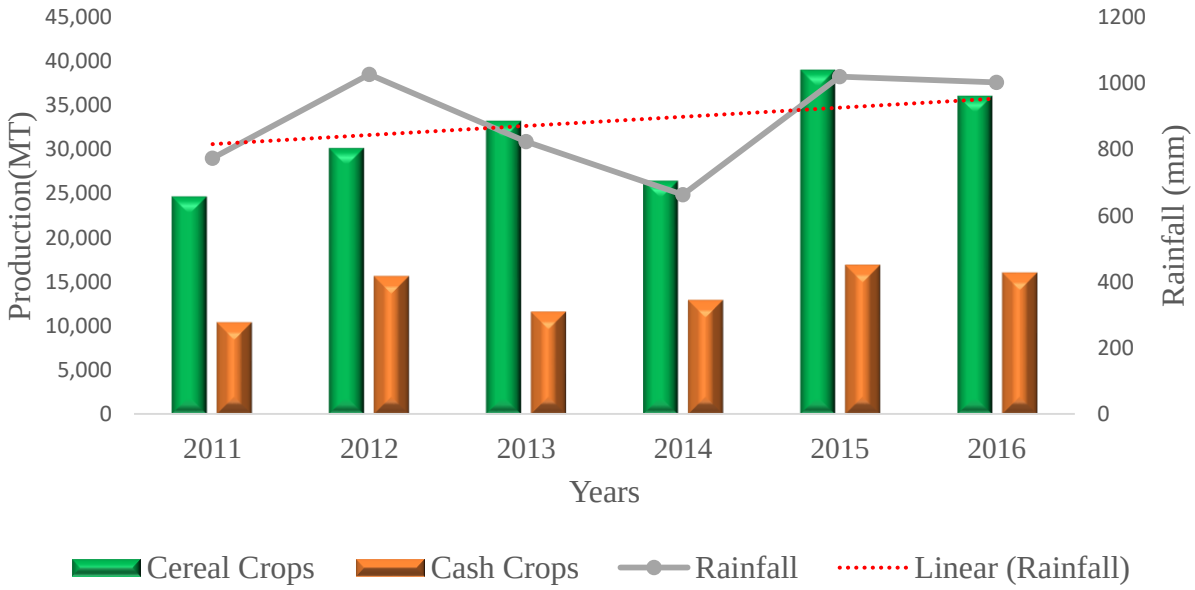

Figure 3.2. Production of Cereal and Cash Crops in the Study Area from 2011-2016

Source: *Department of Planning, 2017*

The Central River Region-South was selected as a case study area for few reasons. First, it can be classified among the most vulnerable regions to climate variability and food poor due to their large dependence on rain-fed agriculture for food production as their livelihoods. Second, not many studies have been done on the effects of climate change and variability on household food security. Third, the spatial settlement of the communities makes it difficult for rural infrastructural and socio-economic development. Therefore, this research focused on the effects of climate variability on household food security among rural farmers in Central River Region-South of The Gambia. The numerous factors that affect food production and household food security in the study area includes, among others:

- the number of households and individuals depending on agriculture for livelihood;
- the number of food poor, vulnerability and low adaptive capacities to the effects of climate change hazards such as drought and floods;
- poor rural development (such as industries) and lack of social infrastructures (such as roads, electricity and transportation networks especially) in the villages located in the interior of the region; and
- poor socio-economic development at household level.

3.5 Research Design

Descriptive research design was adopted to address the stated research objectives. It is applied in order to describe the effects of climate variability on household food security among rural farmers in Central River Region-South of The Gambia, their main sources of food for livelihood, their preferred sources of climate change information, food shortage periods and their coping mechanisms adopted during food shortage periods. As discussed by Burns & Grove (2003), descriptive research is designed to depict a picture of a situation as it naturally happens. It can be used to justify current practices and make judgment and also to develop theories.

3.6 Sample and Sampling Procedure

A multistage sampling, as the name suggests, involved the combination of different forms of sampling procedures. It involved a step-by-step procedure to select the sample respondents. This method is highly flexible and mostly used for cross sectional survey.

The first stage was the purposive selection of one region in country. The Central River Region-South was selected due to its climate sensitivity, high food poverty levels and high participation in farming which is predominantly rain-fed and subsistence.

In the second stage, simple random sampling technique was used to select three districts from the six districts in the region. Using the socio-economic data obtained from GBOS, three most vulnerable districts and food poor in Central River Region-South were purposively selected. Names of each village and population was imputed in the Microsoft excel statistical tool using the randomization formula to select the villages. Three villages were selected from each district making a total of 9 villages for the entire study area.

In the last stage, simple random sampling was used to select households from each community for the entire study as household heads (small-scale farmers) serve as the sampling units for the study. In each selected household, one household head male or female was interviewed. Also in the absence of the household head, any adult member (more than 25 years) could answer the questionnaire on his behalf. In all, 219 household heads were interviewed for the entire study.

3.6.1 Sample Size

The study population comprised all the households in the selected communities for the study. The sample frame for the study was the list of households in the study area with the sampling units being farmer households and the target respondents for the study were household heads.

The sample size determination was based on Kothari (2004) formula. This procedure takes into consideration (1) the nature of the population, (2) the type of investigation, and (3) the degree of precision desired. The method accepts an estimation of tolerable error margin of 0.05, allowing 95% confidence level. Hence, the formula is represented below;

$$n = \frac{Z^2PqN}{e^2(N-1)+Z^2Pq} \qquad \text{Equation……} \quad 1$$

Where: n= the minimum number of sample size within the range of acceptable error margin,

N= the total number of households in the four selected administrative districts;

z= confidence level (95%) and which is 1.96;

e= acceptable error margin (0.05);

p= proportion of sampled population (0.11); and

q= estimate of the proportion of population to be sampled (0.89).

Additionally, sample size calculator (software) was also used for better sample size determination and accuracy.

A sample total of 219 household heads was obtained using the formula, to obtain the exact number of respondents from each village, the total number of households in each community obtained earlier were divided by the total households for the study (506) and the value multiplied by 219.

Table 3.2: Sample of the Study Area

Districts	Settlements	HH. Nº	Sampled Households	Percentage (%)
	Kumbaney Buniadu	23	10	5
Niamina West	Sambang Mandinka Kunda	46	20	9
	Katamina	78	34	15
	Sambel Kunda	81	35	16
Niamina East	Sotokoi	112	48	22
	Kerewan Touray	25	11	5
	Sinchu Magai (Mara Magai)	44	19	9
Lower Fulladu West	Medina Ceesay Kunda	15	6	3
	Sankuleh Kunda	82	35	15
3 Districts	**9 communities**	**506**	**219**	**100**

Source: Gambia Bureau of Statistics (GBOS), 2013

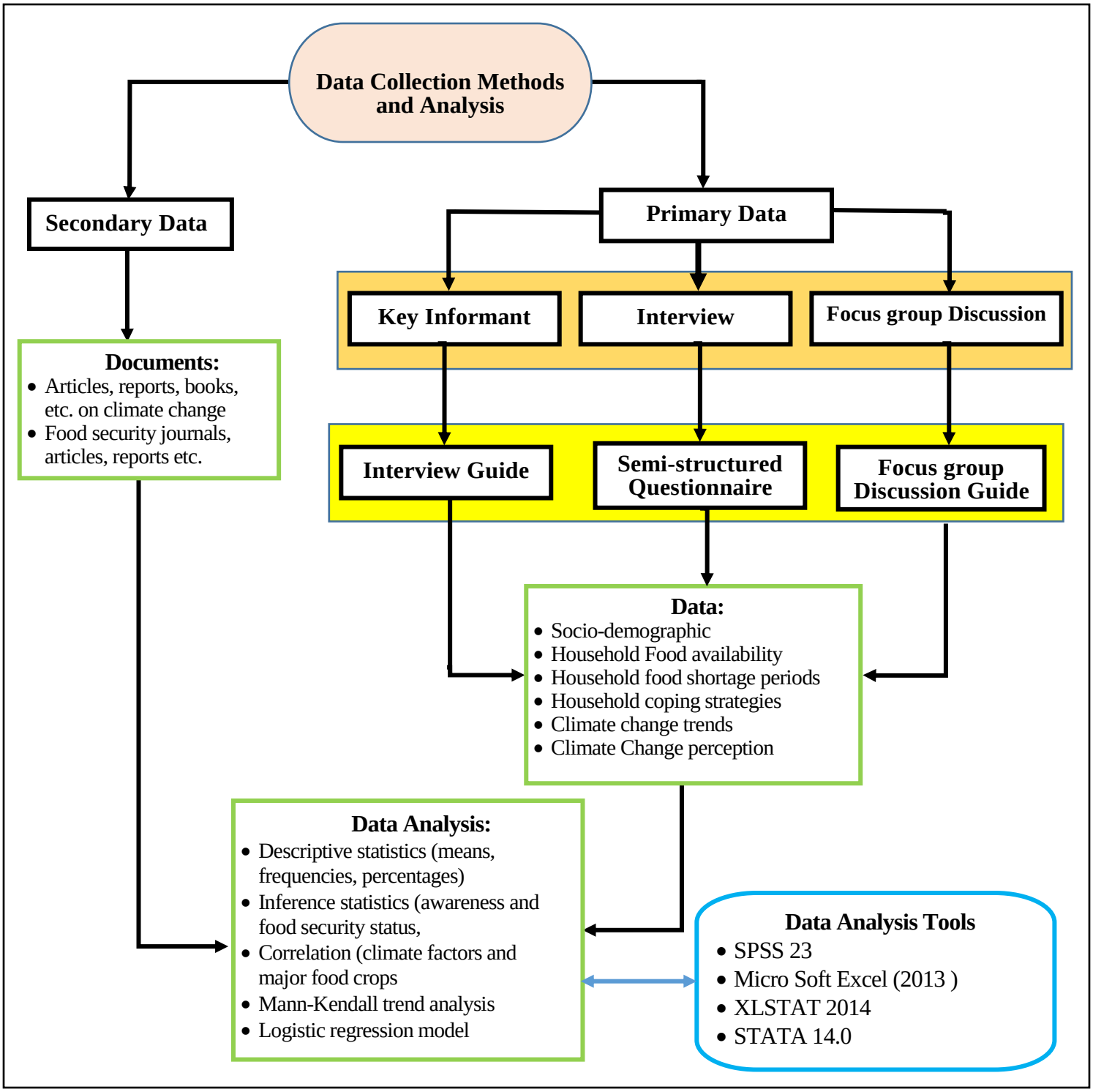

Figure 3.3: Methodological Framework

3.6.2 Research Data and Sources

Figure 3.3 above shows the methodological framework of research and data sources. A combination of quantitative and qualitative data collection techniques was used to collect both primary and secondary data. Primary data collected for the study were socio-demographic characteristic of households, household food security components (availability, accessibility, utilization) household coping strategies to food shortages, perception on climate change, household preferred sources of climate information, and finally data on the challenges farmers faced in their farming systems through structured questionnaire administration.

The secondary data collected were the relevant information obtained from newspapers, books journals, reports and internet. In addition, climate change data (1971-20016) was collected from the Department of Water Resources (DWR) to provide historical trends in climate variables (rainfall and temperature). The climate variables collected included annual precipitation as well as minimum and maximum temperature. Crop production data of the study area was also collected from the department of planning from 2011-2016 as well as the population data of The Gambia from The Gambia Bureau of Statistics (GBOS) 2013 census. Additional information were collected from reports by the Inter-governmental Panel on Climate Change (IPCC), United Nations Framework Convention on Climate Change (UNFCCC) International Organizations such as the Food and Agriculture Organization (FAO), World Food Programme (WFP), National Adaptation Programme of Action (NAPA) of The Gambia among others were also used to gather relevant information or the research.

3.7 Data Collection Instruments

3.7.1 Questionnaire

A semi structured questionnaire was developed comprising of open and closed ended questions that were administered directly by the researcher to sampled households as shown in Figure 3.3 above. The questionnaire was structured in four sections. Section A consist of general information of the respondent; section B consist of household characteristics including physical, natural, human social and financial assets of households. Section C covers questions on food security assessment on the dimensions of food security — availability, accessibility and

utilization, coping strategies to food shortage while section D covers questions on household perception about climate change and how climate factors (rainfall, temperature) affect their food security status.

3.7.2 Focus Group Discussion

Fern (1982) suggested that the ideal size for a focus group discussion is 8-12 members. A total of three focus group discussion was conducted in each of the three selected district in the study area. This is due to the fact that all the respondents in the study area share similar socioeconomic characteristics and challenges as a result of their social and cultural settings and background. The method was adopted to provide more detailed explanations on the data that was collected during household individual interviews. It also provided the opportunity to affirm some responses and serve as a cross check on the responds provided by household during individual interview. In addition, FGD was conducted based on gender to allow a good discussion. Due to culture and other social values, women shy away from expressing themselves explicitly when they are in the midst of men. Men, on the other hand, tend to dominate discussions when they are in the same FGDs with women.

Plate 1: Focus Group Discussion-Male

Plate 2: Focus Group Discussion-Female

3.7.3 Key Informant Interview

A special interview was conducted to key informant individuals who have verse knowledge and play key role in the district (a retired extension officer and a Principal Education Officer at Sankuleh Kunda Village (Plate 3). This method provided an in-depth knowledge on their factor affecting household food production thus food insecurity, coping strategies to food shortages,

climate change awareness and effects on the pillars of food security. They were also asked about their opinions or suggestion on what can be done to enhance household food security at household and national level.

Plate 3: Discussion with Key Informant at his residence

3.8 Pilot-testing of the Research Instrument

To ensure accuracy and reliability of research instruments, pre-testing the structured questionnaire was carried out among 10 households randomly selected from Saruja village within the study area. Saruja village was selected for the pilot-testing because of the socioeconomic characteristics it shares with those villages selected for the study. The pilot-test was done in different days so as ascertain the homogeneity of responses.

The rationale behind the pilot-testing was to strengthen data collection procedure, check for clarity and relevance of questions that supported in making the necessary corrections, adjustments and also confirm that the designed questionnaire would produce the required data and finally to guarantee the reliability and validity of the instrument.

3.9 Data Collection Procedures

3.9.1 Reconnaissance Survey

A three days reconnaissance visit to each of the selected study villages was done as a way of community entry. The main rational of the reconnaissance survey was to know and inform the community/village head (Alkalo) and elders about the purpose of the study and to solicit their permission and support during the data collection process. It was also meant for the researcher to

get familiarized with the geographic and social conditions of the study area. In addition, the visit was also meant to identify a contact person in the communities that the researcher would correspond with for the period of the study.

3.9.2 Interview

A face-to-face interview was conducted with the help of designed questionnaire to the sampled households as shown in plate 4 below. This procedure was done by asking questions directly to the respondents and the responses were recorded on the questionnaires check list. The logic of this method was to enable easy and direct access of information from the respondents since a good proportion of them could not read and write in English. However, the main challenges and weakness of this method is the accurate translation of the questions from English to the local dialects for the respondents to understand clearly, thus, in certain cases, prompt some of them to give false information or irrelevant information. To address this limitation, translators were trained to facilitate the easy understanding of the questions by the farmers.

Plate 4: Interview with household

3.10 Data Analysis

Statistical Software such as STATA (Version14.0), SPSS (Version 23), XLSTAT 2014 and Microsoft Excel (Version 2013) respectively were used to analyze the quantitative data collected. In addition, the qualitative data collected during the focus group discussion and key informant interview sessions were processed to supplement and support the quantitative information

collected through questionnaire administration. Data entry and cleaning was done using SPSS (Version 23). In addition, frequencies, means, models, correlations, maximum, minimum values and percentages (descriptive statistics) were used to analyze household demographic and socioeconomic characteristics, household food security status and food shortage periods. The tool was further used to analyze data on household main source of food, household coping strategies, climate change trends and household perception on climate change.

SPSS (Version 23) was used to analyze data on sociodemographic profile of the respondents, household main source of food, period of food shortage, duration and types of food stores, household level of awareness about climate change and the perceived causes and effects of climate change on their food security status. The software was also used to analyze household coping mechanism to food shortage and length of feeding from farm produce among others.

STATA (Version14.0) was used to run the logistic regression model on factors influencing household food security status. Logistic regression model was applied to examine the effect of various independent variables on household food security status in rural Gambia.

XLSTAT 2014 was used to analyze the Correlation matrix (Pearson correlation) and Coefficients of determination (R^2) between climate elements and major crop production in the study area. This helped in understanding the effects of climate factors on the major food crops (cereal and cash crops) grown in the study area.

Microsoft excel tool was used to determine the sample size of the study area. The tool was also used in selecting the sampled villages to avoid biasness by using "Randomization" function. It was also used to produce charts and graphs of the findings.

3.10.1 Descriptive Analysis

Descriptive analysis is the summarization of the quantitative data into a simpler summary to make it easier to understand measure, and interpret. It was used to characterize the responses from sampled households in the study area. Frequency distribution was drawn to view how frequently each category in demographic and socioeconomic variables of the households behave in this research. The descriptive analysis was done primarily using SPSS version 23.

3.10.2 Logistic Regression Model

Logistic regression model was used to analyze the various factors influencing household food security status in the study area. Various researchers including Abdullah *et al.* (2017) have used this model to analyze different factors influencing household food security. The model was used to describe the relationship between one or more independent variables (e.g., age, household income, Household asset, remittance, etc.) where there is a binary response variable – the likelihood of attaining household food security within the communities – which is expressed as a probability.

The dependent variable—food security status is dichotomous, which means that it only takes two values either the presence of something or absence, so by pursuing the conventional method of binary response it will either take the value of one (1) or zero (0). This value of 1 means that household is food secure and zero means otherwise. This can be achieved by using the linear probability model (LPM). But this LPM is plagued by many problems including heteroscedasticity of the error term, the possibility of 'y' lying outside the range (0, 1). To avoid the problems associated with the LPM, the relationship is modelled in such a way that 'y' is unobservable variable and the relationship is given by;

$$y = 1 \text{ if } y > 0$$
$$0 \text{ if } y < 0$$

Where 1 stands for food security and zero for food insecurity. Logistic regression technique is used to model the relationship between the dichotomous dependent variable and set of independent variables that are hypothesized to affect the outcome.

The log odd of the outcome in logit model is a linear combination of the predictor variables. The simple form of logistic model, according to Peng *et al*. (2002) is shown below:

$$\text{Logit}(Y) = \text{natural log (odds)} = \ln\left(\frac{\pi}{1-\pi}\right) = \alpha+\beta xi \quad \text{.....Equation (2)}$$

This equation helps us to predict the likelihood of the occurrence of the result of interest. This is using antilog in both sides of equation (1) as shown below:

Where;

π= probability outcome of interest

x= Y intercept

β= regression coefficient

e= 2.71828 (the base of natural logarithms)

x= binary or continuous variables

Table 3.3: Description of the Variables used in the Model

Variables Dependent variable	**Description and Measurement**
Food Security Status (FS)	D = 1 if HH is food secure; 0 = otherwise
Independent Variables	
Education (ED)	D = 1 if HH head is literate; 0 = otherwise
Household Size (HS)	D= Number of household members
Age (A)	D= Age of HH head in number of years
Household Income (HI)	D= Household income
Asset Index (AI)	D= Number of Household assets
Economic Activities (EA)	D= 1 if HH main economic activity is crop production; 0= otherwise
Land ownership (LO)	D= 1 if HH own land; 0= otherwise
Assistance (AS)	D= 1 if HH receive assistance; 0= otherwise
Remittances (RM)	D=1 if HH receive remittances; 0= otherwise
Access to Market (AM)	D= 1 if HH has access to market; 0 = otherwise
Access to Credit (AC)	D= 1 if HH has access to credit; 0 = otherwise
Food Aid (FA)	D= 1 if HH received food aid; 0= otherwise

Source: Field Survey, 2017

3.10.3 Mann-Kendall Trend Analysis

Mann Kendall test is a statistical test widely used for the analysis of trend in climatologic and in hydrologic time series. There are advantages and drawback in using this test. First, it is a non-parametric test and does not require the data to be normally distributed. Second, the test has low sensitivity to abrupt breaks due to inhomogeneous time series which can be seen as a drawback. In this test, the null hypothesis H_0 assumed that there is no trend in the series— rainfall and temperature while the alternative hypothesis H_1, assumed that there is a trend in the series.

The computational procedure for the Mann Kendall test considers the time series of n data points and Ti and Tj as two subsets of data where i = 1,2,3,…, n-1 and j = i+1, i+2, i+3, …, n. The data values were evaluated as an ordered time series.

The Mann-Kendall S Statistic is computed as follows:

$$S= \sum_{i=1}^{n-1} \sum_{j=i+1}^{n} sig(Tj - Ti) \qquad \text{Equation……3}$$

$$Sign(Tj - Ti) = \begin{cases} 1 \; if \; Tj - Ti > 0 \\ 0 \; if \; Tj - Ti = 0 \\ -1 \; if \; Tj - Ti < 0 \end{cases} \qquad \text{Equation……4}$$

where Tj and Ti are the annual values in years j and i, j > i, respectively.

If n < 10, the value of |S| is compared directly to the theoretical distribution of S derived by Mann and Kendall. The two tailed test is used. At certain probability level H_0 is rejected in favor of H_1 if the absolute value of S equals or exceeds a specified value Sα/2,where Sα/2 is the smallest S which has the probability less than α/2 to appear in case of no trend. A positive (negative) value of S indicates an upward (downward) trend. For n ≥ 10, the statistic S is approximately normally distributed with the mean and variance as follows:

E (S) =0

The variance (σ2) for the S-statistic is defined by:

$$\sigma^2 = \frac{n(n-1)(2n+5) - \sum t_i(i)(i-1)(2i+5)}{18}$$

in which ti denotes the number of ties to extent i. The summation term in the numerator is used only if the data series contain tied values. The standard test statistic Zs is calculated as follows:

$$Z_s = \begin{cases} \frac{s-1}{\sigma} for\ S > 0 \\ 0\ for\ S = 0 \\ \frac{s+1}{\sigma} for\ S < 0 \end{cases} \qquad \text{Equation……5}$$

The test statistic (Zs) is used as a measure of significance of trend. This test statistic was used to test the null hypothesis, H_0. If | Zs| is greater than Zα/2, where α represents the chosen significance level (eg: 5% with Z 0.025 = 1.96) then the null hypothesis is invalid implying that the trend is significant.

Another statistic obtained on running the Mann-Kendall test was Kendall's tau, which is a measure of correlation and therefore measures the strength of the relationship between the two variables. In common with other measures of correlation, Kendall's tau will take values between -1 and +1, with a positive correlation indicating that the ranks of both variables increase together whilst a negative correlation indicates that as the rank of one variable increases, the other decreases.

In time series analysis it is essential to consider autocorrelation or serial correlation, defined as the correlation of a variable with itself over successive time intervals, prior to testing for trends. Autocorrelation increases the chances of detecting significant trends even if they are absent and vice versa. In order to consider the effect of autocorrelation, Hamed and Rao (1998) suggest a modified Mann-Kendall test, which calculates the autocorrelation between the ranks of the data after removing the apparent trend. The adjusted variance is given by:

$$Var\,[S] = \frac{1}{18}[N(N-1)(2N+5)]\frac{N}{NS*} \qquad \text{Equation…….6}$$

$$Where \frac{N}{NS*} = 1 + \frac{2}{N(N-1)(N-2)}\sum_{i}^{p}(N-i)(N-i-1)(N-i-2)\,p_s(i)$$

N is the number of observations in the sample, NS* is the effective number of observations to account for autocorrelation in the data, ps (i) is the autocorrelation between ranks of the observations for lag i, and p is the maximum time lag under consideration

Addinsoft's XLSTAT 2014 was used to perform this test. The null hypothesis is tested at 95% confidence level for both, temperature and precipitation data of the study area. In addition, to compare the results obtained from the Mann-Kendall test, linear trend lines are plotted using Microsoft Excel 2013.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.0 Introduction

This chapter reveals the results of data analyzed according to the objectives of the study. It presents the analyses and discussion of descriptive statistics which begins with the demographic characteristic of the respondents, household main sources of food. It also shows the correlation between climate factors (temperature and precipitation) and the major crops production in the study area. Seasonality of household food shortage in the last 5 years, household coping strategies to food shortage among others were also discussed. In addition, the chapter further shows the result generated from the logistic regression model of the factors affecting household food security status among others. The presentation of the results is done alongside with the discussions.

4.1 Socio-Demographic Characteristics of Households

Out of the 219 households surveyed, the results indicated that 83.1% of the households were male headed while 16.9% were headed by female as shown in table 4.1. This shows the dominance of male headed household in the study area. This can be attributed to the culture and religion as most cultures recognizes male as household heads compared to their female counterparts. In most cases, men tend to dominate females with regards to household head.

As shown in table 4.1 below, the findings further revealed that 70.3% of the surveyed households were involved in monogamous married and 30% were in polygamous married. The results also shown that 4.6% of the respondents were widowed while 3.2% were single. In terms of food production, this has a positive implication especially for households that are involved in agricultural activities. This is evident that married farmers who are engaged in active farming activities could have the support of their spouse(s) in terms of labour and also help supplement the income needed to acquire agricultural input and to provide the needed food requirements of the household. Citing Nnadi *et al*. (2012), Ozor N. *et al.* (2015) illustrated that marriage encourages, support and promote adaptation efforts among farming communities, thus improving household livelihoods.

Furthermore, the socio-demographic characteristic of the respondents as shown in Table 4.1 illustrated that out of the 219 household respondents surveyed, the youngest household head was 25 years while the oldest was 80 years respectively with a mean age of 55 years. The results also indicated that 9.1% of the respondents fall under 25-36 age bracket while 6.4% were 73 years and above which is above retiring age under The Gambia civil servant regulations. Majority representing 30.6% of the respondents were within the age bracket of 37-48 and 31.1% were within 49-60 years old. There is enough reason to state that majority of the respondents in the study area were predominantly in their middle ages hence, are economically active and thus can undergo stress and manpower to increase in food production. Furthermore, most of the respondents also expressed that the younger population within 25-36 years are abandoning the rural areas especially farming activities to look for better opportunities in the cities within The Gambia or outside The Gambia. This can influence negatively the household food production in the near future if the situation continues.

In addition, the data revealed that majority (46.6%) of the surveyed respondents had household sizes of between 10-17 persons. Others are 37.9% and 11.9% having household sizes of 2-9 and 18-25 person respectively with the average household size of 12 persons per household. This indicates that most of the households within the surveyed area have fairly larger family sizes. The lowest family size was 2 while the largest was 40 persons. This indicates that the larger the household size, the more they would be capable of providing cheaper family labour especially agricultural activities which most of them relay on for consumption. In addition, large family size will encourage and provide diversification of enterprises by farmers and other livelihood activities that are vital in enhancing household food production and productivity and boost household income. Large family size will also minimise expenses especially on labour and other activities.

The results from the study also revealed that 58.4% of households have attended lower basic education in English and Arabic known as ‘Madrassa’ while 8.2% and 5.0% have attended Upper Basic School in English or Arabic education systems respectively. In addition, the results also illustrated that 24.7% of household have never attended any form of education. It can be inferred from this that the majority of the respondents in the study area are literates although their level of literacy differs.

Table 4.1: Socio-demographic Profile of the Respondents

Variables	Frequency	Percentage (%)
Gender (n=219)		
Male	182	83.1
Female	37	16.9
Age of household head (n=219)		
25 -36	20	9.1
37-48	67	30.6
49-60	68	31.1
61-72	50	22.8
73 and above	14	6.4
Marital status (n=219)		
Single	7	3.2
Married monogamous	154	70.3
Married polygamous	48	21.9
Widowed	10	4.6
Household size (n=219)		
2-9	83	37.9
10-17	102	46.6
18-25	26	11.9
26-37	7	3.2
33 and Above	1	.5
Educational level of Household head (n=219)		
Never attended school	54	24.7
LBS/Madrasa	128	58.4
UBS/Madrasa	18	8.2
Secondary	11	5.0
Tertiary	8	3.7
Economic activity (n=219)		
Crop production	195	89.0
Petty trading	3	1.4
Fishing/hunting	4	1.8
casual works	9	4.1
Others	8	3.7

Sources: Field Survey, 2017

4.2 Household Main Sources of Food

In the study area, the main sources of food in the household can be categorized into two; own production and from purchase. Out of the 219 respondents' interviewed, an overwhelming proportion (90%) of them reported that their primary source of food consumed in the households is from their own farm production while 10% of the respondents reported that purchase is the second source of household food supply. This is evident that in the study area, a large proportion of the rural population depends on crop production and animal rearing among other farming activities for their livelihood which is subsistence and purely rain-fed.

Though the findings revealed that the majority of households were engaged in farming, almost all households are net purchasers of food. Most of the households do not produce sufficient food quantities to cover the household consumption needs throughout the year. Some of them sell part of their production to cover the production expenses and other needs such as children school fees and other social events. The vulnerability to food insecurity is more severe during poor harvest seasons in which most households were unable to produce enough food to keep feeding their members throughout the year.

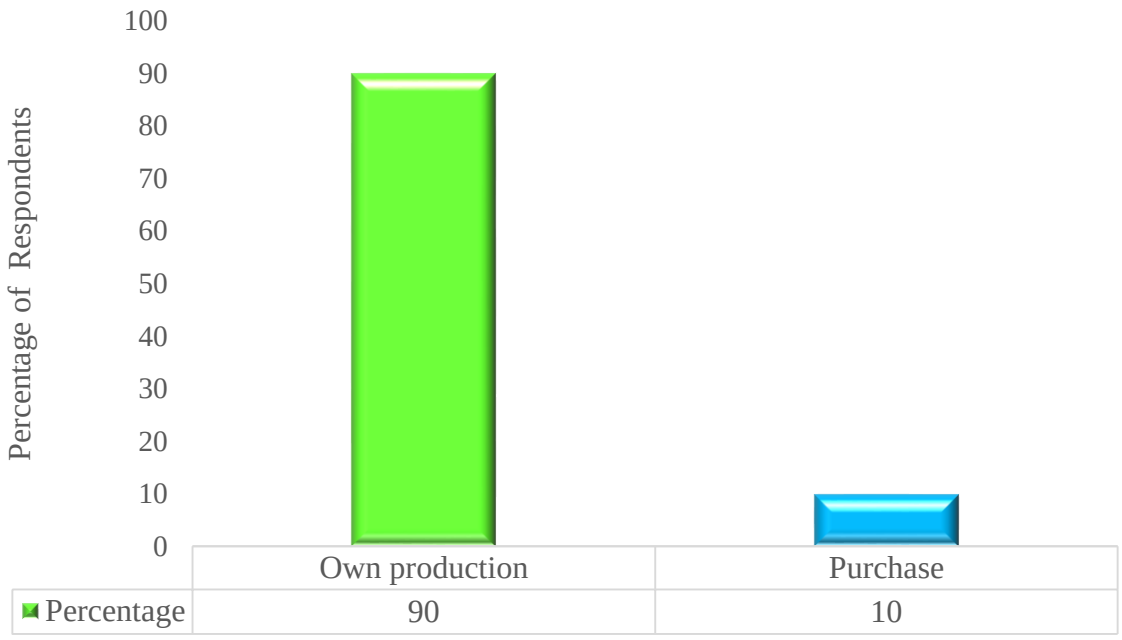

Figure 4.1: **Distribution of Households' Main Sources of Food**

Source. Field Survey, 2017

FGD further revealed that the majority of the households sell a large proportion of the farm produce to the market to supplement other household needs such as providing education and other basic needs of the household. Household mostly engage in food purchase when the farm harvest is poor and the food stored has been exhausted. In addition, petty trading constituted 10.5% and livestock 11.0% respectively contribute greatly in generating household income needed to complement household food needs.

4.3 Household Food Availability

Findings from household interview revealed that, most of the respondents (72%) reported that farm produce can only cater for less than 5 months for family consumption while 26.9% of the surveyed respondents explained that their farm produce can only cater for 6-8 months. Findings further revealed that only 0.5% of the respondents narrated that their farm produce can cater for 9-12 and more than 12 months respectively. This can be further attributed to the family sizes and poor harvest among many other factors. Most of the respondents expressed their views during FGD that, climate variability and lack of adequate farm inputs are the main contributing factors to poor yields. Poor storage and processing facilities was also highlighted due to fact that most of the interviewed communities lack these facilities.

In most cases, household food production, especially in rural Gambia are not enough even in the normal rainfall year, to feed the member of the household for the whole year period. This is mainly as a result of extended families depending on a single source of livelihood. This compelled most households to struggle to get additional food from other sources such as remittance and neighbourhood assistance during months of food shortage. During FGD, the majority of the respondents affirmed climate variability is a serious challenge and it severely affects livelihoods as the majority of the respondents expressed that their own farm produce cannot feed their household for the whole year.

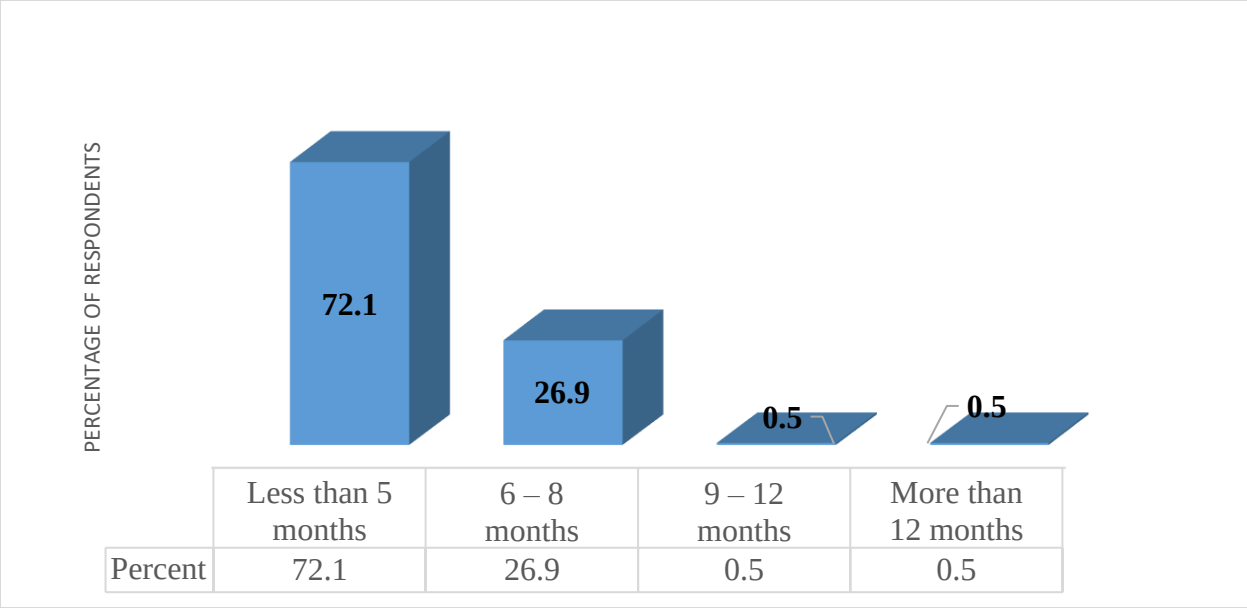

Figure 4.2: **Distribution of Respondents' Time Periods that their Farm Produced Last**

Source. Field Survey, 2017

4.4 Household Additional Sources of Food Supply

When asked about household additional food sources, majority of respondents outlined that they resorted to other mechanisms to acquire food items. Findings from the study exposed that a good proportion 57.4% and 21.3% of the respondent stated that they normally get assistance from family members/relatives in The Gambia, abroad and neighbourhood respectively in form of food and non-food items such as money in cash as for remittance while 14.8% of the respondent gained assistance from NGOs such as Action Aid The Gambia, FAO among others.

Only few respondents (6.6%) stated that they gained assistance from government institutions such as agricultural projects through the department of agriculture (DoA) in form of agricultural implements such as seeders, power tillers, fertilizers to increase in production and productivity, thus enhancing household food availability.

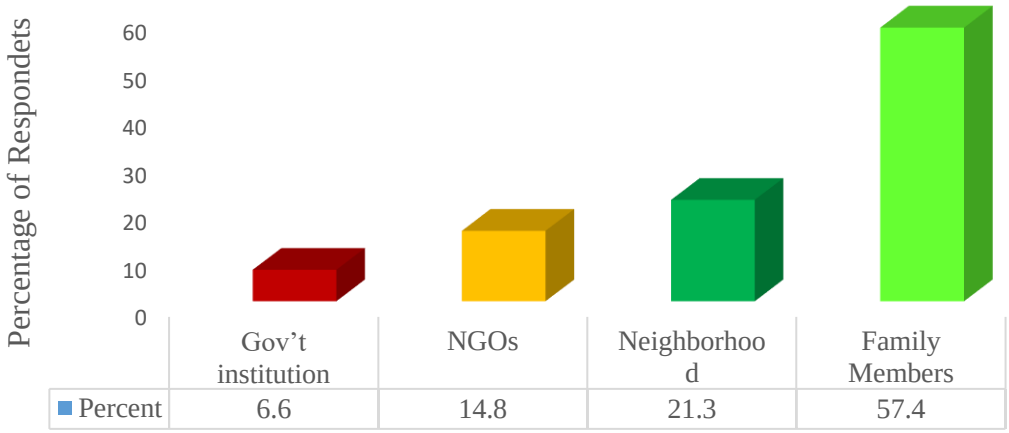

Figure 4.3: **Distribution of Household Institutional Support**
Source. Field Survey, 2017

4.5 Effect of Climate Variability on Major Crop Production in the Study Area

Climate is fundamental in the growth of cereals and cash crops. Correlation between climate elements and major crop production (cereals and cash crops) in the study area was analyzed using XLSTAT version 2014 (Pearson correlation). The results revealed that climate elements (mean rainfall, maximum temperature, minimum temperature, relative humidity) have substantial effects on the production of cereal and cash crops in the study area. These findings corroborate with Adamgbe & Ujoh (2013), Yamusa *et al.* (2015) and Ali *et al.* (2017) that variability in climate change presents a major challenge to cereal crop production and rural livelihoods as rural farmers depend on agriculture for food production. Crop production is directly influenced by precipitation and temperature. Precipitation determines the availability of freshwater and the level of soil moisture, which are critical inputs for crop growth.

Table 4.2: Correlation between Climate Elements and Major Crop Production

FOOD CROPS	Mean Rainfall	Maximum Temperature	Minimum Temperature	Relative Humidity
	r	r	r	r
Early Millet	-0.04	0.03	0.06	0.49
Late Millet	0.27	0.69	0.04	-0.84**
Sorghum	0.62	-0.21	0.15	0.26
Maize	0.28	0.88**	0.21	-0.69
Rice	0.71	0.54	0.42	-0.68
"Findo"	0.57	0.27	0.07	-0.40
Ground nut	0.84**	0.46	0.77*	-0.50
Sesame	0.16	0.65	0.11	-0.95***
Cereal crops	**0.74***	**0.59**	**0.39**	**-0.46**
Cash Crops	**0.81****	**0.50**	**0.74**	**-0.57**

*The association between each food crop production and climate variable is computed using Pearson correlation and the significance level are denoted as follows:***1% ,**5% and *10%*

Sources: Department of Planning, 2017

From the findings, the correlation between early millet and rainfall was (-0.04) indicating that rainfall have negative effects on the production and productivity of early millet. Furthermore, the results have shown that rainfall have significant positive effect on groundnut production. The correlation between rainfall and groundnut was (0.84**), showing that the yields of groundnuts are likely to increase as rainfall increases. It is evident from the correlation matrix that both cash crops (0.74*) and cereal crops (0.81**) respectively have strong correlation with rainfall in that the yields of these crops depend on the amount of rainfall received. Although data from the meteorological records have indicated that rainfall has been fluctuating, late onset and early cessation of rainfall as reported by respondents have contributed to the variation of yields of cereals and cash crops per season. The results further revealed that the correlation between maize and maximum temperature was (0.88**) showing that maize yields are likely to increase with the increasing maximum temperatures. This shows that every cultivar responds negatively or positively to a certain threshold throughout its growth stage.

Moreover, the results also pointed out that there is a significant correlation between late millet and relative humidity (-0.84**), indicating that relative humidity can increase the yield of late millet. This is clear that efforts to sustain household food security are suffering from serious challenges of agricultural vulnerability to climate change. The negative impacts of climate change such as increase in temperature and variation in rainfall are expected to lower the benefits for production of the agricultural sector, thus threaten household food security status.

4.6 Household Food Storage Systems

The findings indicated that a large proportion (97%) of the respondents have food storage while only 2.3% of the respondents do not have food storage. The assumption is that those who do not have food stores do not practice cropping as their main sources of livelihood.

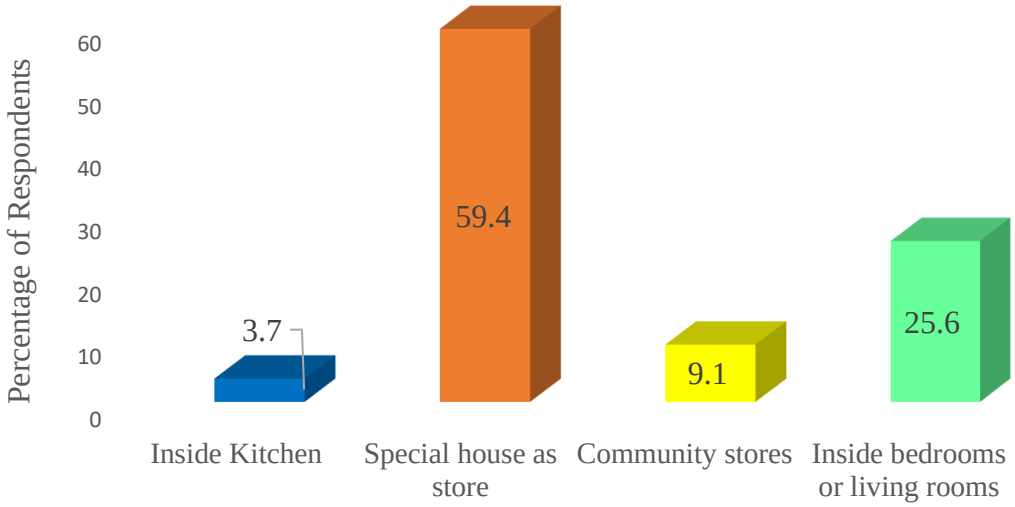

Figure 4.4: Distribution of Household Food Storage Systems

Source. Field Survey, 2017

Appropriate food storage plays a very important role in maintaining household food security. Food processing (value chain addition) and storage of agricultural produce in rural Gambia has been a priority of government and other existing agricultural projects to enhance sustainable household food security. As alluded by the respondents, before, government supported rural communities with storage houses to alleviate poverty and to enhance household food safety and availability. But due to poor sustainability and coordination strategies, dilapidated storage facilities lack regular maintenance which obliged the farming communities to store their farm

produce in their traditional ways such as storing the inside kitchen or inside the living rooms which is not sustainable and reliable.

Only few government storage houses were in good conditions. This can be seen from the results that only 9.1% of the respondents stored their foods items in community storage facilities and 25.6% of the survey respondents stored their food stuffs inside their living rooms or bedrooms. Only a few proportion 3.7% of respondents stored their food items inside a kitchen. However, cultural activities also triggered farmers to store their farm produce within the household. This will enable them to have an easy access to the farm produce whenever needed compared to the community storage house where immediate accessibility will be a challenge. The data indicated that 59.4% of the respondent have special houses as stores. However, adequate storage facilities are very important in determining the durability and availability of the stored food when needed.

4.7 Seasonality of Household Food Insecurity in the Last 5 Years

From the analysis, a large proportion (93%) of the respondents lamented that they faced food shortage in the last five years while 7% said they have not faced food shortage in the last five years. As buttressed respondent during FGD, household food shortage have a variety of causes. Among the contributing factors, seasonal variations and climate extremes such as flood and drought, lack of farm inputs among others, are leading factors to household food scarcity. As a coping and adaptation mechanism, households have to indulge into various activities such as sales of household assets, sales of firewood and/or rely from remittance or assistance from family members to complement the food requirements of the household.

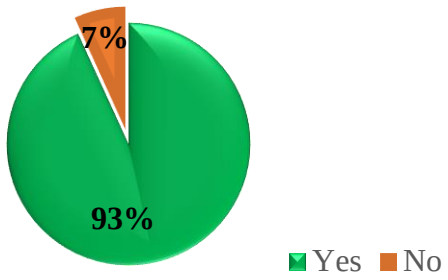

Figure 4.5: Proportions of Households that Experienced Food Shortage in the Last 5 Years

Source. Field Survey 2017

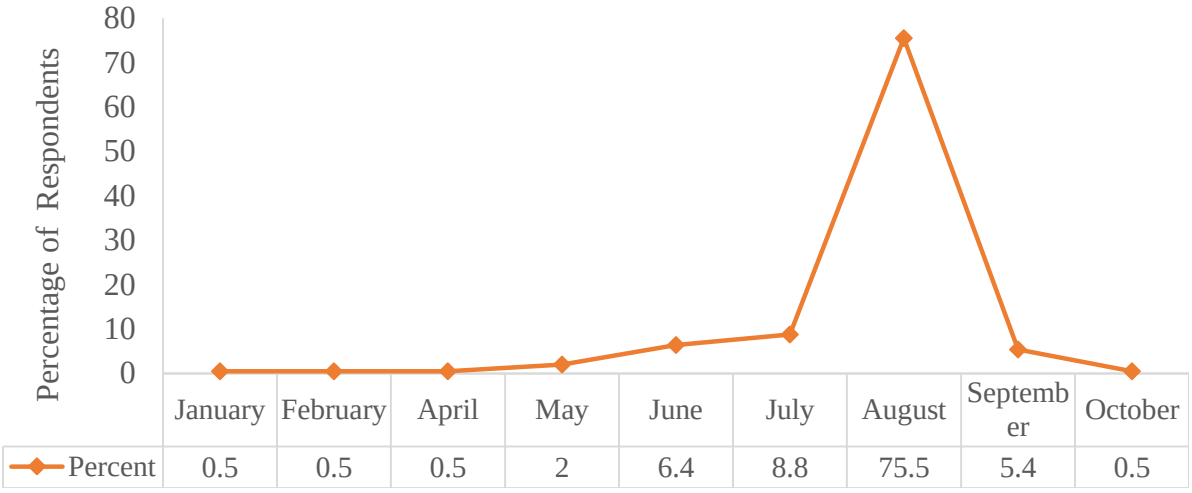

Figure 4.6. Time (Month) of the Year that Households Mostly Experienced Food Shortage

Source: Field Survey 2017

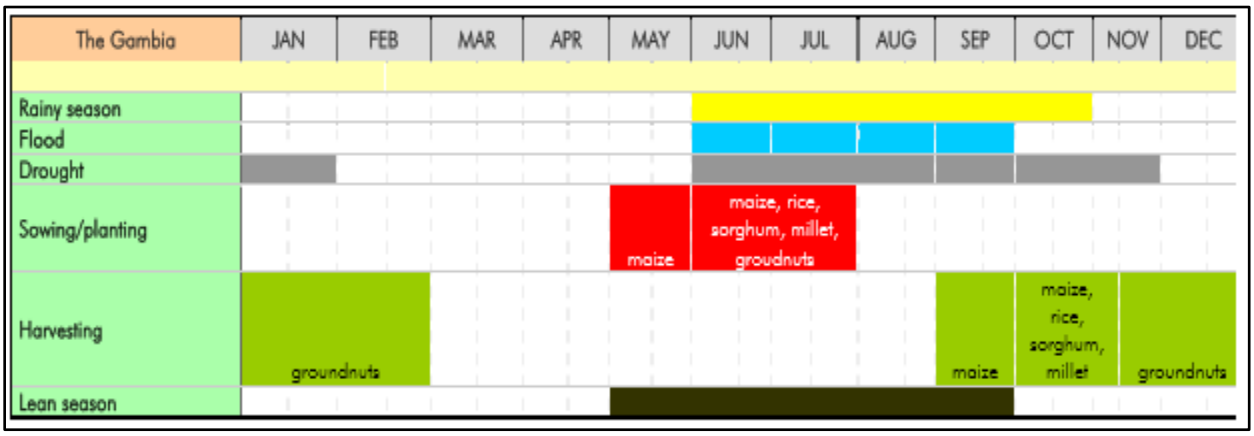

Figure 4.7 Agricultural Cropping (seasonal) Calendar in The Gambia

Source: http://www.hewsweb.org/hazcal/

Food shortage in The Gambia is seasonal in both urban and rural areas. The findings obtained from the study area exposed that August (the peak of the rainy season) is the most difficult month for households to provide food requirements for their members. The results highlighted that the majority (75.5%) of the respondents usually face food shortage in August. This finding is similar to the results of a Comprehensive Food Security and Vulnerability Analysis (CFSVA) conducted by WFP 2015. However, the severity depends on the level of household coping and resilient power. In addition, households begin to face challenges of food shortage from June while August records the peak of challenges.

This is evident taking into consideration the agricultural cropping calendar. It can be observed that most farmers begin sowing/planting of cereal or food crops from May to July and harvesting of some cereal crops starts from September. This is further supported by information gathered during Focus group discussion that the most difficult periods/month in terms of getting enough food correspond to the lean season period – spanning May to September. During this period, households do not have sufficient food stocks to rely on.

The findings further established that a larger proportion of households are subsistence farmers and that household's food production is not enough to cater the household food needs throughout the year. Moreover, food prices at the markets at this period are high because demand increases while supply remains low and most households do not have additional funds to purchase food items at that price. Food shortage can contribute to health complications such as malnutrition and diseases, especially to lactating mothers, old and children, particularly low household income earners who are already vulnerable to food insecurity.

4.8 Household Coping Strategies to Food Shortage

In The Gambia, strategies to cope during food shortage are diverse. It could be noted that coping strategies to food shortage needs a careful decision in order to minimize further threats. This was further lamented during FGD where majority of the households reported that they combined two or more coping strategies within the same period of food shortage. In order to understand how household cope in responding to food shortage, respondents were asked to identify from the list provided, the most common combination of strategies adapted by household to cope in case of food shortage periods;

- rely on less preferred and cheaper foods
- borrow food, or rely on help from a friend or relative
- limit meal sizes
- restrict consumption by adults in order for small children to eat
- reduce number of meals eaten in a day
- reduce the number of people eating at home (e.g. sending a child to eat with relatives or friends)
- sales of household assets.

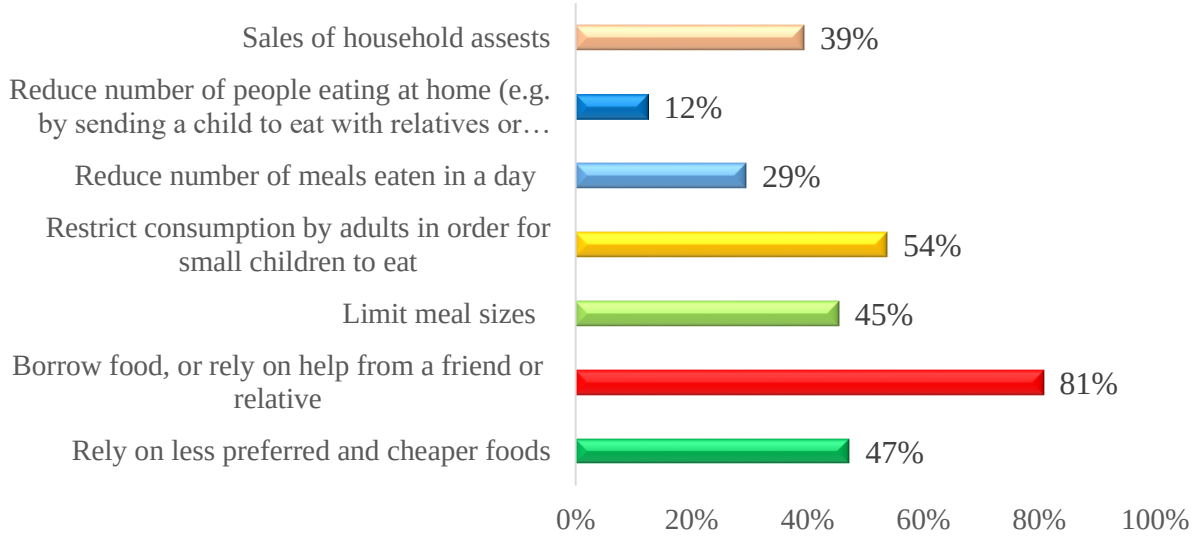

Figure 4.8: Proportion of Households Coping Strategies during Food Shortage

(**multiple response to household coping strategies)

Source. Field Survey, 2017

The findings have revealed that households are engaged in multiple coping strategies to food shortage. Among household surveyed in the study area, the coping strategy most prevalent is borrow food, or rely on help from a friends or relatives which represent 81% of respondents. One of the main reasons as expressed during the household interview and FGD is that they borrow money to cover food need, health expenses and pay school fees. In addition, 47% of the respondents also alluded that they rely on less preferred and cheaper foods as a coping strategy during food shortage. This means that households consumed food items that are not expensive such as forest foods among others. Meanwhile 39% of the respondents reported that as a coping strategy, they sell their household assets such as jewelries, assets and other household materials while 54% stated that they restrict food consumption by elders to allow the younger ones, elderly, and the less immune people to eat.

The findings further revealed that 29% of the respondents reduce the number of meals eaten in a day while 12% of the respondents reported that they reduce the number of people eating at home by sending them to relatives or neighbors. The results also highlighted that a good proportion (45 %) of respondents reported that as coping strategies, most households limit meal sizes consumed

in a day. This implies that households that consume, for instance, 5kg per three square meals per day are compelled to reduce to 3kg per three square meals per day. Reducing the number of meals eaten in a day on the other hand implies that households that consume three-square meals per day are compelled to reduce to two or one meal per day as a way of coping strategy during food shortage.

4.9 Observed Changes in Climate Factors and Climate Change Awareness

Respondents were asked about perceived changes in climate factors. The findings revealed that overwhelming proportion (98.6%) of the respondents said that they have percieved changes in climate factors such as rainfall, temperature and wind respectively while only 1.4% of the respondents argued that they have not perceived changes in climate factors for the same period.

Furthermore, the concept of climate change was perceived differently by respondents in the surveyed area. Analysed data differentiated the level of understanding of the term "climate change" in the study area. The results show that an overwhelming proportion (93.6%) of respondents were aware of climate change while 6.4% of the respondent argued that they are not aware of climate change. This study corroborate with the previous study conducted by Kutir *et al.* (2015) in which 80.6% of respondent in the north Bank region of The Gambia are aware of climate change. The limited knowledge about climate to respondents could be attributed to their inability to access scientific information on climate change which could also be attributed to inadequate number of extension workers, lack of radio/mass media and inadequate engagement in community base organization (Onyeneke and Madukwe, 2008). This may hamper their ability to adapt to clime change thus leading them to poor agricultural harvest.

Table 4.3: Climate Change Perception and Awareness

Variable	frequency	Percentage (%)
Observed changes in climate factors: *Rainfall, wind etc.*		
Yes	216	98.6
No	3	1.4
Climate Change Awareness		
Yes	205	93.6
No	14	6.4

Source: Field Survey, 2017

4.10 Perceived Causes of Climate Change

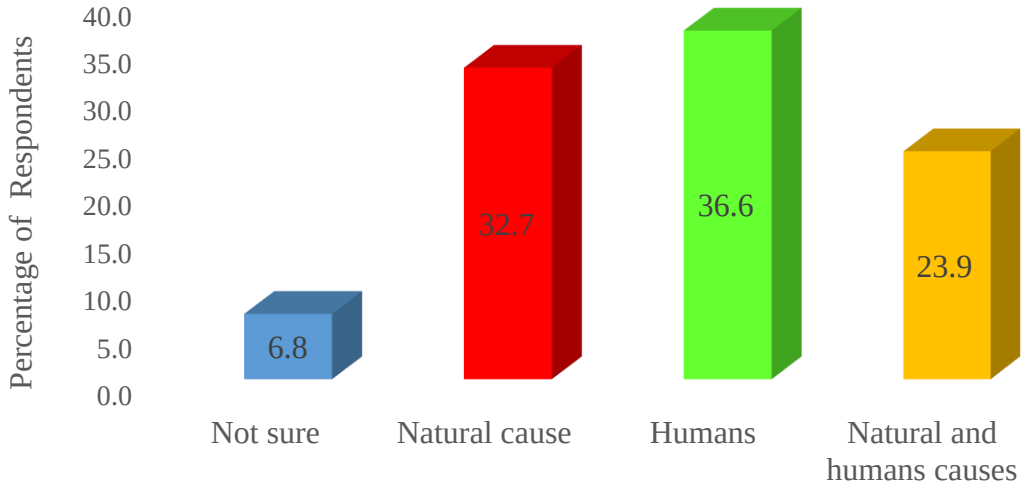

Figure 4.9: **Distribution of Household Perceived Causes of Climate Change**

Source: Field Survey, 2017

When asked about perceived causes of climate change, the findings revealed that 36.6% of the respondent attributed the causes of climate change to human activities while 23.9% and 32.7% of the respondent attributed it to natural and human causes respectively. This argument is further supported during FGD, where most of the respondent attributed continuous deforestation and bushfires as the main human activities contributing to climate change. Other respondent during the FGD linked climate change to the violation of our local customs. This is common in rural areas where customs, cultures are well observed and practice. This research corroborate the findings of Ozor N. *et al.* (2015) on the perceived impacts of climate change among rural farmers in Imo State, Nigeria where farmers attribute any disaster or calamity in the environment to the anger of "***GOD.***"

4.11 Preferred Sources of Climate Information

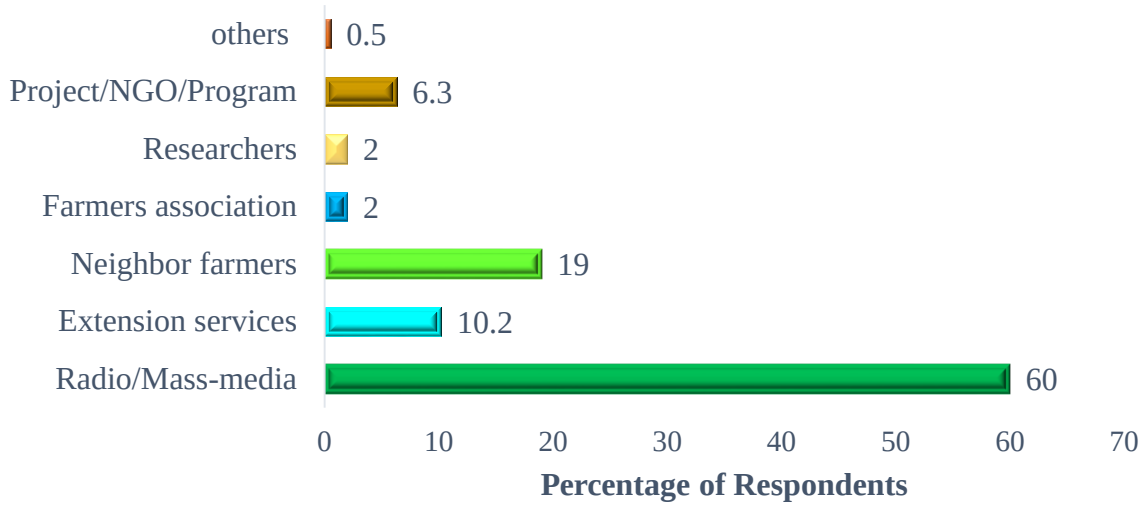

Figure 4.10: Distribution of Preferred Sources of Climate Information

Source: Field Survey, 2017

Responding to climate change information, both household interview and FGD disclosed that they have diverse sources of climate information. From the results, 60.0% of the respondents preferred Radio/Mass-media broadcast as their main source of climate change information. The justification for their preference was that they have confidence and trust in the climate change information from the radio broadcast because experts discuss on the radio. Others also indicated that, radio broadcast was their only reliable source of climate change information and for its capacity to reach illiterate farmers with matters associated to crop production in a comprehensible language.

This finding corroborated with the findings of Churi *et al.* (2012) in which the majority of the farmers preferred radio broadcast as their source of climate and agricultural market information. In addition, neighbor farmers was another preferred source of climate change, representing 19.0% of the respondents. The farmers who preferred extension service which represent 10.2% dilated the reason that the extension workers are government appointed, trained, and knowledgeable people with the responsibility to educate, train and advise farmers on farming and climate issues and help them address the challenges.

Moreover, those who preferred information and training from their neighbour farmers manifested that they are closer to their colleague farmers and can easily get information on climate change and crop production without wasting of time. The poor ration of farmer-extension services is the main contributing factor for which farmers prefer their neighbor farmers to discuss their farming activities and challenges than waiting for extension workers. The results also indicated that 6.3% of the respondents gain climate information from Agricultural projects and NGOs such as Action Aid The Gambia. This shows a substantial participation of projects and NGOs in educating farmers about climate change. Farmer association 2.0% and researchers 2.0% respectively indicated a little interaction and integration among farmers and researchers. The least preferred source of climate change information for the study was (***Bantabas/Ghetos***) representing 0.5%. These are social camping where households, neighbors can meet and share freely their challenges on daily or regular basis. This could be attributed to the fact that information from these social gathering lack credential and most of them can be fake news and as such, can be misleading.

4.12 Trends and Changes Observed in Rainfall Distribution in the Study Area

4.12.1 Rainfall Trend of the Study Area

Figure 4.12.1 below is a graphical representation of seasonal distribution of rainfall for four rain-gauge stations in the study area. Upon plotting the linear trend line $R^2 = 0.2807$, the statistics were almost similar to the precipitation trends found by the Mann–Kendall test with a P=0.0030 and Kendall Tau of 0.3429 respectively.

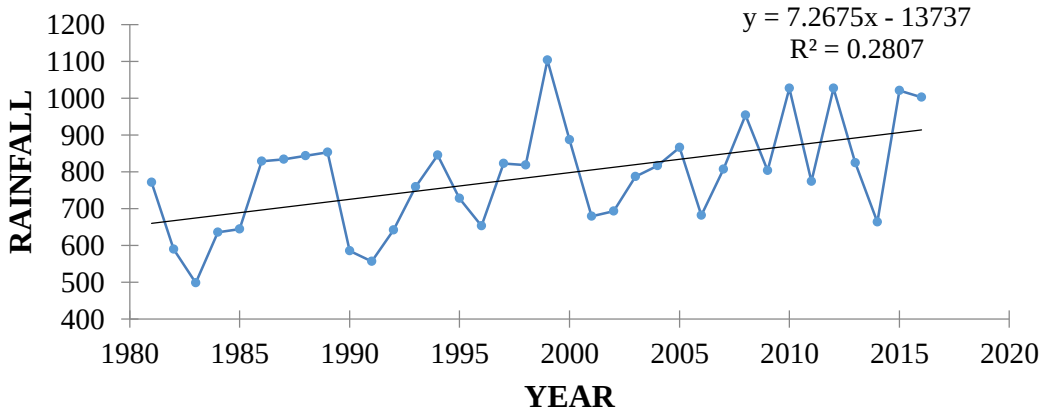

Figure 4.12.1 Distribution of Rainfall in the Study Area

Sources. Department of Water Resources, 2017

Table 4.4: Results of the Mann-Kendall Test for Precipitation in the Study Area

District	Mann-Kendall statistic(S)	Kendall Tau	Var (S)	p-value (two tailed test)	alpha	Test Interpretation
CRR/S	216.0000	0.3429	0.0000	0.0030	0.05	Reject H0

On running the Mann-Kendall test on precipitation data, the statistical were obtained as shown in Table 4.4 above. The Mann-Kendal statistic test results indicated that there is an increasing precipitation trend series with P=value of 0.003 and a Kendal Tau =0.3429 in the study area. If the p value is less than the significance level α (alpha) = 0.05, H0 is rejected. Rejecting H0 indicates that there is a trend in the time series, while accepting H0 indicates no trend was detected. On rejecting the null hypothesis, the result is said to be statistically significant.

The data show a significant positive trend in the year 1999, recording high rainfall. The data further indicates that there was a decrease in rainfall pattern from 1982-1983 and also a sharp drop in rainfall was recorded in 2006, 2011 and 2014 respectively. The result is strongly in line with the erratic rainfalls pronounced in 2006, 2011 cropping season which had significantly affected the development of animals and crop yields across the country.

Variation in annual rainfall has been strongly associated with poor yields, leading to high number of people facing food shortages, thus need assistance to complement food requirements. In addition, this fluctuations in rainfall patterns can cause serious implications for crop/animal production, thereby contributing to food insecurity as lamented by most of the respondents.

4.12.2 Household Perceived Rainfall Distribution

Responding to onset and cessation of rainfall, a large proportion (68.9%) of the respondents mentioned that they have observed late onset early cessation while 16.0% mentioned that they have observed early onset early cessation of rainfall pattern for the past 5 years. In addition, Ozor, N.*et al.* (2015) citing Warren *at al.* 2006 projected that changes in climate factors such as temperatures, rainfall onset and cessation etc. will reduce the production and yields of certain major crops like Maize in southern western Africa, which have severe consequences on household food security. Furthermore, Ensor (2009) also alluded that climate change will induce

negative impacts on agricultural production by increasing the risk of exposure to new pest and diseases variants. Educating farmers on the impacts and adaptation to climate change will, therefore enable them prepare and develop new technologies that will reduce household vulnerability to food insecurity.

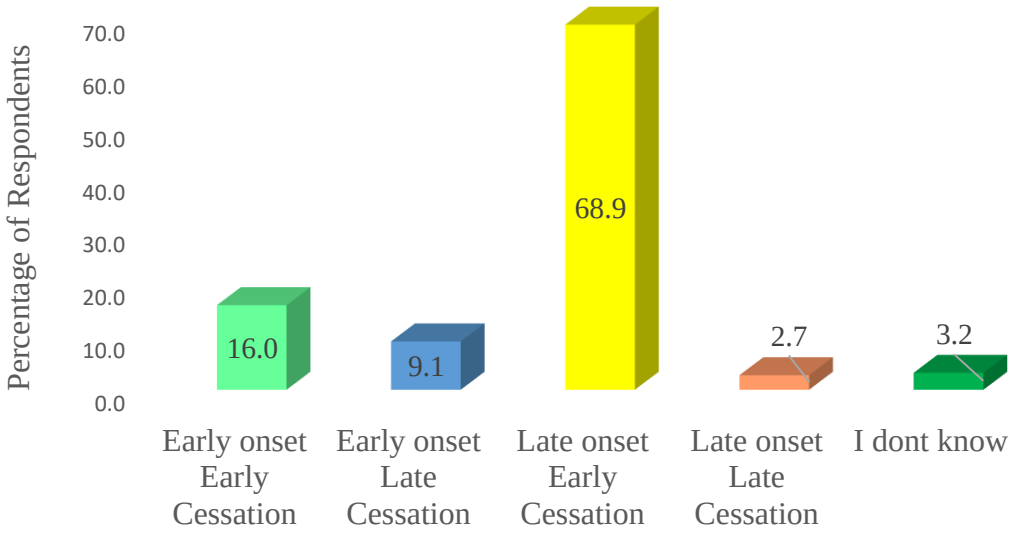

Figure 4.12.2 Proportion of Household Perceived Rainfall Distribution

Source. Field Survey, 2017

4.13 Trends and Changes Observed in Temperature Distribution in the Study Area

4.13.1 Temperature Trend in the Study Area

Figure 4.13.1 below shows a graphical representation of mean temperature recorded in the study area. On plotting the linear trend line, the following results were obtained with $R^2 = 0.0576$.

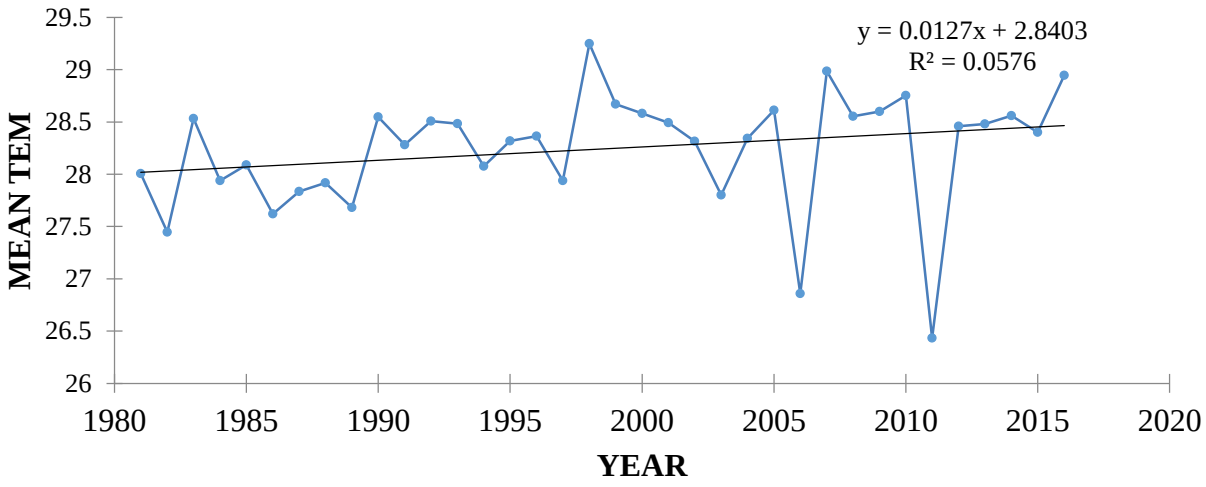

Figure 4.13.1: Trend of mean Temperature in Study Area

Sources: Department of Water Resources, (2017)

Table 4.5: Results of the Mann-Kendall Test for Temperature in the Study Area

District	Mann-Kendall statistic(S)	Kendall Tau	p-value (two tailed test)	alpha	Test Interpretation
CRR/S	12.0000	0.3333	0.1801	0.05	Reject H0

On running the Mann-Kendall test on temperature data, the statistical results were obtained as shown in Table 4.5 above. The Mann-Kendal statistic test results indicated that there is an increasing temperature trend series with P=value of 0.1801 and a Kendal Tau =0.33 in the study area. However, if the p value is less than the significance level α (alpha) = 0.05, H0 is rejected. Rejecting H0 indicates that there is a trend in the time series, while accepting H0 indicates no trend was detected. On rejecting the null hypothesis, the result is said to be statistically significant.

4.13.2 Household Perceived Temperature Distribution

When respondents were asked about changes in temperature over the past 5 years, 96.3% of the respondents perceived an increased in temperature over the past 5 years while 3.7% stated that they are not clearly sure of the changes in temperature. This findings corroborate the studies conducted by Oruonye (2014) in Taraba state of Nigeria and Adebayo (2012) in Adamawa State, Nigeria, where farmers perceived an increase in temperature in Taraba and Adamawa state

of Nigeria. During the FGD, the respondents further illustrated that yearly temperature had been increasing for the past 5 years with each succeeding year having a slightly higher temperatures due to continuous deforestation and bush fires. Temperature is a clear variable perceived by farmers which also correspond to meteorological record showing an increase in temperature. This, they said have repercussion on the maturing period of crops and reduced grain production as the effects of increased temperature on their crop yields.

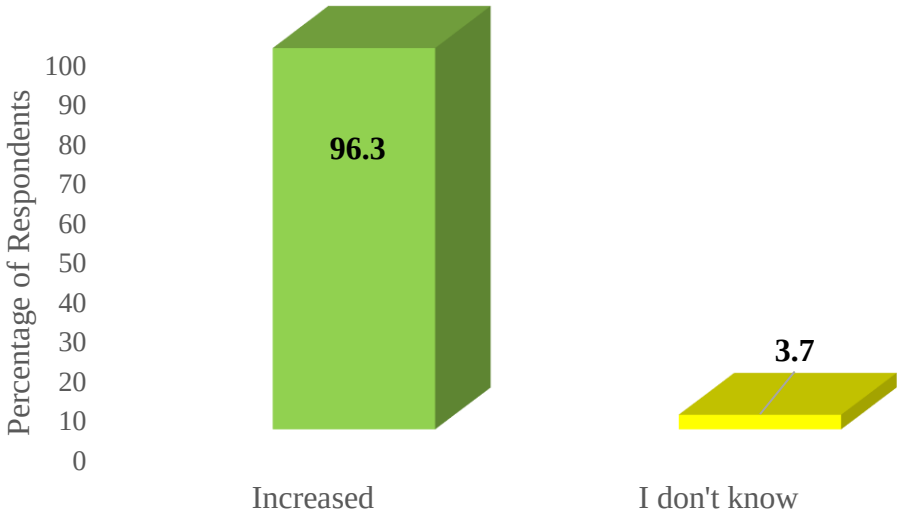

Figure 4.14: Proportion of Household Perceived Changes in Temperature
Source. Field Survey, 2017

4.14 Factors Affecting Household Food Security in the Study Area

Factors affecting household food security status are complex and multidimensional. There are no universal causes of food insecurity but the phenomenon vary from country and cultures and from one household to individual, depending on their coping strategies. Several factors are responsible for household food insecurity in The Gambia. This was clear during the survey that factors such as climate change and the socio-economic characteristics of the household are crucial in determining household food security.

In this study, logistic regression model was applied to examine the effect of various independent variables (education (ED), household size (HS), age (A), household income (HI), household asset (HA), economic activities (EA), land ownership(LO), assistance (AS), remittances (RM),

access to market (AM), access to credit (AC) on dependent variable (Food Security Status (FS). The food security status was modeled as a binary response variable where 1 = food secure and 0 = not secure. The overall predictive power of the model was good, indicating that dependent variables had significant impact in explaining the food security status. The independent variables which were found significant were household income, household assets, household economic activities, assistance and remittance. Age, land ownership, access to market and credit including food aid were also found positive but not significant.

Each of the regression coefficients describes the size of the contribution of that factor to the securing household food status. In other words, the coefficients illustrates how much the logit changes are based on the values of the predictor variables. A positive regression coefficient means that the explanatory variable increases the probability of the outcome, while a negative regression coefficient means that the variable decreases the probability of that outcome. Furthermore, a large regression coefficient means that the factor strongly influences the probability of that outcome, while a near-zero regression coefficient means that the factor has little influence on the probability of that outcome. In this regression model, the Maximum Likelihood Method was used to estimate all the parameters using the STATA (Version 14.0) computer programme where model appropriateness was analyzed through the chi-square test.

Table 4.6 Logistic Regression Coefficient Showing the Factors Influencing the Household Food Security Status

Food Security Status	Coef.	Std. Err.	Z	P-value
Education	1.116957	.9102449	1.23	0.220
Household Size	-.0272264	.054765	-0.50	0.619
Age	.0433891	.0267083	1.62	0.104
Household Income	.0001868*	.0001031	1.81	0.070
Household Asset	.0403017**	.0197466	2.04	0.041
Economic Activity	-2.272404***	.859962	-2.64	0.008
Land Ownership	.5826386	1.157704	0.50	0.615
Assistance	-1.934729**	.9704878	-1.99	0.046
Remittance	2.29223***	.8067339	2.84	0.004
Access to Market	.4612084	.6913773	0.67	0.505
Access to Credit	.1758985	.424602	0.41	0.679
Food Aid	1.168522	1.218525	0.96	0.338

*The significance level are denoted as follows: ***1%, **5% and *10%*
Source: Field Survey, 2017

The logistic regression model results indicated that household income and household economic activities (crop production, livestock rearing and petty trading) were found positively significant with a (P =0.070*) and (P = 0.008***) respectively. This illustrated that household with high income earnings are more likely to have a higher purchasing power and are more likely to be food secured than household with low income earning while household who grow crops are more likely to be food secured than those who do not grow crops.

Household size is another factor expected to influence household food security status. It can be noted that the larger family size is more likely to be food unsecured than small household size.

Household assets were found significant in influencing household food security status. Assets in this case comprises (car, motorbikes, carts, mobile phones, wheelbarrow, television set, radio/tape generator/solar). The model revealed that the effect of household asset on food

security status was found significant with (P = 0.041**). This demonstrated that household having assets were more likely to be food secured compared to non-assets holders.

Remittances was found positively significant (P = 0.004***) while assistance was found significant with (P = 0.046**). It is evident in the study area that people, receiving assistance or remittances, were more likely to be food secured than those who are not receiving assistance or remittance. Those household who receive remittances are more likely to increase their purchasing power of food varieties and are also more likely to be food secured, while household who do not receive remittances are less likely to be food secured. Assistance and remittances are considered an important source of additional earnings that can support and enhance household food security.

The results from the model indicated that education (Madrassa or English) has a positive influence on household food security status though not significant with (P = 0.220). This implies that the more educated a household head is, the more likely food secured the household would be compared to the less educated household. The findings corroborate with the research conducted by Asghar and Muhammad, *(2013)* which substantiated that education played a key role in enhancing household food security status.

Moreover, land ownership is also another variable in determining household food security. The model indicated that land ownership was positive although not significant with (P = 0.615). This depicts that household who own land are likely to be more food secured than household with no land ownership. Land ownership will allow household to have access to land and can sell the land or rent to enhance household food security status.

Access to market and credit were also found positive although not significant with (P =0.505) and (P=0.679) respectively. This finding implies that households who have access to market are likely to have access to food and are likely to be food secured than those household who do not have access to market.

CHAPTER FIVE

CONCLUSION AND POLICY RECOMMENDATION

5.1 Summary

The research was meant to contribute to the body of knowledge about effects of climate variability on household food security among rural farmers in Central River Region-South of The Gambia. The study was conducted in the Central River-South Region of The Gambia. The aim of the study was to examine the effects of climate variability on household food security among rural farmers in Central River Region South of The Gambia.

The specific objectives were first, to identify the main source of food within the households. The second objective examined the variability and trends of climate elements in the study area and the third objective aimed to examine the effects of climate variability on household food availability in the Central River Region-South. The fourth objective was to examined the factors affecting food security status among rural households and the last objective was to identified the coping mechanisms adopted by households in case of food shortages in the study area as outlined in chapter one. In order to achieve the stated objectives, the study reviewed literature on climate change and household food security issues.

The literature reviewed relevant related literature on the concept of climate change and food security. It looked at the concept of food security among others. It equally discussed climate change and household food vulnerability. The chapter further illustrate household food production and food insecurity in The Gambia. It also considered household coping mechanisms to food insecurity and theoretical framework used in this research work among other issues.

Descriptive design method was adopted for the study. The target population were household heads, mainly farmers in the Central River Region-South. Two hundred and nineteen (219) household heads, one retired extension worker and a principal education Office from Sankulah Kunda village, were selected from the nine selected communities by means of simple random and purposive sampling procedures. Questionnaires were developed and pre-tested as instruments to establish their reliability and validity before being used for data collection from respondents.

The statistical packages SPSS (version 23), STATA (version 14.0), XLSTAT 2014 and Microsoft excel (version 2013) were used to analyze the data. Results of the study were presented in a form of both descriptive and inferential statistics such as minimum, maximum, summations, means, and percentage among others. These were summarized in figures, charts and tables. Logistic regression model was used to analyze factors influencing household food status in the study area while Mann-Kendal statistical test was used to examine the trend of climate factors—rainfall and temperature in the study area.

CONCLUSIONS AND RECOMMENDATIONS

5.1 Major Findings

The major findings for the study are discussed below:

1. Findings from the first objective which is to identify the main source of food within the households in the Central River Region-South stated that majority of the farmers representing 90%, depend on their own production as the main source of livelihood while 10% expressed that they depend on food purchase as their main sources of livelihood.
2. The second objective was to examine the variability and trends of climate elements in the study area. Most of the respondents lamented that they perceived increase in climate factor (rainfall and temperature) in the last past 5 years. A large proportion (96.3%) of the respondents affirmed that they have observed an increase in temperature while only 3.7% of the respondents explained that they have not observed any changes in temperature for the past 5 years.
3. On the effects of climate variability on household food availability in the Central River Region-South, findings have revealed climate factors such as rainfall, minimum and maximum temperatures and relative humidity have effects on cereal crops with a coef. of (0.74*) and cash crop (0.81**). This shows that any major fluctuation on these factors will affect the yields of cereal and cash crops, thus affecting household food security.
4. Concerning the factors that influence food security status among rural households in the study area, the logistic regression model has shown that factors that affect household food security are complex and multidimensional. The results from the model indicated that

household size, education, household income among many factors, are among the factors contributing to household food security in the study area.

5. To identify the coping mechanisms adopted by households in case of food shortages, it can be realized that most households employed a combination of more than one coping mechanism. The prominent coping mechanism adapted by household is borrow food, or rely on help from a friends or relatives representing (81%) of the respondents.

5.3 Conclusion

Inferring from the major finding above it can be concluded that:

As outlined in the major findings, the majority of households in Central River Region-South of The Gambia largely depend on their own production to secure food for livelihood. They are also net purchasers of food items. It can therefore be concluded that household own food production is insufficient to sustain the food needs of the family.

It can also be concluded that households, through personal observations and experiences, have adequate knowledge on the changes and effects of climate factors—rainfall and temperature—on their food production and household livelihood status. Household perception on temperature was in line with meteorological records and Mann-Kendall trend analysis results while there was a contradiction between farmers' perception on rainfall and the meteorological data for the past 30 years.

Correlation matrix between climate elements and major crops (Cereal and Cash crops) production have indicated that climate factors have consequences on cereal and cash crops production. Therefore, it can be concluded that variations in climate factors have repercussions on crop and livestock production, thus affecting household food insecurity status.

From the logistic regression model, it can be concluded that the most critical factors that influence household food status among others include; climate change, access to credit, household economic activity etc. These factors have adversely affected the ability of household to adequately address household food status.

Coping strategies to food insecurity vary from household to household. However, it can be concluded that the majority of household used a combination of coping strategies. The most prevalent among the coping strategies is borrow food or rely on help from a friend or relative representing 81%.

5.4 Policy Recommendations

The household food security status could be improved through so many ways. However, based on the findings of the study concluded above, the following recommendations were drawn:

1. Households can meet their food demand and be food secured by diversifying their farming practices such as growing other non-traditional food crops.
2. The study also recommend that Government and other stakeholders/actors need to clearly outline climate change adaptation needs such as dry season irrigated farming systems, especially for small holder farmers who depend on rain-fed for livelihood.
3. Government should help to establish cereal banks that would enhance the coping mechanisms toward food availability throughout the year.
4. Government, Non-Governmental Organizations and existing Agricultural projects should facilitate easy access to micro-credit and farmer insurance systems where they can easily recover from any climate-induced food shocks.

5.5 Suggestions for Further Research

The following further researches are suggested based on the findings of the study on household food security

- A comparative study in relation to food security could be done covering both harvest and post-harvest seasons in the study area.
- A similar study could be conducted covering climate variability in different agro ecological zones of The Gambia.
- Similar studies on how farmer insurance can enhance farmer resilience to climate change and increase household food security.

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APPENDICES
APPENDIX 1

EFFECTS OF CLIMATE VARIABILITY ON HOUSEHOLD FOOD SECURITY AMONG RURAL FARMERS IN CENTRAL RIVER REGION-SOUTH OF THE GAMBIA

SURVEY INSTRUMEN. HOUSEHOLD QUESTIONNAIRE

Research Student: Mr. Badjie Momodou

Consent: My name is (interviewer)
Name……...

Thank you very much for the time and Participation. I am a student at Université de Lomé undergoing a Masters Research Programme on Climate change and Human security. I am conducting a research on ***"EFFECTS OF CLIMATE VARIABILITY ON HOUSEHOLD FOOD SECURITY AMONG RURAL FARMERS IN CENTRAL RIVER REGION-SOUTH OF THE GAMBIA."*** The interview will take 45 - 60 minutes. The information will be used for academic purpose only. The participation is voluntary. Your views and personal details will remain strictly confidential. Can we start now?

Date: |__|__| / |__|__| /|__|__||__|__|
Day Month Year

Section A:- General Information about the Community

A1. L.G.A: ----------

A2. District Name: ……..…

A3.Village Name:

1. Kumbaney Buniadu [ ]
2. Sambang Mandinka Kunda [ ]
3. Katamina [ ]
4. Sambel Kunda [ ]
5. Sotokoi [ ]
6. KerewanTouray [ ]
7. SinchuMagai (Mara Magai) [ ]
8. Medina CeesayKunda [ ]
9. SankulehKunda [ ]

A4. Geographical coordinates

X (long)----------

Y (lat) ----------

SECTION B HOUSEHOLD CHARACTERISTICS

Household ethnicity(s):……

Household listing (continue with a different sheet if household members are more than 15)

No	Name (starting with Household head)	Sex*	Age	Educ. Level**	Marital status***	Employment Type (7 years and above)	
						Main	Secondary[i]
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							

*** sex*1***. *Male 2. Female*

****Educational level**: *0.Never attended school 1. LBS/Madrasa 2.UBS/Madrasa 3.Secondary 4. Tertiary*

*****Marital Status:** *1. Single 2.Married monogamous 3. Married polygamous 4.Widowed 5.Divorcee*

******Employment type:** *1. Crop production 2. Livestock rearing 3. Petty trading 4. Fishing/hunting 5. Handicraft 6. Hired labourer 7. Driver 8.student 99. Others (specify):* ----------

HOUSEHOLD ASSETS

HP: Physical Assets

Questions

HPQ1. What is the roof and walls of your house made off?

1. Corrugate and cement blocks [ ]
2. Corrugate and mud [ ]
3. Mud and thatch roof [ ]

4 .Other Specify ……..

HPQ2. How many of these assets do the household members have?

ASSETS	NUMBER (*record 00 if none)*
Cars	
Motorbikes	
Bicycles	
Carts	
Mobile phones	
Wheelbarrow	
Television set	
Satellite	
Radio/tape	
Generator/solar system	
Others specify (exclude farming implements)	

HPQ3. Does this household have access to electricity?

1 Yes [ ]
2 No[ ]

HPQ4. Does this household have access to toilet facilities?

1 Yes [ ]
2 No[ ]

HPQ5. What is the main economic activity in this Household?

1. Crop production [ ] 2. Livestock rearing [ ] 3. Petty trading [ ] 4. Fishing/hunting [ ]
5. Handicraft [ ] 6. Casual works [ ] 7. Driving [ ] 8. Others (specify): ----------

HPQ6. What is the main source of the food your family live on?

1. Own production [ ] 2. Purchase [ ] 3. Neighbourhood assistance [ ]
5. Others Specify…….

HPQ7. Does this household have any form of food stores?

1 Yes [ ]
2 No[ ]

HPQ8. If yes to *HPQ7*, what type of food stores do you have?

1. Silos [ ] 2.inside kitchen [ ] 3.Special house as store [ ] 4. Community seed store[ ]
5. Inside bedroom or living room [ ] 6. Others specify…….

HPQ9. From the food storage system in*HPQ8*, how long can you keep your food in that storage system to

feed your HH in a year?
1:-Less than 2 months of feeding [ ] 2.-3 – 4 months of feeding [ ]
3:-5 – 8 months of feeding [ ] 4:- 8 ≥months[ ]

HPQ10. Does this Household participate in communal farming?
1 Yes [ ] 2. No [ ]. ******If no, go to HPQ12***

HPQ11a. If yes to ***HPQ10,*** does your HH benefit from the proceeds of the communal farm?
1 Yes [ ] 2. No[ ]
HPQ11b. If yes to ***HPQ11b***, what form of benefit?.....
HPQ12. Do you receive any form of assistance in the last 6months?
1 Yes[ ] No[ ] ******If no, go to HPQ15***

HPQ13.If yes to ***HPQ12***, what kind of assistance did you receive?
1. Money [ ] 2. Food items [ ] 3.Non-food items [ ] 4. Others specify

HPQ14. If yes to ***HPQ12,*** Where did you receive assistance from?
1. Gov't institution [ ] 2.NGOs [ ] 3.Neighbourhood [ ] 4. Family members [ ] 5.Others Specify……

HPQ15. Did any member of your household receive any cash loan or in-kind from the following schemes in the past 6 months?

Type of scheme	Yes = 1 No = 2	Quantity in-kind	Amount in cash
"Osusu"			
MFI /NGOs			
Government			
Farmers association			
Middlemen (Banabana)			
Shopkeepers			
Other (specify)			

HPQ16. Does your household use the following farming implements in your crop production?

Implements	1.Yes 2. No	If Yes, How?		
		Self-own	Hired	Borrowed
Sine hoes *(golo)*				
Seeders *(chumuwaro)*				
Draught animals				
Tractor/Power Tiller				
Others (specify)……				

HN: Natural Assets

Questions

HNQ1. How many members of the household grow the following crops (*pls explain dimension of hectare = 100 X 100m or 14 seeders = hectare)*[1]*(record 00 if none)*

Crop Type	Number of household members	Total area in (Ha)
Rice		
Millet/coos (early/late Millet)		
Groundnut		
Maize		
Others		

HNQ2. What % of land did the household borrow last year as a % of total farm size cultivated?

1. None [ ]
2. Less than 25% [ ]
3. 25 – 50% [ ]
4. More than 50%

HNQ3. Does the household have access to double cropping (twice) in a year?

1. Yes [ ] 2. No[ ]

HNQ4. Do you use improved crop cultivars?

1. Yes [ ] 2. No [ ]

HNQ5.If yes to *HNQ4*, which crop(s) cultivars?…….

HNQ6. If YES to *HNQ5*, above, what was/is the source?

1. NARI [ ] 2. NGOs [ ] 3. Farmers associations [ ] 4.Neighbours [ ] 5. Specify.....

HH: Human Assets

Questions

HHQ1. How many household members earn a monthly salary?…….

HHQ2. How many HH members are skilled workers?……

HHQ3. Skill types *(Tick as appropriate)*

1. Tailor [ ] 2.welding [ ] 3.driver [ ] 4.carpenter [ ] 5.mechanic [ ] 6. Mason [ ] 7.Others specify……

HHQ4. How many household members were too sick to work or go to school in the past 6 months?*(record 00 if none)*

No. of days	No. of household members
Less than a week	
One – two weeks	
More than two weeks	

[1] *Instruction to Interviewers : It is important to demonstrate the size of a hectare to the respondent to ascertain the validity of the information*

HS: Social Assets

Questions

HSQ1. Do you have household members in the following CBOs in the village or outside?

	Yes = 1 No = 2	Number of HH members
VDC		
Women's group		
NGO or MFI group		
Youth group		
WDC		
Farmers' Association		
Other group(s)		

HSQ2. For how many years have you settled in this village?
1.) Born in the village [ ] 2) less than 15 years [ ]
3) 15 - 30 years [ ] 4) More than 30 years [ ]

HF: Financial Assets

Questions

HFQ1.What is the estimated household income in a month? ……

HFQ2. Did this household receive remittances (locally and abroad) in the past six months?
1. Yes [ ] 2. No [ ]
HFQ3. Value of remittances (in cash or kind) received by the household in the last six months

1. less than D1000 [ ]
2. D1000 - D2400 [ ]
3. D2500 – D5000 [ ]
4. More than D5000 [ ]

HFQ4. Livestock in the household *(record 00 if none)*

Livestock	Number of livestock
Cattle	
Sheep	
Goat	
Poultry	
Horses	
Donkeys	
Others	

HFQ5. Do the following members of the household have a saving account in Microfinance Institutions or Bank?

	1=Yes 2. =No 3.=I don't know	Amount in MFI(D)	Amount in Bank (D)
Household head			
Spouse			
Other members			

SECTION C: FOOD SECURITY ASSESSMENT

Food Availability

Questions

FSQ1. Can you please tell us the number of bags of the following crops your household produced in the last year and your expectation this year?*(record 00 if none)*

Crop	No. of bags last year	Expecting this year
Groundnut		
Rice		
Millet/coos		
Maize		
Other (……)		

FSQ2. How many months of feeding did your farm produce for your household in the last season?

1. Less than 5 months [ ] 2. 6 – 8 months [ ] 3. 9 – 12 months [ ] 4. More than 12 months [ ]

FSQ3. Have you ever experienced food shortage in the last 5 years?

1. Yes [ ] 2. No [ ]

FSQ4. If yes to *FSQ3*, which month of the year do you regularly have food shortage to feed your household:*(Circle or tick the month)*

Jan.	Feb.	March	April	May	June	July	August	Sept	Oct.	Nov	Dec.

FSQ5. In case of food shortage in *FSQ4*, what did you do as a coping measure?

1. Borrow/loan money [ ] 2. Reduced the number of meals/quantity per day [ ] 3. Sell your household materials [ ] 4. Reduced the portion of meal size per day [ ] 5. Others Specify…….

FSQ6. How do you compare the current food availability of your household with the situation during the following periods? *(tick the appropriate box).(record 00 if none)*

Time periods	Is better	The same	worse
This time last year			
Six months ago			

FSQ7. Did any HH member work for another household in the last 6 months for payments to be used for the feeding of household or in payment of a loan used for the feeding of household?

Yes = 1 [ ]. ***If yes, how many days ……

No =2 [ ]

FSQ8. If Yes to *FSQ7* above, how often does this happen?

1. Always [ ] 2. Seldom [ ] 3. Not often[ ]

Food Accessibility

Questions

FSQ9. Did you or any household member sell any of the following farm produce in the last 12 months?

Crops	YES= 1 No = 2	No. of bags	Unit price (D)	Market sold to
Rice				
Millet				
Groundnuts				
Others				

FSQ10. Did you or any household member buy any of the following farm produce in the last 12 months?

Crops	YES = 1 No = 2	No. of bags	Unit price (D)	Source
Rice				
Millet				
Groundnuts				
Others				

FSQ11.Where do you purchase your essential food items most often?	1. Village Market [ ] 2. Shops [ ] 3. Lumo [ ] 4. Others specify……
FSQ12.How long does it take to buy food items from the market to your house?	1. Less than 15 minutes [ ] 2. 15 minutes -1 hour [ ] 3. More than 1 hour, but less than 2 hours[ ] 4. More than 2 hours, but less than half a day [ ] 5. More than half a day [ ] 6. No answer [ ]

FSQ13.Did you or any member of your Household sell any of the following livestock over the past 12 months?

Livestock	1. Yes 2. No	Amount sold in cash (D)
Cattle		
Sheep		
Goat		
Poultry		
Others (……)		

FSQ14.Did you or any member of your Household buy any of the following livestock over the past 12 months?

Livestock	1.Yes 2.No	Amount bought in cash (D)
Cattle		
Sheep		
Goat		
Poultry		
Others (……)		

FSQ15. What % of your total annual income (farm and non-farm) is used for the following in the past 6 months?

(1) Food _____%
(2) Education expenses _____%
(3) Health expenses _____%
(4) Other expenses _____%

FSQ16. What % of your food (or money used to buy food) in the past 6 months comes from the following sources?

(1) Self – produced (on-farm) _____%
(2) Self- generated (off- farm) _____%
(3) Loans (Cash or in kind) _____%
(4) Remittances _____%
(5) Other sources _____%

Food Utilisation

	Questions
	FSQ17. How many meals does your household consume in a day for the past 6 months? (1) One [ ] (2) Two [ ] (3) Three [ ] (4) Others specify…… FSQ18.Comparing your current situation to six months ago, has the quantity of your food consumed daily increased or decreased. 1. Increased significantly now [ ] 2) Increased slightly now [ ] 3.) Remained the same [ ] 4) Decreased slightly now [ ] 5. Decreased significantly now[ ]
	FSQ19. Do you face challenges satisfying the food needs of your household? 1. Yes[ ] 2.No[ ] FSQ20. If yes to FSQ19, highlight the challenges……..... FSQ21. Which of the following coping mechanisms did your HH rely on to secure food in the last 6 months? *(tick all appropriate boxes)* 1. Rely on less preferred and cheaper foods [ ] 2. Borrow food, or rely on help from a friend or relative [ ] 3. Limit meal sizes [ ] 4. Restrict consumption by adults in order for small children to eat?[ ] 5. Reduce number of meals eaten in a day [ ] 6. Reduce number of people eating at home (e.g. by sending a child to eat with relatives or friends)[ ] 7. Sales of household assests [ ] 8 Others specify…….. FSQ22. In the last 6 months, did you ever eat less than you felt you should because there was not enough food stored or money to buy food? 1. Yes [ ] 2. No [ ]

	FSQ23. If yes to FSQ22, what was the reason for you eating less because there wasn't enough food stored or money to buy food?..... ……

SECTION D: PERCEPTION ABOUT CLIMATE CHANGE

Code	Questions
CCQ1	Have you observed any changes in climate factors for the past 5 years? E.*g. of factors: Rainfall, temperature, wind, etc*. 1) No [ ] 2) Yes [ ]
CCQ2	What changes have you observed in the distribution of rainfall in the past 5 years? 1) early onset early cessation [ ] 2) early onset late cessation [ ] 3) late onset early cessation [ ] 4) late onset late cessation [ ] 5) I don't know [ ]
CCQ3	How have the changes in rainfall affected your food security status? 1) Severely affected [ ] 2) Moderately affected [ ] 3) Fairly affected [ ] 4) No changes [ ] 5) I don't know [ ]
CCQ4	What are the changes you have observed in temperature in the past 5 years? 1) Increased [ ] 2) Decreased [ ] 3) Do not know [ ] 4) Others (specify) ……..
CCQ5	How have the changes in temperature affected your food security status 1) Severely affected [ ] 2) Moderately affected [ ] 3) Fairly affected [ ] 4) No changes [ ] 5) I don't know [ ]
CCQ6	Have you ever heard of Climate Change? 1. Yes [ ] 2. No [ ] ***if no, go to *CCQ10*
CCQ7	If yes to *CCQ6*, Where have you first heard about climate change? (Tick as many as applied) 1. Radio/Mass-media [ ] 2. Extension services [ ] 3. Neighbor farmers [ ] 4. Farmers association [ ] 5. Researchers [ ] 6. Project/NGO/Program [ ] 7. Other (specify) …….

Code	Questions
CCQ8	To you, what is currently causing climate change? 1) Not sure [ ] 2) Natural cause [ ] 3) Humans [ ] 4) Natural and human causes [ ] 5) Other (specify).....
CCQ9	How often do you receive information (or training) to cope with climate change? 1) Never[ ] 2) Once every week[ ] 3) once every 2 weeks [ ] 4) once every 3 weeks[ ] 5) Other (specify) ……
CCQ10	Do you face any challenge in your farming system? 1. Yes [ ] 2. No [ ]
CCQ11	If YES in *CCQ10* above, what were the challenges? 1. Drought [ ] 2. Flood [ ] 3.pest & disease [ ] 4. Farm inputs [ ] 5 Inadequate/lack of inputs to buy [ ] 6. Inadequate/lack of farming implements/draught animals [ ] 7. No money to buy inputs/pay for services [ ] 8. Hire own services for food/money to buy food[ ] 9 Others Specify……..

[i] **Secondary employment** refers to the other economic activities that household members rely on off-farm
Household definition: A household is defined as "a group of people who are generally but not necessarily relatives, who live under the same roof and normally eat together, including individuals who live for part of the year or the entire year elsewhere, without having established their own family (with spouse and/or children) in that other place"