CLIMATE CHANGE ADAPTATION AND FOOD SECURITY IN LAMWO DISTRICT, NORTHERN UGANDA

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A DISSERTATION SUBMITTED TO THE DEPARTMENT OF GEOGRAPHY AND SOCIAL STUDIES IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF ARTS IN GEOGRAPHY DEGREE OF KYAMBOGO UNIVERSITY

2018

DECLARATION

I declare that this research thesis entitled Climate Change Adaptation and Food Security in Lamwo District Uganda, is as a result of my own efforts and has never been presented to any other institution for any ward.

Signature: _____ Date: 3RD DECEMBER, 2018

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Approval

This is to certify that this research entitled; 'Climate Change Adaptation and Food Security in Lamwo District, Uganda has been carried out under my supervision and is submitted for examination with my approval.

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Dedication

This research report is dedicated to my father, Mr. Oketta Wilson Willy

Acknowledgements

I thank the Almighty God for His love, guidance, protection and provision throughout the period of my studies. I also thank my parents especially my father, Mr. Oketta Wilson Willy, for the moral, financial and continuous support during my studies.

I am grateful to my supervisors Professor Nabalegwa Muhamud Wambedde and Mr. Asaba Joyfred, who worked tirelessly to see that I complete my studies and have encouraged me to keep on moving towards achieving this degree. I thank the entire department of Geography especially the head of department and the research coordinator, geography Department, KYU. I also thank the department of sociology, KYU for the time they spent in teaching me how to use the SPSS software especially Mr. Ediru Steven.

I extend my heartfelt appreciations to all my course mates, Makoba Paul, Akello Getrude, Kyarala Asuman, Songha Ramanthan, Namuli Deborah and Chepskol Bernard. I cannot forget to thank all my friends AkelloTamalie Jacqueline, Olinga Emmanuel, Aganyo Sarah, Nyirabeni Penninah, Oyella Jenniffer Lopez, Naigaga Masitula, Achieng Vivian, Candiru Andima Grace, Amuto Joan, Aguti Susan, Amoding Agnes Isabella, Masika Doreen and many more for the moral support and encouragement they offered to me during my studies.

I thank my sisters Acayo Grace, Akera Vicky, Adira Annet Jesca, Arach Irene, Aber Evelyn and my brothers Lubangakene Kenneth, Okwany Simon, Acac Stanley as well as all my cousins for all the care and support they gave to me during my studies.

I thank the entire staff of Skyland High School, Lira and St Michael International School for supporting me both financially and morally during my studies

Lastly, I thank my research assistants, production manager Agoro self help irrigation scheme, CDO of Madi Opei, District Agricultural officer, Lamwo district, the personnel at Kitgum weather station and all the households who accepted to be part of this research work.

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Abbreviations

IPCC : Intergovernmental Panel on Climate Change

CCAPS: Climate Change Adaptation Practices

CGAIR : Consortium of International Agricultural Research Centers

QG : Queensland Government

UNFCCC: United Nations Framework Convention on Climate Change

FAO : Food and Agricultural Organization

IPC : Integrated food phase classification

USAID: United States Agency for International Development

NAADS : National Agricultural Advisory Services

HFIAS: Household Food Insecurity Access Scale

HDD: Household Dietary Diversity

PRELINOR: Project Restoration of Livelihood in Northern Uganda Region

ABSTRACT

The study was carried out to investigate the effects of climate change adaptations on food security in Lamwo district. Specifically, it identified climate change trends in Lamwo district, analyzed the effects of climate change adaptation practices on food availability, access, utilization and stability. The study was conducted in two sub counties of Agoro and Madi Opei that were purposively selected from the whole district because these two sub counties lie in the little rain corridor hence experience long dry conditions. There were 375 households who were randomly selected for the study. The methods used to collect data from the field included documentary review which was used to collect data on climate change trends ,direct observation which was used to obtain information about Climate Change Adaptation Practices (CCAPs) in Lamwo. The interview method was used to collect data on the relationship between CCAPs and food security. The findings revealed that there were great variations in the rainfall amounts, number of rain months, rain days and temperature. Early planting was found to be the most dominant on-farm CCAP with 38.2% followed by use of new crop varieties by 25.4%, drought resistant crops by 21.6%, small scale irrigation farming by 7.8% and crop diversification by 6.4%. The most dominant off-farm CCAP was motor cycling with 50%, followed by operation of shops by 25%, brick laying and market vending with 10%. It also found out that that 1.2% households had inadequate food to eat, 95.7% had moderate food availability while 3.1 % had adequate food availability. The study revealed that 19.5% households had access to food, 63.2% had moderate access to food and 17.3% had inadequate access to food. 37.5% households had less dietary diversity, 58.2 % had moderate dietary diversity while 4.3 % had great dietary diversity. It also revealed that 5.0% households had stable food stability while 95% had unstable food stability. The study concluded that adaptation was better than non-adaptation. It therefore recommended that households should adapt to climate change using the various strategies since in all aspects, adaptation was better than non-adaptation.

CHAPTER ONE: INTRODUCTION

1.0 Background to the study

Climate change is one of the main global issues affecting all people both in the developed and developing countries. The effects of climate change are being felt most by the poor and water scarce developing countries (Boko et al., 2007). IPCC (2007) defines climate change as a change in the average weather conditions over time. Climate change is evidenced by the decrease in ice extent, rise in temperature, change in precipitation pattern, rise in sea level, warming and acidification of the ocean (EPA, 2014). The future climate projections indicate that the sea level might raise further, precipitation patterns are expected to change, ocean acidification is expected to increase and global temperatures are likely to increase by 4.5^{0}C by 2080 (IPCC, 2014; IPCC, 2013).

Climate change is already adversely affecting agricultural output on which we depend on for food (Richard et al., 1998). In Africa, the increase in temperatures coupled with change in precipitation patterns has made the region very susceptible to the impacts of climate change (Kansiime, 2012). As such, Africa is projected to have a decline in rain fed agriculture of up to 50% by 2020 and this is likely to increase the food security threat in the region that mainly depends on local technology for food production (Boko et al, 2007). Climate change has affected all components of food security in the following ways: it has led to crop failure which in turn has led to an increase in food prices hence reducing food access; it reduces incentives to invest in agricultural production thus reducing food stability; it also leads to a decrease in crop yields and this affects food availability and affects food utilization through changing the consumption patterns as people change the nutrient content of food as well as compromise food safety (Bloem, Semba and Kraemer, 2010).

In East and Central Africa, the unpredictable weather has led to poor yields, inadequate pasture and a reduction of crop yields hence increasing food insecurity (Oxfam, 2008). The future climatic change projections indicate that there will be changes in rainfall pattern, distribution and duration as well as an increase in temperatures that will further affect agriculture, which is the main export earner and employment sector for the region (Christensen et al, 2007). This in turn will exacerbate the food security problem in the region.

Climate change has affected agriculture which is the main source of food for the rapidly growing population (Deschene and Greenstone, 2012; Pearce, 1996). In Uganda, climate change has led to a

reduction in crop yields, loss of livestock, loss of farm inputs such as seeds and fertilizers, flooding of gardens especially in Eastern Uganda, price fluctuations in agricultural products, loss of soil nutrients, and reduction in soil moisture leading to crop failure. All these have affected the food security status of many households in Uganda (IPCC, 2014; CARE, 2011).

In response to the effects of climate change, humans have learnt to adapt. They have adapted using different Climate Change Adaptation Practices in order to; reduce crop failure, increase crop yield, reduce the rate of loss of livestock, increase water availability and agricultural productivity (IPCC, 2015). This is because they have realized that adaptation is the only way of managing the impacts of climate change that mitigation cannot solve (IPCC, 2015; CARE, 2011). People in developing countries have adopted both re-active and anticipatory adaptation in order to reduce the negative effects of climate change (UNFCC, 2007). The re-active adaptations include; erosion control, supplementary irrigation, migration among communities, change in fertilizer use and applications, changes in the planting and harvesting times, soil fertility maintenance, introduction of new crops, rain water harvesting among others while anticipatory adaptations include; the development of crops that are resistant to drought, soil-water management diversification and intensification of food production. (UNFCC, 2007; Sperling and Szekely, 2005).

Despite the fact that adaptation practices have been adopted all over the world, food insecurity still remains a global issue especially in the developing countries in referral to FAO (2002). It is noted that Uganda in particular is facing a declining food security (Oxfam, 2008). In northern Uganda, particularly the Acholi region has been classified under boarder line food insecure districts (IPC, 2014). In Lamwo district, food insecurity still occurs despite the adaptation of different Climate Change Adaptation Practices (IPC, 2014; FAO, 2010).

1.1 Statement of the problem

Climate change is exacerbating food insecurity in Uganda. Nandozi et al (2012) noted that the rainfall patterns have changed while the frequency of droughts, occurrence of diseases, landslides and floods are increasing in Uganda hence increasing food insecurity. The reduction in rainfall amounts, its unreliability as well as its unpredictability has resulted into crop failure, which in turn has led to increased food prices hence food insecurity (FAO, 2006). Furthermore, UNAPA (2007) explains that the increase in temperatures leads to emergence of new pests and diseases and has

reduced yields of temperature sensitive crops like vegetables, cassava and soya beans. The negative effects of climate change on agricultural productivity have forced the farmers to adopt different CCAPs. (Zizinga et al, 2015). In Uganda, the different ways by which people have adapted to climate change include; off-farm activities, mixed farming, small scale irrigation, dam construction and use of improved varieties that are drought resistant and high yielding and other practices (Mubatsi, 2013). However, the efficiency of these CCAPs in attaining food security is unknown.

In Lamwo district, the annual rainfall amounts have decreased from 1200 mm to 700 mm hence weeding out rain dependant crops like yams and rice (Oxfam, 2008). In addition, rainfall has become unpredictable, unreliable and unevenly distributed hence affecting crop planting and harvesting (ACCRA, 2011). The temperatures in the area have increased and this has led to a decrease in cassava and soya beans in the area (UNAPA, 2007). As a response to Climate Change, the farmers in Lamwo have adapted using CCAPs (FAO, 2010). Despite the adaptation efforts by farmers, the district is still classified among the borderline food insecure districts and it is predicted that it might slide into an acute food and livelihood crisis, humanitarian emergence or famine food insecurity phase (IPC, 2014). Given this background, it is critical to investigate the extent to which various adaptations contribute to food security.

1.2 General objective

This study examined different Climate Change Adaptation Practices and their effect on food security in Lamwo district.

1.2.1 Specific objectives

i. To examine climate change trends in Lamwo district
ii. To characterize the climate change adaptation practices in Lamwo district.
iii. To establish the influence of climate change adaptations on food availability.
iv. To examine the relationship between climate change adaptations and food access.
v. To establish the effect of climate change adaptation practices on food system stability.
vi. To examine the relationship between climate change adaptation and food utilization.

1.3 Hypotheses

i. There is no significant difference in food availability between adapters and non-adapters of climate change adaptation practices.
ii. There is no significant difference in food access between adapters and non-adapters of climate change adaptation practices.
iii. There is no significant difference in food utilization between adapters and non-adapters of climate change adaptation practices.
iv. There is no significant difference in food stability between adapters and non-adapters of climate change adaptation practices.

1.4 Significance of the study

It was essential for this research to be undertaken because it will help in addressing food shortage in Lamwo district. This is because the research findings will show the most effective climate change adaptation practices that promote food security and this will be communicated to the peasant farmers hence addressing the food insecurity issue in Lamwo district and Uganda at large.

The research findings will also be useful to organizations such as National Agricultural Advisory Services (NAADS) that aims at ensuring food security to all. This is because the research will aid in the identification of climate change adaptation practices that will ensure food stability, food utilization, food availability and food access.

Since agriculture is the backbone of Uganda's economy and one of the major challenges affecting this sector is climate change, the study will therefore aid in the investigation of intensity of climate change in Lamwo. This will help the policy makers to ascertain better ways of making the communities to prepare for further climate change effects in relation to agriculture.

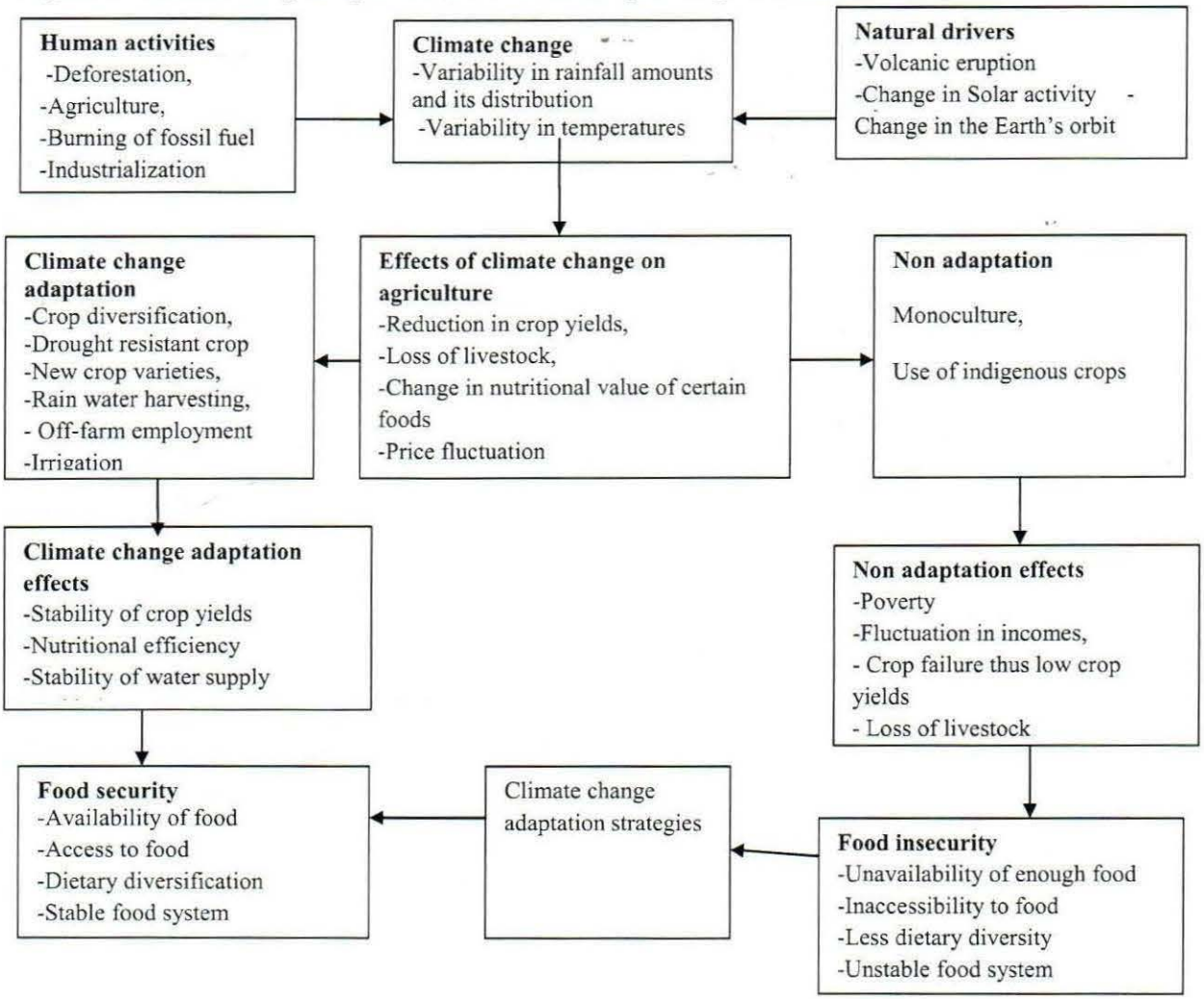
Given that agriculture is the major source of food for many Ugandans as well as a source of employment directly and indirectly, the findings of the study will enable the government to identify the most effective climate change adaptation practices for Northern Uganda. It will help the government to know the practices where most resources should be allocated to in order to increase crop productivity amidst a changing climate.

While some farmers in Uganda have adapted to climate change in order to mitigate the effects of climate change, the effectiveness of the climate change adaptations in attaining food security is not known. The research will therefore contribute new knowledge about the effectiveness of the climate change adaptation practices in Uganda.

1.5 Conceptual framework

The conceptual framework links to climate change the four aspects of food security highlighting the causes of climate and as well as the effects of both adaptation and non-adaptation as shown in figure 1

Figure 1: climate change adaptation and food security conceptual framework



From the above conceptual frame work, human activities and natural processes are the major drivers of climate change. However, human activities, to a great extent are responsible for climate change. This is because the human activities accelerate climate change through increasing and altering the amount of carbon dioxide present in the atmosphere. Climate change in turn, affects agriculture. This is through changing the amount of carbon dioxide, variability in rain distribution, rain amount and duration of rainfall, variability in temperature, emergence of new pests and diseases, change in sea level.

The above drives of climate change impact both positively and negatively on agriculture. In Uganda and Lamwo in particular, the negative effects have been more felt than the positive effects. These negative effects include a reduction in crop yields due to crop failure, loss of livestock, change in the nutritional value of certain foods and agricultural price fluctuation. All these in turn affect food security in the developing countries. In order to counteract the above negative effects, different adaptation practices have been developed and adapted to especially by many farmers in Lamwo and Uganda at large. These include; use of fertilizers, inter cropping, rain water harvesting, introduction of new crop varieties, use of drought resistant crops, crop diversification as well as off-farm employment opportunities. The farmers who have adopted climate change adaptation practices have benefitted in terms of the stability of crop yields, nutritional efficiency, stable incomes, and stability of water supply hence food security.

While some people have adapted to climate change, some people have not adapted, they have instead maintained the indigenous farming methods. The consequences of non-adaptation include poverty, fluctuation in incomes, crop failure, low crop yields, loss of livestock and severe famine hence food insecurity.

1.6 Scope of the study

The study examined the effects of CCAPs on food security. It specifically focused on the climate change trends, exploration of CCAPs, influence of CCAPs on food availability, access, utilization and stability. It covered two Sub Counties namely Madi Opei and Agoro in Lamwo district.

CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

This chapter deals with the written scripts of various scholars concerning climate change, climate change adaptation practices, food security, the relationship between climate change adaptation practices and food security.

2.1 Climate change

The IPCC (2007) defines climate change as, "Change in climate over time due to natural variability or as a result of human activity". Worldwide, climate change has manifested its self through rising global temperatures, melting of ice and glaciers, change in rainfall duration, amount and distribution, rise in sea level as well as acidification of oceans (IPCC, 2014; UNFCCC, 2007). The major noticeable weather elements that cause climate change are rainfall and temperature and are discussed as below;-

2.2 Climate change trends

Rainfall and temperature have been varying over time and this has mainly been attached to human factors more than the natural factors (USAID, 2013). The rainfall distribution has become more uneven and unreliable while the temperatures have become hotter than before with an increase of about 0.37 per decade (ACCRA, 2011). Almost all farmers in Uganda have acknowledged that climate change is actually taking place (Mubiru, Agona and Komutunga, 2009). This variability in rainfall and temperature has had enormous impact on food security (Mwongera et al, 2014) in various ways as discussed below:-

2.2.2 Rainfall

From 1980, the rainfall patterns in Uganda have become unpredictable (UNAPA, 2007). The farmers have observed that it is very hard to predict the start and end of the rainy season compared to the previous years (ACCRA, 2011). The farmers have failed to accurately predict when the rains will arrive and this has affected the planting dates due to the prolonged drought which is associated with the delay of rains hence the agricultural activities have been disrupted (Oxfam, 2008). In rare cases, the rains received are above the normal rains and this leads to rotting of the crops in the gardens especially the root tubers and that the heavy rainfall received together with hailstones

destroyed most crops hence has led to a decline in farm productivity and has increased food insecurity in the area (Mwongera et al 2014; Oxfam , 2008).

From 2000 to 2009, the rainfall amount received in Uganda reduced by 8% when compared to the rainfall of 1920 and 1969 (USAID, 2012) while McSweeney, New and Lizcano (2010) notes that the annual rainfall has been declining by 6.0mm per month every decade. All these affect the amount of soil moisture available for the crops (USAID, 2012). Due to the reduced soil moisture, some of the crops such as groundnuts and vegetables have failed hence increasing food insecurity in the area while the March to June rainfall has also declined leaving a short growing season of August to September hence leads to low crop yields hence food insecurity (USAID, 2012; ACCRA, 2011).

In 2013, the rain season started in early July and ended in mid-December and this greatly disrupted the agricultural activities especially the harvesting season (Mwongera et al, 2014). The prolonged rains also led to the rotting of crops as a result of flooding while the heavy rainfall that was received in the study area coupled with hail storms also led to the destruction of most of the crops in the farms and as a result, food insecurity was at its peak (Mwongera et al, 2014; USAID 2013).

2.2.3 Temperatures

Between 1960 and 1989, the temperature in the area was 26^0C. By 2013, the temperatures had increased by 0.5^0C to 1.2^0C (ACCRA, 2011). This increase in temperatures introduced new pests and diseases that affected both the crops and livestock leading to low crop yields and low quality livestock products respectively (USAID, 2013). The temperatures across Uganda have been increasing by 1.5^0C with a rate of 0.2^0C per decade. This has affected crop growth especially the flowering stage of the crops hence low crop yields and food insecurity (McSweeney et al, 2010).

Temperatures are expected to rise between 0.5^0C and 8.6^0C by 2100 and this will weed out some temperature sensitive crops (IPCC, 2013). In Uganda, temperatures have been increasing, there is emergence of pests and diseases, floods are frequent in some areas while others suffer from increased occurrence of prolonged droughts (NEMA, 2012). The farmers have noticed that the temperatures are hotter than it used to be (Oxfam, 2009)

These climate change trends have led to crop failures, shortage of water, water logged gardens, crop damage, lower milk production in pastoral communities, reduced fish production, famine, malnutrition and reduction in the staple food yields hence affecting food security (IPCC 2014, CARE 2011, UNFCC 2007). These effects of climate change are not uniform worldwide; they differ on local basis, regional and nationally (Simane, Zaitch and Ozdogan, 2013). In order to counteract the negative effects caused by climate change, many farmers in different parts of the world have learnt to adapt to climate change (zizinga et al, 2015).

2.3 Climate change adaptation

Climate change adaptation is one of the ways that the farmers are adapting to the changing climate so as to reduce the negative impacts of climate change (IPCC 2015; UNFCCC, 2007). Climate change adaptation refers to the human actions to cope up with the climate change and its effects and it is in most cases undertaken by farmers so as to manage loses presented to them by the changing climate (IPCC, 2015). Most of the farmers have recognized that climate change is actually taking place and they have recognized that the rains delay to arrive and the temperatures have become hotter than before (Oxfam, 2008). They have therefore developed certain adaptations so as to counteract the negative effects of climate change (Simane et al 2013, Mubatsi, 2013). Jalsrot (2014) noted that adaptation practices adopted by farmers vary from one area to another, although some of them are imitations.

2.4 Climate change adaptation practices

They are different climate change adaptation practices that farmers have adopted world over and these include both anticipatory and an re-active adaptation practices. The anticipatory methods include development of drought resistant crops, soil water conservation, diversification of food and plantation crops while re-active adaptation include erosion control, supplementary irrigation, migration among communities, changes in planting and harvesting dates, rain water harvesting, soil fertility maintenance, change in fertilizer use and application (UNFCCC, 2007). However, some of the farmers maintain the use of indigenous crops. These indigenous crops not only improve food security but also save those involved from malnutrition and earn them incomes when sold (Sarah, 2015) the indigenous eggplants yield highly and are drought resistant, the African cabbage is rich in proteins, vitamins and other micronutrients (Sarah, 2015).

2.5 Food security

Food security has been defined by many scholars. However, the most acceptable definition is that of FAO (2002) which states that, 'Food security is a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life.' Food security can be achieved when the quality, quantity, safety, type, nutritional value and social value of food are considered and the food can easily be afforded by the people who prefer it. (Rainer, Schoeneberger, Pfeifer, Hans-Joachim and Preuss (2000). This clearly brings out the four dimensions of food security. These include; food availability, food access, food systems stability and food utilization. This four dimensions of food security are further discussed as follows;-

Food availability is "the physical presence of food in the area of concern through all forms of domestic production, commercial imports and food aid" (WFP, 2009). Food availability can be assessed at different levels such as at community, district, national or regional levels. There are mainly three elements of food availability namely financial, socio-cultural and physical elements while food access refers to the degree to which a household is able to purchase a sufficient amount of food from the market place, and other sources such as gifts and transfers. This depends on the resources owned by such as assets and disposable income of the household that can be converted in liquid form to purchase food or exchanged for food (Webb and Rogers, 2003).

According to USAID, food utilization is when, "Food is properly used; proper food processing and storage techniques are employed; adequate knowledge of nutrition and child care techniques exists and is applied; and adequate health and sanitation services exist and food systems stability combines food availability and food access dimensions of food security and it is concerned with availability and accessibility of food at all times (Maxwell and Frankenberg, 1992). Food stability exists when the prices of foodstuffs are stable and when food supply is constant throughout a given period of time (Webb and Rogers, 2003).

2.6 The relationship between climate change adaptation practices and food security

Climate change has forced humans to look for ways to survive under such conditions and in Uganda; the negative effects of climate change have been experienced through unpredictable weather (IPC, 2010). The farmers have used their traditional knowledge to use different climate

change adaptation practices so as to cope up with the climate change (NEMA, 2012). All these adaptations are being directed towards counteracting the negative effects of climate change and achieving food security (Simane et al, 2013)

2.6.1 Early planting and food security

The planting date is very important in determining the performance of different crops (Burke and Lobell, 2010). In many African countries, the farmers have resorted to planting crops early so as to be able to tap the early rain. The crops are planted one week or one month earlier based on the predictions that the rains will fall soon and it is carried out by farmers who depend on rain fed agriculture. The plants therefore have a length growing period since it taps the entire rain season (Wyffels, 2011; IPC, 2010).The farmers especially those who depend on rain fed agriculture shift the planting dates a week or month earlier from year-to-year in response to variability in when the rains will arrive and this decision of planting crops early is normally taken in consideration of the soil moisture, expected timing of rain and extreme temperatures (Wyffels, 2011).

The farmers prepare gardens and plant crops a week or a fortnight earlier such that when the rain falls, the crops have a lengthen season of growth and this makes the plants to flower and mature before the temperatures become very hot hence enabling the farmers to harvest and dry crops when the temperatures are hot thus promoting food availability (Burke and Lobell, 2010). QG (2012) wrote that the use of early planting increases yields but reduces the level of proteins obtained from the crop. Early planting makes it possible for the farmers to have a stable yield because it reduces the negative impact of the hotter temperatures (ACCRA, 2011). However, at times the farmers prepare and sow seeds earlier in accordance with the timing of the expected rains but the rains may take longer to arrive and this leads to crop failure because the seeds are exposed to unfavorable conditions such as inadequate soil moisture and hot temperatures and a delay in arrival of the rain creates dry conditions that result in uneven crop growth, stunted growth and low crop yields hence reducing food availability (Wyffels, 2011)

2.6.2 Drought resistant crops and food security

These are crops that survive under extreme heat and drought prone environments particularly in the dry regions of the world that receive very hot temperatures and very little rainfall that is inadequate to support normal plant growth (Mubatsi, 2013). In 2003, drought resistant crops were identified as

one of the top five most crucial biotechnological interventions needed in Africa. These crops produce better yields during drought conditions and at the same time do not compromise yields in the situations that are unstressed The drought resistant crop varieties include drought tolerant maize, drought tolerant beans, new rice for Africa and drought tolerate hardy foods for example sorghum, cassava and millet. These crop varieties are sufficient in overcoming the negative effects of climate change and they yield immediate benefits in terms of food security (CGIAR, 2009). The drought resistant crop varieties include drought tolerant maize with over 50 varieties, new rice varieties that have the characteristics of high productivity rice of Asian and African rice that survive under harsh conditions and drought tolerant hardy foods like millet, sorghum and cassava and drought tolerant beans that yield between 600 and 750 kilograms per hectare (CGIAR, 2009).

The farmers in Northern Kenya testified that the use of drought tolerant crops led to a double harvest of the crops mainly the beans and maize (End hunger, 2009). These drought resistant crops have the ability to withstand extreme weather conditions such as prolonged droughts and inadequate rainfall as well as hot temperatures and as such are able to produce high crop yields and in some cases produce twice the amount of yields produced by non-drought resistant crops in the semi-desert to tropical climates hence encouraging food availability (CGIAR, 2009). ICRISAT (2017) stated that adapting using this practice was being appreciated by the farmers in Kenya who said that the crops had enabled them to attain food and nutrition security. The introduction of multipurpose grain legumes such as cowpeas in Africa earns the farmers income when the excess grains are sold (CGIAR, 2015)

The CGIAR (2013) noted that drought resistant staple crops such as pearl millet and sorghum have ensured food stability in the drought prone areas of Africa especially the sub Saharan region. These two staple food crops are not only a source of food but are also used as animal feeds and they have been successful in addressing food security in Namibia and Southern Chad. However, the drought resistant crops are associated with resistant pests that that affect other inter planted with or grown near the drought resistant crop hence requires development of new pesticides that are expensive to the farmers especially in the developing countries and the resistant pests cause a decline in crop yields of other crops that are not drought resistant thus negatively affecting food availability (Renee , 2011).

2.6.3 Crops diversification and food security

This is a practice of planting a mix of crops and at times involves a shift of resources from low value crops to high value crops and there are two types of crop diversification that is horizontal and vertical crop diversification (Smit and Skinner, 2002). Horizontal crop diversification involves the addition of new high value crops to the already existing crop system so as to improve the total crop productivity and vertical crop diversification involves value addition to the crop through branding, drying, packaging, processing and merchandizing to enhance the crop product (Josh, 2005).

The planting of different crop varieties enables the farmers to have food throughout the year and different crop varieties are susceptible to different pests and diseases and absorb water from the soil at different depths (Lin, 2011). In situations of little rainfall and hot temperatures, the crops with shallow depths might have a low crop yield while those with deep tap root systems might produce a high crop yield and when both crops yield a lot, the farmer can store some and even sell the excess and obtain income that he uses for buying other basic needs. Crop diversification aids in solving the problem of economic risks associated with climate change (Smit and Skinner, 2012; Hugh and Oscar, 2012; Sayed and Harmdollah, 2011).).

The use of crop diversification enables the farmers to grow different crops that yield various economic returns and the farmer is able to get food crops of nutritious values as well as manage the price risks in the market (UNFCC, 2007). The losses of one crop due to crop failure and low crop yields is moderated by yields from another crop that are high yielding and the farmer does not have to depend on a single crop for food and income (CGAIR, 2005).

CGAIR (2015) noted that crop diversification plays a great role in ensuring food utilization by providing a variety of crops to the households since different crops are grown in one season. CGAIR (2015) further explains that crop diversification has been of great importance to the people of Cambodia and this is through improving nutrition of rural famers in the area thus improving dietary variations of the household and the sale of the crops obtained through this practice generates income to the households.

2.6.4 Inter cropping and food security

This is the practice of planting two or more crops on the same piece of land. There are four types of inter cropping and these include; mixed cropping where two or more crops are grown

simultaneously on the same field without following a row arrangement, row intercropping where two or more crops are planted simultaneously on the same field following a row arrangement, relay intercropping where one crop is planted after the first one has reached its reproductive stage and strip intercropping which involves the growing of crops in strips such that the crops can interact but also have a wide space to grow independently (Hugh and Oscar, 2012; Sayed and Harmdollah, 2011)

Intercropping plays a vital role in food availability. It increases production due to its ability to reduce weeds, pests and effective use of the available resources and besides that, it provides two or more crops for the farmer in one cropping season (Hugh and Oscar, 2012). When one crop is affected and has a low yield, the farmer gets food from the crop that has a higher yield and in cases where both crops produce lower yields; the farmer still gets food that can sustain the household from a combination of the two crops or more hence food availability (Sayed and Hamdollah, 2011). Intercropping plays a very vital role in enhancing food systems stability through its provision of two different crop produce in one crop season. Intercropping enables the farmers to obtain double yields from his crops and even in case of crop failure in one crop, the farmer can still obtain crop produce from the crop that yields. This is because the pests and disease that attack one crop might not attack the other crop hence not all the crops are subjected to crop failure. This ensures food system stability (Sayed and Hamdollah, 2011).

2.6.5 Mixed crop- livestock systems and food security

This is a practice of growing crops and keeping livestock on the same field so that double benefits can be obtained from the crop-livestock interaction and the livestock provides manure that is used as manure to fertilize the soils on which the crops are planted while crop residues are used as feeds for the livestock and in case of crop failure, the livestock can be slaughtered or sold and income used to buy food from other farmers who have high crop yields. This promotes food access aspect of food security (Philip and Marion, 2015).

This climate change adaptation measure has been adopted by many people in Uganda because it is associated with double benefits from the crops and the livestock (Mubatsi, 2013). Mixed farming contributes to food systems stability by providing a variety of animal products and crop produce. In the phase of a changing climate where crops that are climate sensitive wither and low crop yield is

realized, the farmers depend on the livestock products such as eggs and milk that are obtained daily and in some instances, the farmers sell the livestock products and some livestock and use the money to purchase food from farmers who have excess crop produce within the same village or outside the village (CGIAR, 2015).

2.6.6 off-farm activities and food security

These activities are in most cases adopted by farmers in dry areas experiencing severe climate impacts and include brick making, opening up small shops and kiosks, hair dressing, tailoring, carpentry, charcoal burning, bee keeping, fish farming, taxi and motor driving (Oxfam, 2008). Some of the farmers abandon their farm lands and get involved in the off-farm activities where they get income that they use to buy food and other basic items hence reducing their vulnerability to climate change (Kimty, 2015). Raphael and Matin (2016) noted that the households who adopt the use of off-farm activities have better nutrition than those who do not participate in the off-farm activities.

The famers who adapt to climate change by using non- farm income sources which are less prone to climate change compared to agriculture and using the income obtained, the farmers are able to have access to food hence food availability and food systems stability (Burke and Lobell, 2010; Pandey, Patel and Patel, 2007, Howden, Soussana and Tubiello, 2007).

2.6.7 Small scale irrigation scheme and food security

Irrigation is a practice of artificially transferring water from the water source to the land so as to increase its soil moisture and make it more productive. Through small scale irrigation, the farmers are able to have more than one crop season in the year since crops are grown throughout the year hence increasing food security (Burke and Lobell, 2010; Mekuria, 2003,).

Small scale irrigation reduces risks of crop failure and enables the farmers to have two or more crops in one year due to presence of soil moisture from the irrigation practice leading to increased production hence increasing food availability (EDO 2014; Mengistu, 2008). Small scale irrigation enables households to get more than one crop a year hence increasing the number of crops obtained from the farmlands per year (Awulachew, 2005) Irrigation addresses the problem of soil moisture deficiencies and reduces the frequency of droughts by alleviating water stress hence food stability

(Burke and Lobell, 2010; Smit and Skinner, 2002). Apart from increasing food production, small scale irrigation expands land under crop cover

When not properly monitored, irrigation not only leads to water logging but also soil acidity or alkalinity. This in turn affects the growth of the crops that are susceptible to flooding and alkalinity or acidity leading to a reduction in crop yields thus a reduction in food availability (Mengistu, 2008).

2.6.8 Rain water harvesting and food security

This involves storage, collection and conservation of rain water. In Uganda, many people harvest rain from the roof tops using tanks and utensils such as basins and buckets while ground run off rain is stored in constructed open and underground reservoirs and communal dams (UNAPA, 2007). Rain water harvesting is crucial in food security because it promotes food access by aiding off-farm activities such as brick making and also provides water for crops and livestock in the dry season hence encouraging food availability. (UNAPA, 2007; Lakew, 2004). Onyango and Imbai (2017) noted that the communities that were adopting this practice had better nutrition than those who had not adopted it. The rain water is boiled for drinking and used in food preparation for the household hence promoting food utilization (Lakew, 2003). Rain water harvesting aids in ensuring food stability where irrigation is not possible. This is because the harvested water is used in watering the crops during the dry season until the rains arrive hence ensuring constant food supplies.

2.6.9 Introduction of new crop varieties

The development of new crop varieties provides greater benefits under the new climatic conditions. A variety of genetically modified organisms that are fast maturing and are short duration crops (Walter, Streck, and Kruger, 2008). The farmers have adopted many of these genetically modified organisms in an attempt to combat the negative effects of climate change such as crop failure, reduction in crop yields among others. The new crop varieties include banana, new maize varieties, cassava, and sorghum varieties (Mubatsi, 2013). These crops are suitable to the current and future temperature, soil moisture and unreliable rainfall (Smit and Skinner, 2002). These varieties when used by the farmers aids in overcoming the unreliable weather. The farmers who might be using the indigenous crop varieties change to fast maturing variety if the rainfall received in the area is little (Burke and Lobell, 2010). Benton (2016) noted that the fast maturing crop varieties can increase

supply in a sustainable way. Thompson (2017) wrote that the new crop varieties have the ability to improve the nutrition of the households and to increase crop production hence food security.

2.6.10 Use of fertilizers

Worldwide, both organic and inorganic fertilizers are being used by many farmers. The most crucial and most common fertilizers used by the farmers are Nitrous fertilizers, Phosphorus and potassium fertilizers while some farmers use mulches as fertilizers in their farms. (Rockström and Barron, 2007). These mulches improve soil infiltration, conserve soil moisture and add organic matter into the soil when they decay hence improve soil moisture retention and water drainage hence increase land productivity and make the crops to grow faster (Rockstorm et al, 2007). The fertilizer not only improves the soil texture but also encourages breeding of essential bacterial in the soil and improves the quality of the land leading to an increase in crop yields hence promoting food security (Stewarta and Roberts, 2012). Benton (2016) stated that the use of fertilizers facilitated the tremendous increase in crop production between 1960 and 2000.

CHAPTER THREE: RESEARCH METHODS

3.0 Introduction

This chapter contains the research design, research approach, study population, sampling procedure, sample size, sampling design, methods of data collection and data analysis.

3.1 Research design

The research employed a cross-sectional survey research design. The research collected information from a sample population during a single specified time frame from May to June 2017. This involved a brief discussion with different individuals concerning the different Climate Change Adaptation Practices and how they relate to food security in the district at the specified time frame.

3.2 Research approach

This involved the collection of both quantitative and qualitative data from the field. Quantitative data was obtained on the trends of rainfall and temperature, dominant CCAPs, food availability, access, utilization and stability. Qualitative data was obtained basing on the people's perception of the most effective climate change adaptation practices.

3.3. Description of area of study

The study covered two sub counties of Agoro and Madi Opei, in Lamwo district. The physical background and socio-economic background of the area are discussed as below

3.3.1 Physical background of the area

Lamwo district has got different physical and human features that define the district. This is include the physical location in terms of absolute and relative location, climate of the area, drainage, relief, geology, vegetation cover and social-economic conditions of the place. These are covered in details as follows;-

3.3.2 Location and area coverage

Lamwo district is located within the tropics in the Northern part of Uganda as referred to in Figure 2. It is located at latitude $3^0$32'47'' and longitude $32^0$48'6". Lamwo District is bordered by South Sudan to the north, Kitgum District to the east and south east, Pader District to the south, Gulu District to the south west, and Amuru District to the west as shown in Figure 2. The town of Lamwo is approximately 66 kilometers, by road, northwest of Kitgum, the nearest large town refer

to map. This is approximately 150 kilometers, by road, northeast of Gulu, the largest city in the Acholi sub-region. Lamwo district is divided in to 9 sub counties (Lamwo district information portal, 2014)

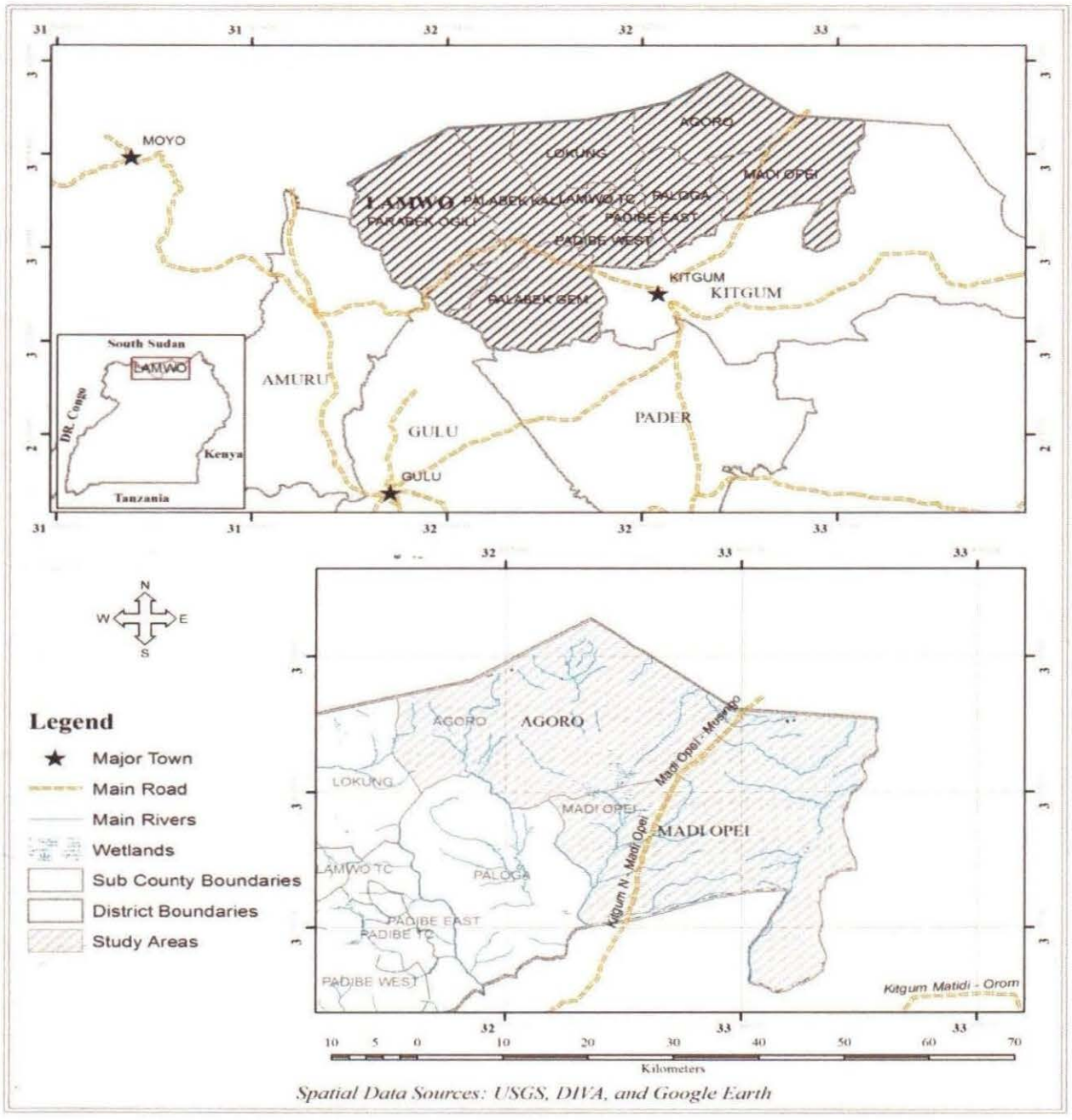


Figure 2 : Map of Lamwo district showing its location, major towns, main roads, main rivers, wetlands and study area

3.3.3 Geology and relief

The northern Uganda terrain mainly comprises of neorchean gneissose magmatic rocks and these rocks include granite, diorite, anthosites and monazites. There are also felsic intrusive igneous rocks

that compose of mainly feldspar and quartz. These rocks belong to the basement complex and were formed during the pre-Cambrian era and this makes them very old rocks. The area has the crystalline Precambrian basement which is found underneath the sedimentary platform). Most of the rocks found in Lamwo are metamorphic rocks that were derived from the original igneous rocks through change in the mineral content due to temperature difference and pressure (Ocitti, 1996).

The altitude of Lamwo ranges from 975 to 1524 m above sea level (Mubiru, 2010). Lamwo lies in the Northern interior plateau which is at times referred to as a peneplain. Lamwo has got numerous hills such as Agoro hills that boarder Uganda and South Sudan, Lamwo hills found in Paloga, Abayo (believed to have fallen from heaven, has spiritual attachment and is named after a god that throw the stone hence it is not utilized) hill that separates Palabek from Padibe East, Lalak hill that separates Lukung sub county from Padibe West, latolim hill in Ywaya which lies between Agoro-Madi Opei boarder (Ocitti, 1996).

3.3.4 Drainage

The district contains a few seasonal wetlands such as yiklar and Akeno seasonal wetlands and seasonal streams such Lagura and Larubi stream and rivers such as R. Ateppi, R. Nyimur, R. Aringa and pager river which flows north wards and joins Achwa river (Atinkson, 2015). Pager and its tributary flows through Kitgum into Lamwo before crossing the border and flowing into in southern Sudan (Ocitti 1996).

3.3.5 Climate

Palabek Sub County receives rainfall of between 700 mm and 900 mm annually. The rainfall season is unpredictable and it has become shorter due to the climate change (USAID 2013). The sub county experiences one dry season and the rainfall peak is normally experienced between June and July (Mubiru 2010). Between 1960 and 1989, the temperature in Lamwo was 26^0C but by 2013, the temperatures had increased by 0.5^0C to 1.2^0C (USAID 2013). ACCRA (2011) notes that from 1980, the rainfall patterns have become unpredictable and the farmers have observed that it is very hard to predict the start and end of the rainy season compared to the previous years (ACCRA 2011).

3.3.6 Soils

There are two major soil types in Lamwo and these include leptsols which are shallow soils that develop on hard rocks and plithosols which have a high content of iron and or aluminum (Bakama,

2010). The soils in this district are of low productivity and are not suitable for crop cultivation but support animal rearing and tree growing on a large scale (Bakama 2010). Lawmo has got soils of high productivity especially in Palabek and Lukung. Lukung, Palabek Kal and Palabek Ogili have clay loam soils, Padibe West, Padibe East, Lamwo town council, Palabek Gem and Paloga have sandy loam soil, Agoro especially Pobar and Potika have black clay laom soils and clay sandy soils respectively while Madi Opei has got rocky soils and sandy loam soils.

3.3.7 Vegetation

Savannah grassland type of savannah vegetation is the dominant vegetation type found in this area. Savannah grassland is characterized by scattered trees that have small leaves, and highly deciduous trees that are drought resistant. Grass is the dominant form of plant life and they are about one meter high. The dominant grass species in the area are elephant grass and spear grass. The grasses dry up in the dry season hence offer a brown cover. However, in the wet season, the grasses form a green covering (NEMA 2012). Lamwo has got savannah woodland and savannah grassland in almost all the sub counties. However, shrubs tend to dominate Madi Opei and parts of Agoro sub counties.

3.3.8 Socio-economic background

Lamwo had a total population of 134379 by 2014. Out of this, 65196 were males while 69183 were females. The urban population was 21,742 while the rural population was 112,637. The household population was 134,077 while the non-household population was 302. The growth rate was 1.3% and the population increased from 115,300 in 2002 to 134,379 in 2014 (UBOS, 2014).

The farmers in this area are mainly subsistence farmers who grow food crops such as sesame, sweet potatoes, cassava, groundnuts and beans and a few cash crops such as cotton, soya beans and sunflower (Mwongera et al, 2014). The people also carry out hunting, bricklaying, trade activities, motor cycling, operate restaurants, numerous shops, clinics and administrative activities especially at the headquarters (Ocitti 1996)

3.4 Study population

Most of the people living in Lamwo district are subsistence farmers with a few famers practicing commercial farming. This study considered the population of mainly peasant households living in Lamwo district.

3.5 Sample determination

Purposive non random sampling technique was used in the selection of the study area and the population.

3.5.1 sample area

Lamwo has nine sub counties and these include Agoro, Padibe East, Padibe West, Palabek Kal, Palabek Ogili, Palabek Gem, Lokung, Madi Opei and Paloga. Among the four sub counties most affected by food insecurity in Lamwo district (IPC report, 2014). Two sub counties namely; Agoro and Madi Opei were purposively selected for the study because they have the highest number of households and they lie in the little rain corridor where the weather is unpredictable. Agoro has 6 parishes while Madi Opei has 4 parishes making a total of 10 parishes. A representative sample of 50% of the parishes that is, 3 parishes from Agoro and 2 from Madi Opei were chosen for a detailed study. The selected parishes include Pobar, Patika and Lopulingi from Agoro, Okol and Kal from Madi Opei. From each of the 5 parishes, 3 villages were selected by simple random sampling making a total of 15 villages from which the participants for the study were chosen. The villages Include; Kal Central, Guruguru, Pobudi, Panyul, Lopulwigi, Lobinonga, Ywaya, Loromibenge, Tumanun, Simba, CinyLoyo, Pitber, Kakira, Kapeta and Pama

3.5.2 Sampling of participants

Madi Opei has 2460 households while Agoro has 3533 households making a total of 5993 households. A sample of participants was obtained using the sample size formula stated below

$$n = \frac{N}{1 + N\,(e)^2}$$

Where n is the sample size

N is the total population which is 5994

E is the level of precision which is 0.05%

Thus the sample for the study was determined as below

$$n = \frac{5993}{1+5993(0.05)^2}$$

$$n = \frac{5993}{1+5993\ (0.0025)}$$

$$n = \frac{5994}{1 + 14.9825}$$

$$n = \frac{5993}{15.9825}$$

$$n = 374.972626$$

$$n \cong 375 \text{ households}$$

As such, a sample of 375 households were selected for the study from the 15 sampled villages by taking 25 participants from each village

3.6 Methods of data collection and instruments

Primary data was mainly sourced from the field and different methods were used to collect the data. Each objective was achieved by collecting data using various methods. These methods include interview method, documentary review and observation.

3.6.1 Climate change trends

In order to collect data about the climate change trends particularly rainfall and temperature trends in the area, documentary review method was used. The study collected data from Kitgum weather stations and compiled information about the rainfall and temperature. This data was then plotted on line graph so as to check whether there was a change in the trends of rainfall and temperature. This information helped to attain the first objective of the study.

3.6.2 Characterization of climate change adaptation practices

The data on climate change adaptation practices adopted by different peasant households was characterized using two methods and these include direct observation and interview methods. The different on-farm and off-farm climate change adaptation practices were observed for both under crop and livestock farmers in Agoro and Madi Opei Sub Counties. The participants and the District

Agricultural Officer were also interviewed about the current climate change adaptation practices in the study area.

3.6.3 Establishing the relationship between climate change adaptation and food availability among farmers

In order to collect information about the relationship between climate change adaptation practices and food availability, the interview method was used and farmers were asked to state the months in which their households had enough food to eat. Coates, Swindale and Bilinsky (2007) used the Month of Adequate Household Food Provisioning (MAHFP) to assess food availability status of the households. The study adopted Coates et al (2007) MAHFP for assessing the food availability status of the farmers in Lamwo district. The MAHFP computes food availability by establishing the number of months that a household had enough food. The total scores are 12 with each month being given a score of one (Coates et al, 2007). Scores close to 12 indicate that food was available while scores far away from 12 indicates that food was not available.

MAHFP=12 - number of months that a household is food insecure..... (i)
Using equation i, three categorizes of food availability can be derived. The first category is that with scores10-12 which means a household has adequate food availability; scores of 4-9 means the household has moderate food availability while a score of less than 3 means that the household has inadequate food availability (Coates et al, 2007).

3.6.4 Establishing the relationship between climate change adaptation practices and food access among households

Interview method was used to obtain data about the relationship between climate change adaptation practices and food access. The peasant farmers were asked about the particular Climate Change Adaptation Practices that they are using and their food access status was assessed using the Household Food Insecurity Access Scale (HFIAS). The indicators of food access according to Coates et al (2007) include worrying about the ability to get food, eating food that one does not prefer due to limited resources, eating a limited variety of food due to lack of resources, eating food that one does not want due to lack of resources to obtain other types of food, eating a smaller meal because there was not enough food, eating fewer meals in a day because there was not enough food, having no kind of food because of lack of resources to get food, going to sleep at night without food

because of lack of resources to get food and going a whole day and night without food because there was not enough food. Each interviewee was asked about the occurrence of events as indicated in table 3.1.

Table 3.1: HFIAS occurrence questions

No.	Occurrence Questions
1.	In the past four weeks, did you worry that your household would not have enough food?
2.	In the past four weeks, were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?
3.	In the past four weeks, did you or any household member have to eat a limited variety of foods due to a lack of resources?
4.	In the past four weeks, did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?
5.	In the past four weeks, did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?
6.	In the past four weeks, did you or any household member have to eat fewer meals in a day because there was not enough food?
7.	In the past four weeks, was there ever no food to eat of any kind in your household because of lack of resources to get food?
8.	In the past four weeks, did you or any household member go to sleep at night hungry because there was not enough food?
9.	In the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough food?

Table 3.1 presents two indicators that can be used to find out the food access status of households. For this study, the HFIAS score was adopted.

3.6.4.1 HFIAS score

The first is the HFIAS score which considers if any of the events in table 3.1 occurred once (1), sometimes (2) or often (3) or never (0) occurred at all. The sum of the questions add up to an upper limit of 27 if the respondent answers often to all the nine questions with a code of 3 and minimum of zero if the answers are never to all the nine questions De Cook (2012).

HFIAS score = Q1+Q2+Q3+Q4+Q5+Q6+Q7+Q8+Q9..... (ii)

Where Q1, Q2, Q3, Q4, Q5, Q6, Q7, Q8 and Q9 are occurrence of events stated in questions shown in table 3.1. If the score was closer to 27, then the household experienced food inaccessibility. However, if the score was closer to 0, then the household experiences food access (Coates et al, 2007).

3.6.4.2 Household Food Insecurity Access Prevalence (HFIAP)

The second indicator is the Household Food Insecurity Access Prevalence (HFIAP) which categorizes food insecurity into severely food insecure, moderately food insecure, mild and food secure (De Cook, 2012). The food security status of the household was calculated by obtaining data about the frequency of days that the household experienced serious conditions which De Cook (2012) noted as "running out of food, going to bed hungry or going a whole day and night without eating food". Food secure means that a household does not experience any of the severe conditions stated and can obtain sufficient quantities of preferred food on a daily basis and may never worry about not having appropriate quantity of food for the members, a mild food insecure is one where the household may worry about not having food sometimes but on a rare case and cannot afford the preferred food on a daily basis but can provide adequate quantities of food to the members and does not experience any of the three quoted severe conditions. Moderately insecure food means that a household not only reduces the quantity of food consumed by the household but also starts reducing the number of meals in a day but does not experience any of the three stated severe conditions; food insecure is where a household experiences one of more of the quoted severe conditions in a period of at least thirty days and the household keeps reducing the number of meals and quantity of food eaten by the members. It also compromises the quality of food consumed (De Cook, 2012).

3.6.6 Establishing relationship between climate change adaptation practices and food systems stability

This was tested using the Household Hunger Scale (HHS) which considers the two extreme conditions of HFIAS which are the occurrence of events 8 and 9 in table 3.1. According to Vhurumuku (2014), the HHS "Tends to capture more severe behavior" and the questions asked are similar to those of HFIAS. The households are asked whether one or all of them spent a whole day without eating food because food was not enough or if one of them or all of them went to bed

hungry due to lack of food (Vhurumuku 2014). If they spent a day without adequate food then they have unstable food system but if they have access to food every day, then they experience stable food systems.

3.6.7 Assessing the relationship between climate change adaptation practices and food utilization

The data on climate change adaptation practices and food utilization was collected using interview method and the Household Dietary Diversity score (HDDs) was used to measure the quality of food consumed in various food groups by a household (Ndeyapo, 2013).The households were asked whether they have eaten any of the 12 food groups in table 3.2 within the last 24 hours. Each food group is given a score and the nearer the score is to 12, the greater the dietary diversity of a household hence reflecting food security while the nearer the score is to 1, the lesser the dietary diversity of a household (Ndeyapo, 2013)

Table 3.2: various food groups

NO	FOOD GROUPS
1	Any (local food) bread, rice, noodles, biscuits or any other foods made from millet, sorghum, maize, rice, wheat or (any other local grain)
2	Potatoes, yams, manioc, cassava or any other foods made from roots and tubers
3	Vegetables
4	Fruits
5	Beef, pork, lamb, goat, rabbit, wild game, chicken, other birds, liver, kidney, heart, or other organ meat
6	Eggs
7	Fresh or dried fish or shellfish
8	Foods made from beans, peas, lentils or nuts
9	Cheese, yoghurt, milk or milk products
10	Foods made with oil, fat or butter
11	Sugar/ honey
12	Any other foods such as condiments/tea/coffee

Adapted from Ndeyapo (2013)

3.7 Data analysis

The data collected from the field was entered using Statistical Package for Social Scientists (SPSS). Descriptive data was represented in form of line graphs and tables. The Pearson chi square test was used to check whether there was a significant difference in terms of food security between adapters and non-adapters of climate change adaptation practices at 5% significance level. The chi square formula is stated below

$$X^2 = \sum \frac{(O - E)}{E}$$

Where X^2 is chi square

O is observed frequency

E is expected frequency

$\sum$ is summation

The calculated chi square value above 0.05 would show no significant difference while below 0.05% would indicate a significant difference between CCAPs and food security.

CHAPTER FOUR: PRESENTATION AND DISCUSSION OF RESULTS

4.0 introduction

This chapter contains the presentation of data collected from the field, testing of hypotheses and discussion of the results.

4.1 Climate Change Trends

One of the objectives of the study was to find out the extent to which the climate of Lamwo district had changed over time. Data on this was collected from Kitgum weather station. This included data on temperature for the last ten years, average annual rainfall, wet season and rain days for the last 25 years.

4.1.1 Average Annual Rainfall Pattern

Data on the average annual rainfall for the last 25 years was collected in order to find out if there was a change in the average annual rainfall in Lamwo district for the last 25 years. The results were represented in table 4.22 in appendix 4 and represented in Figure 3.

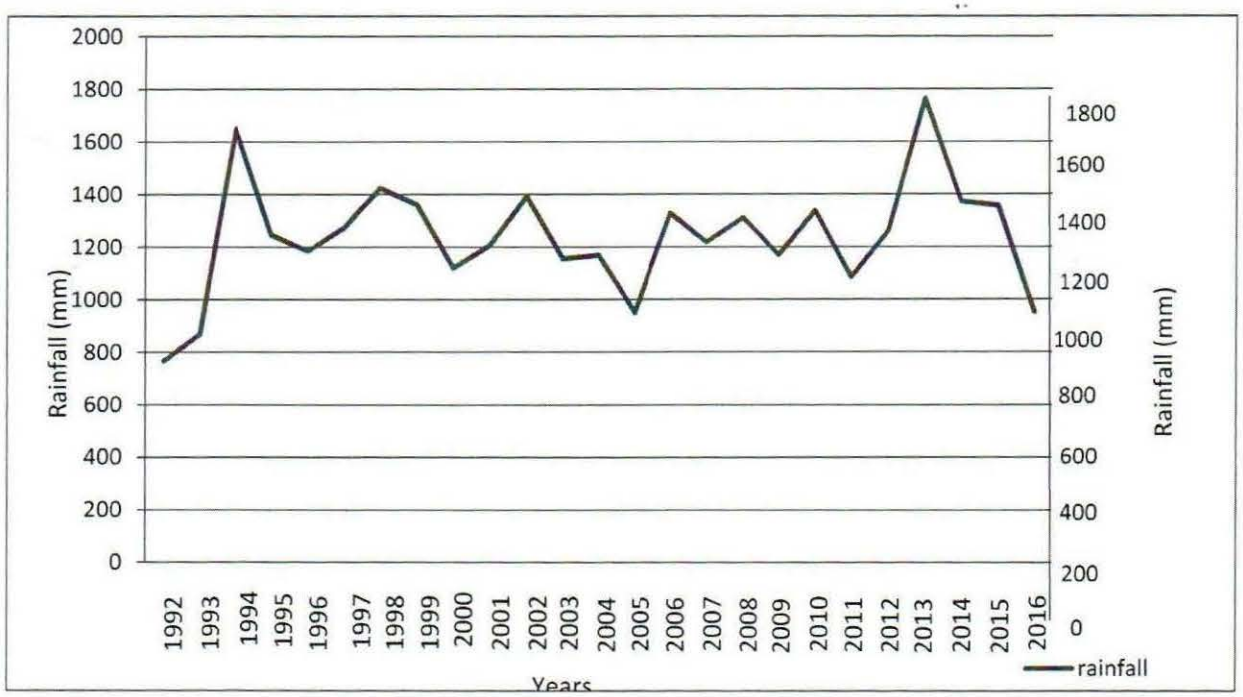


Figure 3: A line graph showing annual rainfall trend from 1992 to 2016

The results revealed that the average annual rainfall increased sharply by 41.5 mm from 1992 to 1994 and then decreased greatly by 38.6 mm from 1994 to 1996. As of 1997 to 2001, there was an increase of 12.5 mm from 1997 to 1998 but this was followed by a decrease of 25.3 mm between 1998 and 2000 and then a slight increase by 7.3 mm in 2001. From 2002 to 2006, the average annual rainfall decreased greatly by 19.8 mm from 2002 to 2003 but increased slightly by 1.1 mm from 2003 to 2004. This was consequently followed by a great decrease in the average annual rainfall from 2004 to 2005 by 18.2 mm and finally a sharp increase of 31.5 mm by 2006. Between 2007 and 2011, the average annual rainfall slightly decreased by 5.2 mm from 2007 to 2008 and this was consequently followed by a slight increase of 11.8 mm by 2009, a decrease by 14.1 mm by 2010 and finally a great decrease of 21.1 mm by 2011. As of 2012 and 2016, there was a sharp increase by 41.8 mm from 2012 to 2013. This was consequently followed by a great decrease in the average annual rainfall from 2013 to 2016 by 67.7 mm. The highest rainfall received was 1764 mm 2013 while the lowest rainfall was 950.7 mm in 2005. This therefore indicates that the area is becoming wetter than before. However, the statistics from 2013 to 2016 show that there was a decrease in the average annual rainfall.

The study was also interested in finding out whether there was a statistical significant difference in the mean annual rainfall in the last 25 years. The 25 years were divided into 5 major groups namely 1992-1996 (group 1), 1997-2001 (group 2), 2002-2006 (group 3), 2007-2011 (group 4) and 2012-2016 (group 5). The mean of each group was calculated so as to compare and find out whether there were mean differences between the five groups. The mean of group 1 was 101.8, group 2 was 106.5, group 3 was 99.9, group 4 was 102.6 and group 5 was 111.8 as represented in Figure 4.

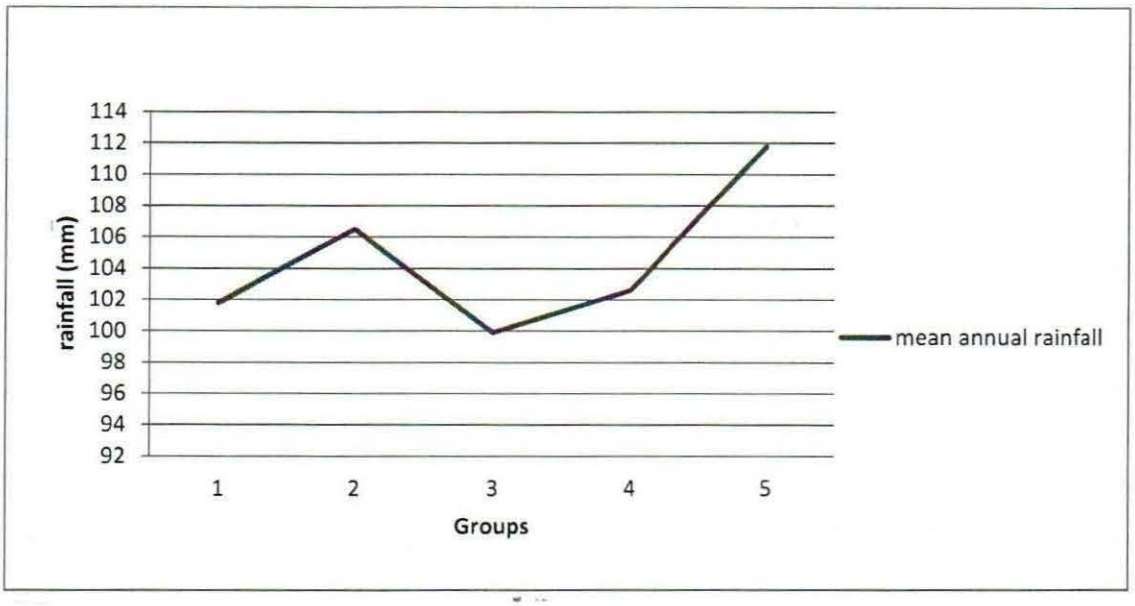


Figure 4: A line graph showing mean annual rainfall of the 5 groups

The results show that there was a sharp increase in the mean annual rainfall from group 1 to group 2 by 4.7 mm. This was followed by a sharp decrease by 6.6 mm between group 2 and group 3. It then increased slightly between group 3 and group 4 by 2.7 mm and sharply by 9.2 mm between group 4 and group 5. The variations in the mean of the groups therefore indicate climate variability which is an indication of climate change in Lamwo district.

4.1.2 Rain days

Data on the number of rain days in Lamwo district was collected so that it could be used to establish whether there were changes in the number of rain days. This data was presented appendix 4 and represented using Figure 5. The number of rain days in a year was also divided into 5 major groups just like the mean annual rainfall.

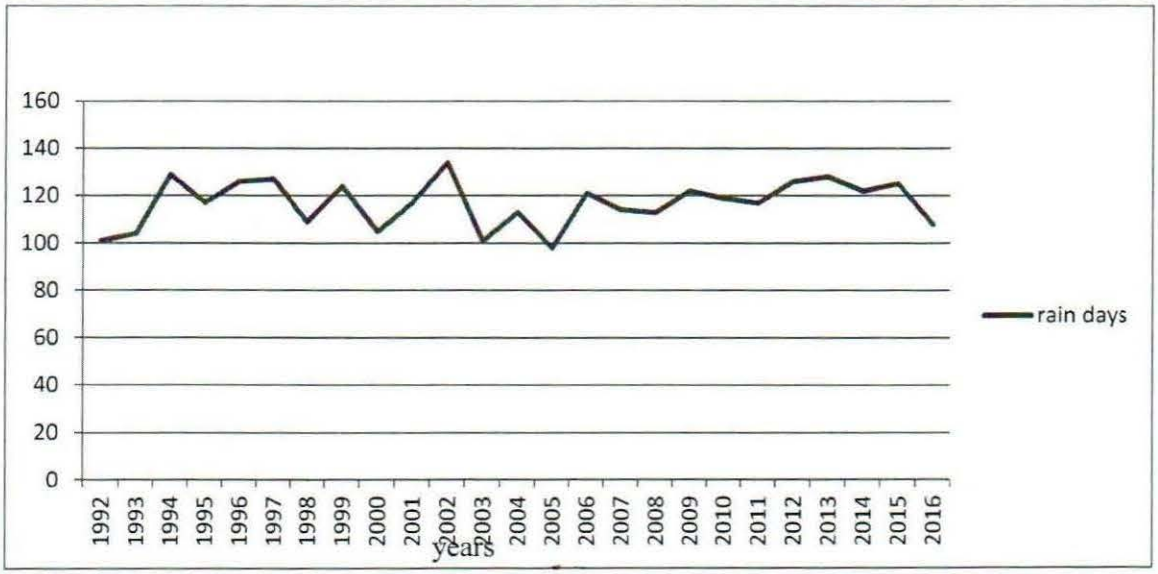


Figure 5: A line graph showing the trend of rain days

The data collected shows that from1992 to 1996, the number of rain days in a year increased slightly by 3 days between 1992 and 1993 and greatly by 25 days by 1994. It then decreased by 12 days between 1995 and 1996 but again increased by 9 days between 1995 and 1996. Starting from 1997 and 1998, there was a great decrease in the number of rain days by 18 days; this was consequently followed by a sharp increase of 15 days between 1998 and 1999. It then reduced by 19 days by 2000 but rose again in 2001 by 12 days. As of 2002 to 2006, there was a great decrease in the number of rainfall days by 33 days between 2002 and 2003, increased slightly by 12 days between 2003 and 2004, decreased by 15 days between 2004 and 2005 and finally increased greatly by 23 days by 2006. Between 2007 and 2011, there was a slight decline in the number of rain days by 1 day between 2007 and 2008 which was consequently followed by a slight increase between 2008 and 2009 by 9 days. It then decreased by 3 days between 2009 and 2010 and by 1 day between 2010 and 2011. From 2012 to 2016, there was a slight increase in the number of rain days by 2 days between 2012 and 2013. This decreased by 6 days between 2013 and 2014 and then decreased by 3 days between 2014 and 2015. It finally decreased greatly by 17 days between 2015 and 2016.

The mean of the groups were calculated so as to compare and find out whether there were mean differences in the number of rain days between the 5 groups. The mean annual rain days for group 1

was 115.4, group 2 was 116.4, group 3 was 113.4, group 4 was 117 and for group 5 was 121.8. These means were presented in Figure 6.

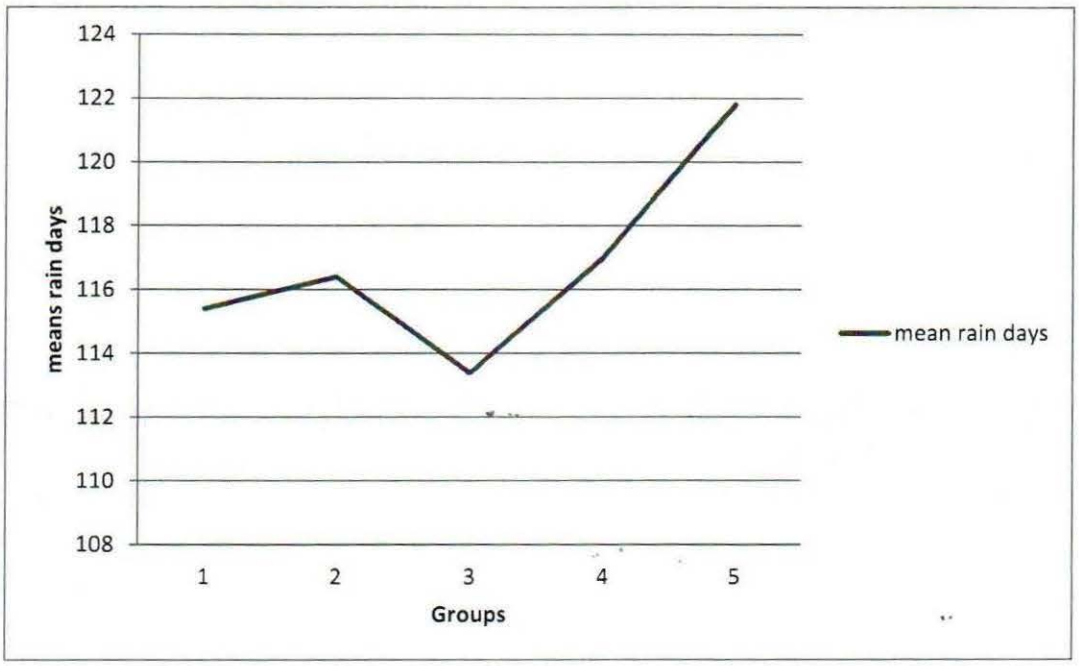


Figure 6: A line graph showing mean annual rain days of the 5 groups

Just like the trend of the mean annual rainfall graph, the trend of the mean annual rain days show a variation in the climate of Lamwo. The mean annual rain days increased slightly from group 1 to group 2 by 1 day. This was followed by a decline of 3 days between group 2 and group 3. It then increased by 3.6 days between group 3 and group 4 and by 4.8 days between group 4 and group 5.

4.1.3 Number of wet months

In order to determine whether there were significant changes in rain season in Lamwo district, data on the wet seasons and dry seasons were collected as shown on table 4:22 in appendix 4. The data was then represented using Figure 7. For the purpose of this study, a wet month was that with rainfall amount above 60 mm while a dry month was that which registered rainfall below 60 mm according to the Koppen classification of tropical climate.

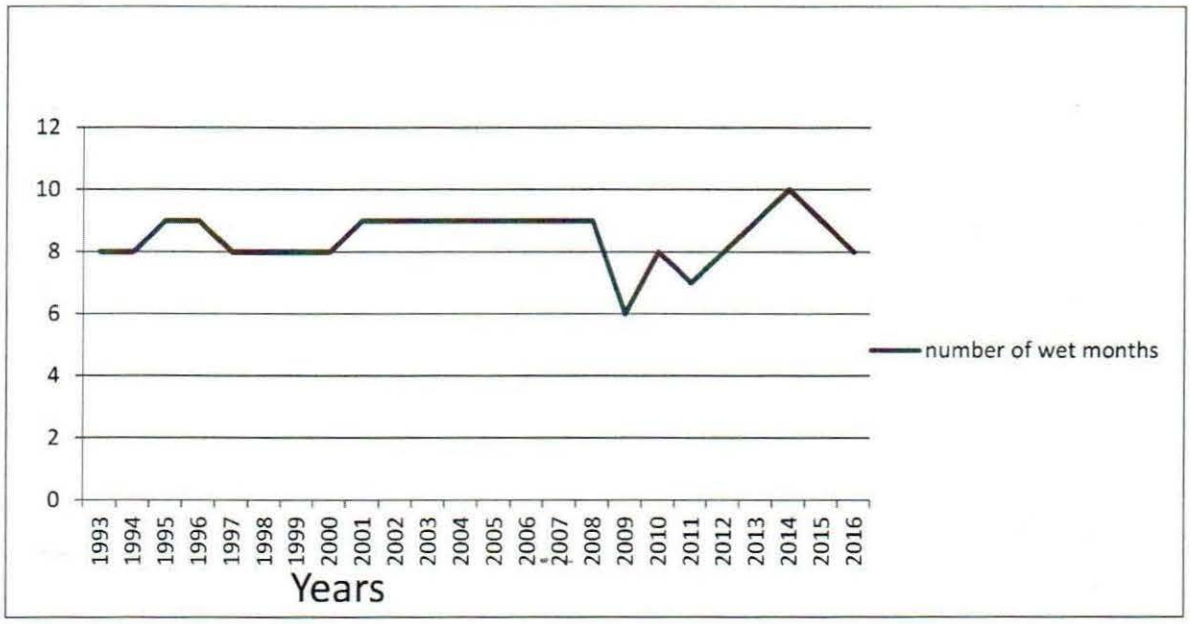


Figure 7: A line graph showing the number of wet months

The results showed that from 1993 to 1994, the number of wet months was 8. This increased by 1 month between 1995 and 1996. It then decreased by 1 month by 1997 and remained at a constant of 8 months up to 2000. This increased by 1 month in 2001 and remained at a constant of 9 months till 2008. It then decreased by 3 months in 2009 and was followed by an increase of 2 months in 2010. This decreased by 1 month in 2011. This was followed by an increase by 1 month in 2012 and by 2 months in 2013. This increased by 1 month in 2014 but declined by 1 month in 2015 and by 2 months in 2016.

The means of each group was calculated so that comparison would be made so as to make conclusions whether there were mean differences between the groups.

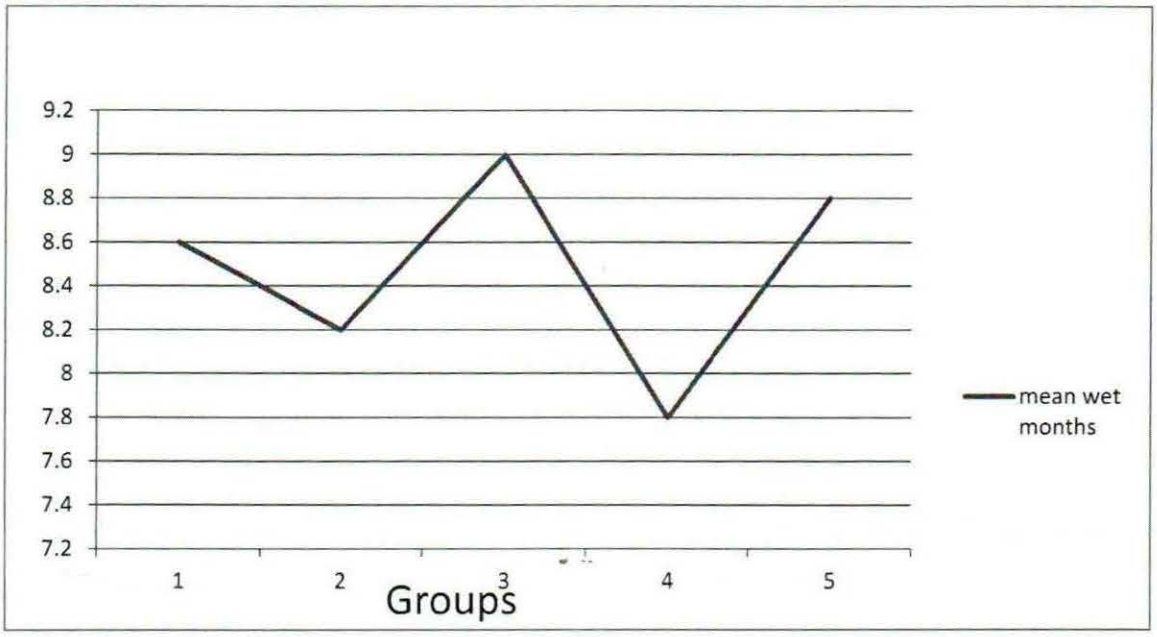


Figure 8: A line graph showing means of wet months

The line graph shows that there was a slight decline in the mean annual wet months by 0.4 wet months between group 1 and group 2. This then increased sharply by 0.8 wet months between group 2 and group 3 but then decreased greatly by 1.2 wet months between group 3 and group 4 and finally increased greatly by 1 wet month between group 4 and group 5.

4.1.4 Temperature

Temperature data for the last 10 years were collected in order to determine whether the temperature in the area had changed. This data was presented in table 4. in appendix. Any significant increase or decrease in temperature would reflect climate variability which would indicate that climate change is a reality in Lamwo district.

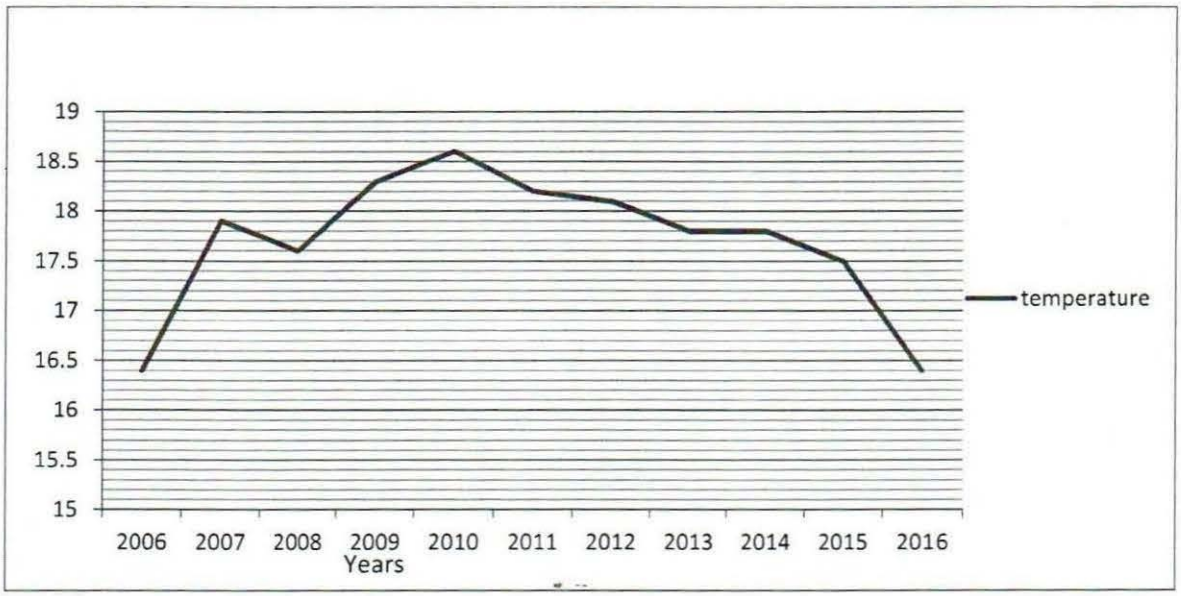


Figure 9: A line graph showing the trend of temperature

In 2006, the average annual minimum temperature was 16.4°C. This increased by 1.5^{0}C by 2007. This was followed by a decrease of 0.3^{0}C in 2008. This increased by 0.7^{0}C in 2009 and by 1^{0}C in 2010. This was followed by a decrease of 2.2^{0}C from 2010 to2016 as shown in line graph 9. The means of the two groups was calculated so as to find out whether there were mean differences in temperature of the two groups. The mean of group 1 was 17.76 while the mean of group two was 17.52.

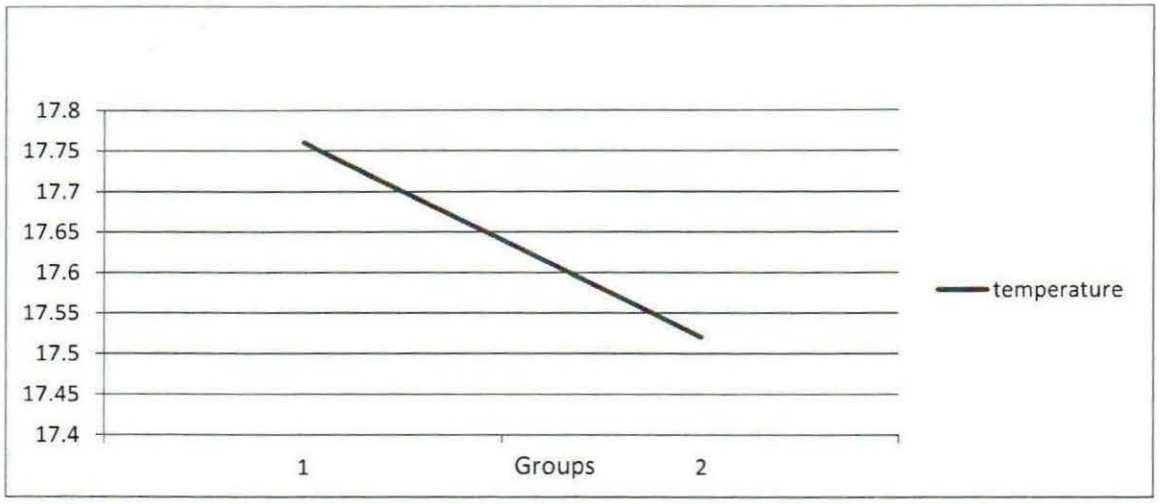


Figure 10 : A line graph showing the means of the group

The line graph shows that the temperatures of Lamwo have decreased in the last 10 years hence the area was becoming cooler than before. In conclusion, the trend of the line graphs showing the means of rainfall averages, rain days, rain seasons and temperatures all show that there is climate variability hence it can be concluded that climate change is indeed a reality in Lamwo district.

4.2. Climate Change Adaptation Practices

The data collected from the field indicates that out of 375 farmers sampled for the study, 323 farmers which is 81.1% had adapted to climate change while 52 farmers which is 13.9% had not. Among the 323 participants who had adapted, 283 (88%) were involved in on-farm adaptation while 40 (12%) were involved in off-farm activities.

4.2.1 On-Farm Adaptation Practices

The on-farm activities were those carried out by the peasant farmers. These adaptations include early planting, the use of drought resistant crops, new crop varieties, small scale irrigation, crop diversification and use of fertilizers. The data for the 283 participants with on-farm adaptation practices displayed in the table 4.1

Table 4.1: Cross Tabulation of Villages and On-farm Climate Change Adaptation Practice

		On-farm						Total
Villages		Early planting	New crop varieties	Fertilizers	Drought resistant crops	Small scale irrigation	Crop diversification	
Kal Central	Count	2	4	0	3	0	0	9
	%	22.2	44.4	.0	33.3	.0	.0	100.0
Guruguru	Count	13	3	0	0	0	0	16
	%	81.2	18.8	.0	.0	.0	.0	100.0
Pobudi	Count	6	2	0	1	0	0	9
		66.7	22.2	.0	11.1	.0	.0	100.0
Panyul	Count	0	17	0	6	0	0	23
	%	.0	73.9	.0	26.1	.0	.0	100.0
Lopulwigi	Count	5	2	0	18	0	0	25
	%	20.0	8.0	.0	72.0	.0	.0	100.0
Lobinonga	Count	10	3	0	1	0	2	16
	%	62.5	18.8	.0	6.2	.0	12.5	100.0
Ywaya	Count	9	2	0	4	0	0	15
	%	60.0	13.3	.0	26.7	.0	.0	100.0
Loromibenge	Count	0	24	0	0	0	0	24
	%	.0	100.0	.0	.0	.0	.0	100.0
Tumanun	Count	0	3	0	0	22	0	25
	%	.0	12.0	.0	.0	88.0	.0	100.0
Simba	Count	16	2	0	7	0	0	25
	%	64.0	8.0	.0	28.0	.0	.0	100.0
CingLoyo	Count	4	0	0	2	0	15	21
	%	19.0	.0	.0	9.5	.0	71.4	100.0
Pitber	Count	12	5	2	4	0	1	24
	%	50.0	20.8	8.3	16.7	.0	4.2	100.0
Kakira	Count	22	0	0	1	0	0	23
	%	95.7	.0	.0	4.3	.0	.0	100.0
Kapeta	Count	5	5	0	14	0	0	24
	%	20.8	20.8	.0	58.3	.0	.0	100.0
Pama	Count	4	0	0	0	0	0	4
	%	100.0	.0	.0	.0	.0	.0	100.0
Total	Count	108	72	2	61	22	18	283
	%	38.2	25.4	.7	21.6	7.8	6.4	100.0

The data collected reveals that farmers in different villages had adapted to climate change in various ways as shown in table 4.1. Early planting was the most dominant on-farm climate change

adaptation practice with 38.2% adapters followed by new crop varieties with 25.4%, drought resistant crops with 21.6%, small scale irrigation with 7.8%, crop diversification with 6.4% and the least practiced was fertilizers with 0.7%

Early planting was the most dominant on-farm CCAP in Kakira with 95.7%, Guruguru with 81.2%, Pobudi with 66.7%, Simba with 64.0%, Lobinionga with 62.5%, Ywaya with 60.0% and Pitber with 50.0% but it was not practiced in Panyul , Loromibenge and Tumanun. Early planting involves planting of crops either one week or one month early basing on the predictions that the rains will fall soon. In order to ascertain whether the practice is related to climate change, participants were asked why they had chosen early planting and the results were shown in the Table 4.2

Table 4.2: Reasons for choosing early planting

No	Reasons	Frequency	Percentage
1	Encouragement from CDO	42	38.9
2	Helps to tap and utilize early rain	8	7.4
3	Good for the rains that fall for a short time	29	26.9
4	Encouragement from extension workers	11	10.2
5	Helps crops to mature and ripen within the rain season	13	12
6	Encouragement from family and friends	5	4.6
	Total	108	100

Table 4.2 revealed that early planting was mainly chosen because of the encouragement from the CDO. From the results, it can be seen that the choice of the adaptation of early planting due to it being good for the rains that fall for a short time with 26.9% participants, helping the crops to mature and ripen within the rain season which constitutes 12% and to tap and utilize early rain with 7.4% were all climate change related. The other reasons include encouragement from the CDO with 38.9%, encouragement from extension workers with 10.2% and encouragement from friends and family with 4.6%. This indicated that only 46% of the participants were engaged in early planting related reasons while 54% practiced early planting for reasons that were not climate change related. Therefore, to a small extent, early planting is undertaken due to climate change related reasons.

New crop varieties were the second most dominant on-farm climate change adaptation practice in Lamwo district with 25.4% households. All the participants in Loromibenge were found to be practicing the cultivation of new crop varieties, followed by Panyul with 73.9 % and Kal central with 44.4%. It was not practiced in Ciny Loyo and Kakira. The participants were asked why they had chosen the new crop varieties in order to find out whether their choices were climate change related. The responses were shown in table 4.3

Table 4.3: Reasons for choosing new crop varieties

No	Reasons	Frequency	Percentage
1	Good for the rains that fall for a short time	38	52.8
2	Helps crops to mature and ripen within the rain season	16	22.2
3	Encouragement from extension workers	3	4.2
4	Encouragement from family and friends	1	1.4
5	Free seeds from operation wealth creation	1	1.4
6	Thrives even with little rain	6	8.3
7	Gives more yields than indigenous seeds	7	9.7
	Total	72	100

From the table 4.3, it can be seen that 52.8% households choose the practice because it is good for rains that fall for short time, 22.2% participants chose it because it helps the crops to mature within the rain season while 8.3% said that it has the ability to thrive even with little rain. All these show that the choice of adapting using new crop varieties was influenced by climate change while the ability of the crops to give more yields than indigenous crops with 9.7% participants, receiving of free seeds from operation wealth creation with 8.3% participants, the encouragement from extension workers with 4.2% participants, encouragement from family and friends with 1.4% and encouragement from extension workers with 1.4% participants were not climate change related. It can therefore be seen that 83.3% reasons were climate change related while 16.7% were not related to climate change. Therefore, to a great extent, the use of new crop varieties is climate change related.

Drought resistant crop varieties were the 3rd most dominant on-farm climate change adaptation practice in Lamwo district with 21.6% of the participants. This on-farm CCAP was most dominant in Lopulwigi with 72.0% and Kapeta with 58.3%. It was not practiced in Guruguru, Loromibenge and Tumanun. In order to find out whether the practice was climate change related, participants were asked why they had chosen the use of drought resistant crops. These reasons were shown in table 4.4

Table 4.4: Reasons for choosing drought resistant crop varieties

No	Reasons	Frequency	Percentage
1	Encouragement from CDO	3	4.9
2	Suitable for the current unpredictable weather	30	49.2
3	Helps crops to mature and ripen within the rain season	6	9.8
4	Encouragement from extension workers	4	6.6
5	Free seeds from operation wealth creation	3	4.9
6	Thrives even with little rain	7	11.5
7	Gives more yields than indigenous seeds	8	13.1
	Total	72	100

Majority of the participants said that the use of drought resistant crops was good for the short rains and this constituted 49.2%, 11.5% participants said that it thrived with little rainfall while 9.8% said that it helped the crops to mature and ripen within the rain season. All these show that the participant's choices were influenced by climate change. Giving of more yields than indigenous crops with 13.1%, encouragement from extension workers with 6.6%, encouragement from the CDO with 4.9%, and free seeds from operation wealth creation with 4.9% indicated that the participant's choice of early planting was influenced by other factors rather than climate change. The results therefore showed that 70.5% of the reasons were linked to climate change while 29.5% were not related to climate change. Therefore, to a greater extent, the reasons for using drought resistant crops were climate change related.

The total number of households involved in small scale irrigation were 7.8%. It was only practiced in Tumanun by 88.0% households. This is because Tumanun is located near the source of R. Aringa

that is tapped to provide water for irrigation in the scheme. Out of the 88.0%, 68.2% households said that the use of the practice enables them to get double benefits that is two or more crops a year which enabled them to fight famine as a result of crop failure associated with climate change. 31.8% households explained that they were using the practice because it enabled them to be fully employed and at the same time manage the changing rainfall patterns since they can have access to water for irrigation purposes hence get food throughout the year. Therefore all the households who were adapting using small scale irrigation did so for climate change related reasons.

Crop diversification had 6.4% households practicing it. It was dominant in Cing Loyo with 71.4% households adapting using crop diversification, Lobinonga with 25% and Pitber with 4.2%. In order to find out whether the adaptation was related to climate change, the participants who were using this practice were asked the reason for adapting using crop diversification. The results were displayed on table 4.5

Table 4.5: Reasons for choosing crop diversification

No	Reasons	Frequency	Percentage
1	It is what their grandfather used to do	5	28
2	Two crops of different nutritious value	3	17
3	More crop yields	2	11
4	Caters for crop failure under changing rain patterns	8	44
	Total	18	100

Out of the 4 choices, catering for crop failure under changing rainfall pattern with 44% participants pointed out that the households were using crop diversification because of climatic factors. The choice of adaptation because it is what their grandfather used to do with 28%, nutritious value with 17% and more crop yields with 11% showed that the choice was not related to climate change. The data collected pointed out that 56% participants had non related climate change reasons while only 44% had climate change related reasons. Therefore, to a small extent, crop diversification was undertaken due to climate change related reasons

The use of fertilizers as an on-farm adaptation was the least dominant climate change adaptation practice in Lamwo. It had only 0.7% households practicing it. It was only practiced in Pitber and had 8.3% of the households in Pitber practicing it. The 0.7% households said that they were adapting using this practice because it adds fertility to the soil and therefore encourages constant

high crop yields. There were 50% participants who added that the temperatures were so hot that they caused rapid evaporation so the use of stem cuttings to cover the soil reduces loss of soil moisture. This therefore indicates that 50% of the reasons for the application of fertilizers is climate change related hence the use of fertilizers is an adaptation practice in Lamwo.

4.2.2 Off-Farm Adaptation Practices

These were carried out outside the garden. There was no single household adapting to climate change using only off-farm activities. They were involved in off-farm activities and at the same time carrying out agriculture on small scale. The major off-farm activities adapted were; motor cycling for cash, brick laying, operation of shop, market vending and rain water harvesting as shown in table 4.6

Table 4.6: Cross Tabulation between Villages and Off-farm Activities

Villages	Off-farm activities	operation of shop	Motor cycling	Brick laying	Market vending	Rain water harvesting	Total
Kal Central	Count	3	9	0	4	0	16
	%	18.8	56.2	.0	25.0	.0	100.0
Guruguru	Count	1	0	0	0	0	1
	%	100.0	.0	.0	.0	.0	100.0
Pobudi	Count	5	7	4	0	0	16
	%	31.2	43.8	25.0	.0	.0	100.0
Lobinonga	Count	0	1	0	0	0	1
	%	.0	100.0	.0	.0	.0	100.0
Cing Loyo	Count	0	2	0	0	1	3
	%	.0	66.7	.0	.0	33.3	100.0
Pitber	Count	0	0	0	0	1	1
	%	.0	.0	.0	.0	100.0	100.0
Kakira	Count	1	1	0	0	0	2
	%	50.0	50.0	.0	.0	.0	100.0
Total	Count	10	20	4	4	2	40
	%	25.0	50.0	10.0	10.0	5.0	100.0

The results showed that 50% of the households were involved in the activity of motor cycling. It was dominant in Lobinonga and Ciny Loyo where all the households were using it, followed by Kal central with 56.2%, Pobudi with 43.8% and Kakira with 50%. It was not adapted to in Guruguru, Lobinonga, Cing Loyo and Pitber. The households were asked why they got involved in motor cycling so that the study could find out if the reasons were climate change related or not. The results were displayed in table 4.7.

Table 4.7: Reasons for choosing motor cycling

No	Reasons	Frequency	Percentage
1	Suitable for the current changing rain seasons	2	10
2	Enabled purchase of food	1	5
3	Gets food throughout the year	6	30
4	Full employment	2	10
5	Double benefits from farm and motorcycling	9	45
	Total	20	100

Out of the 50% participants, 10% participants said that they were practicing the activity because they found it suitable for the current changing rain season. This is because they perceived that when climate change led to crop failure, then they can use money from the activity to buy food to supplement what they get from the farms. However, 45% participants said that they used the activity because it enabled them to get double benefits, 30% said it enabled to get food throughout the year, 10% said that the activity enabled them to be fully employed while 5% said that the activity helped them to purchase food. It can therefore be seen that 90% of the participants have reasons that were not climate change related while only 10% were climate change related hence motorcycling was to a small extent, a climate change adaptation practice in Lamwo district.

There were 25% participants involved in operation of shops in Lamwo district. It was the most practiced in Guruguru were all the households were adapting using it and Kakira with 50% households. It was not practiced in Cing Loyo. The participants were asked why they had chosen this activity so that the reasons would help the study to discover whether the reason for adaptation was climate change related or not. The results were displayed in table 4.8

Table 4.8: Reasons for choosing operation of shop

No	Reasons	Frequency	Percentage
1	Suitable for current unpredictable rain season	2	20
2	Access to food	5	50
3	Double benefits from operating shop and small scale agriculture	3	30
	Total	10	100

The results showed that 50% of the households were involved in operation of shop in order to have access to food since the activity was less prone to climate change compared to agriculture. It can also be seen that 20% were involved in operation of shops because they found it suitable for the current unpredictable rain season because the activity made them less vulnerable to climate change impacts. 30% participants said that they were involved in operation of shops because it enabled them to get double benefits from operating the shop and small scale agriculture. This therefore indicated that such households were able to overcome the negative impacts of climate change. Therefore, all the reasons given were climate change related hence operation of shop was a climate change adaptation practice

There were 10% households involved in brick laying. Brick laying was only practiced in Pobudi with 25% households. It was not practiced in Guruguru, Lobinonga, Cing Loyo and Pitber. 75% participants explained that they had adapted using the practice in order to earn more money during the dry hence making them less susceptible to climate change. They said that they use the money to purchase food from productive areas especially Tumanun that has irrigation scheme and therefore supplies a lot of vegetables. 25% farmer said that they found themselves idle during the dry season when they were no rains to carry out crop cultivation so they resorted to brick laying so as to be fully employed all year round. Given that 75% responds were climate change related, it can therefore be said that the activity of brick laying was an adaptation to climate change.

Market vending had the same numbers of households as brick lying. The 10% households explained the reason for using this practice and these include; 25% households said that they adapted using this practice because they wanted to have access to food throughout the year through crop cultivation and selling of the excess perishable products like vegetables and tomatoes in the market so as to obtain cash to buy food in times of famine. 75% households explained that they wanted to reap double benefits from this practice by having food crops from crop cultivation and by selling excess perishable foods so as to obtain money for purchasing food in times of crop failure associated with climate change. All the reasons for practicing market vending were climate change related hence market vending was a climate change adaptation practice in Lamwo district. Plate 1 shows market vending activity.

Plate 1: photograph showing market vendors at Kal central, near the Madi Opei Sub County offices

There were 5% households involved in rain water harvesting which was the least off-farm climate change adaptation practice. Rain water harvesting was most dominant in Pitber where all the participants were practicing this adaptation while it was not practiced in Guruguru, Lobinonga, Cing Loyo and Pitber. There were 50% households who said that the practice helped them to have double benefits that is crop cultivation and animal rearing throughout the year since the rain water was used for watering plants and drinking by the animals in cases when the rains delayed to arrive. The other 50% household said that the practice was adapted because it helped them to have water for growing vegetables and supplements it with borehole water when the rains fall for a short time. All the responses were climate change related hence this is a CCAP in Lamwo district.

Considering the reasons given for adaptation, it can be concluded that all the above practices were being practiced because they were related to climate change.

4.2.3 Non-adapters

Out of the 52 households who had not adapted, 50% said that they had not adapted to climate change because they had not experienced any change in the amount of yields being obtained from the farms. The 26 % households said that they did not know how to adapt although they had observed that the rains fall for only a short period of time while 24% said that there was no climate change in Lamwo hence did not see the need to adapt.

4.3.0 Climate Change Adaptation and Food Security in Lamwo District

Given that the study was interested in finding out the effectiveness of CCAPs in attaining food security, data was collected on both CCAPs and food security. The data on CCAPs and food security were then cross tabulated so as to find out the food security status of both the adapters and non-adapters. These were discussed in details under sections 4.3, 4.4, 4.5 and 4.6.

4.3.1 Climate Change Adaptation Practices and Food availability

The relationship between CCAPS and food availability is obtained through the cross tabulation of CCAPS and food availability status of the households. The study adopted Coates et al (2007) MAHFP which measures the food availability status of the households by finding out the number of months that the households had enough food to eat. Each month is given a score of 1. Scores that were close to 1 show that food was inadequate while scores close to 12 show adequate food availability. The data in table 4.9 shows the cross tabulation of food availability status of the households and CCAPs.

Table 4.9: Climate Change Adaptation Practices and Food availability status of adapters

		Food availability status			
CCAPs		1-3 months	4-9 months	10-12 months	Total
Early planting	Count	0	105	3	108
	%	.0%	97.2%	2.8%	100.0%
New crop varieties	Count	1	70	1	72
	%	1.4%	97.2%	1.4%	100.0%
Fertilizers	Count	0	2	0	2
	%	.0%	100.0%	.0%	100.0%
Drought resistant crops	Count	0	59	2	61
	%	.0%	96.7%	3.3%	100.0%
Operating of shops	Count	0	10	0	10
	%	.0%	100.0%	.0%	100.0%
Motor cycling	Count	3	17	0	20
	%	15.0%	85.0%	.0%	100.0%
Brick lying	Count	0	4	0	4
	%	.0%	100.0%	.0%	100.0%
Small scale irrigation	Count	0	18	4	22
	%	.0%	81.8%	18.2%	100.0%
Market Vending	Count	0	4	0	4
	%	.0%	100.0%	.0%	100.0%
Crop diversification	Count	0	18	0	18
	%	.0%	100.0%	.0%	100.0%
Rain water harvesting	Count	0	2	0	2
	%	.0%	100.0%	.0%	100.0%
Total	Count	4	309	10	323
	%	1.2%	95.7%	3.1%	100.0%

This MAHFP categorizes food availability into 3 major groups. Scores of less than 3 show inadequate food availability, scores of 4-9 show moderate food availability while scores of 10-12 show adequate food availability.

Among those involved in early planting, 97.2% had enough food to eat for 4-9 months while the remaining 2.8% had enough food to eat for 10-12 months. It can therefore be seen that the households using early planting had moderate to adequate food availability. The success of the practice in addressing food availability lies in its advantage of ensuring a stable yield which therefore provides the households with enough food to eat for a prolonged period of time.

The households who were practicing the use of new crop varieties had 1.4% participants who had enough food to eat for 1-3 months hence had inadequate food availability, 97.2% had enough food

to eat for 4-9 months thus had moderate food availability while 1.4% had enough food to eat for 10-12 months hence had adequate food availability. It can therefore been seen that most of the households had moderate to adequate food availability. This was because the new crop varieties had the ability to grow fast and mature even with the little rains received in the area.

For those undertaking cultivation of drought resistant crops, 96.7% households had enough food to eat for 4 to 9 months while 3.3% households had enough food to eat for 10 months hence have adequate food availability. It can therefore be seen that all the households had moderate to adequate food availability. This was because drought resistant crops have the ability to withstand harsh conditions of hot temperatures and little rainfall and still give a high crop yield to the farmers involved.

Among the households who practiced motor cycling, 85% had enough food to eat for 4-9 months while 15% households had enough food to eat for 1-3 months hence they had moderate to inadequate food availability. Although the use of motor cycling had most of the households with moderate food availability, in comparison with other CCAPs, it had the highest percentage of food insecure households. This is because the use of motor cycling is associated with uncertainties as less cash may be obtained that cannot purchase enough food for the households.

Among those involved in small scale irrigation farming, 81.8% households had enough food to eat for 4 to 9 months while the remaining 18.2% households had enough food to eat for 10 to 12 months. This indicates that the households involved in small scale irrigation farming had moderate to adequate food availability. The success of the practice in addressing food availability lies in its advantage of providing water which reduces the risks of crop failure as a result of prolonged drought.

All the households practicing the application of fertilizers, operation of shops, brick laying, market vending, rain water harvesting and crop diversification had enough food to eat for 4-9 months. This therefore pointed out that they all had moderate food availability. The use of fertilizers is associated with the benefit of increasing crop yields which explains why the households involved in this practice had moderate food availability. For those involved in operation of shop, market vending and brick laying, their status as households with moderate food availability was because these off-farm activities enabled them to become less risky to climate change. The households involved in

rain water harvesting had moderate food availability because the water they harvested enabled them to grow the crops when the rains delayed so they had food throughout. For those involved in crop diversification, the practice enabled them to get more than one crop in a year hence providing them with food which explains why they had moderate food availability

4.3.2 Food Availability among Adapters and Non-Adapters

In order to test whether climate change adaptation influenced food availability, data was desegregated into adapters and non-adapters as shown in table 4.10

Table 4.10: Cross Tabulation of Adaptation Status and Food Availability Status

Adaptation status		food availability status			Total
		Inadequate food availability	moderate food access	Adequate food availability	
adapters	Count	4	309	10	323
	%	1.2%	95.7%	3.1%	100.0%
non-adapters	Count	15	37	0	52
	%	28.8%	71.2%	.0%	100.0%
Total	Count	19	346	10	375
%	%	5.1%	92.3%	2.7%	100.0%

The data revealed that among the adapters, 1.2% had inadequate food, 95.7 % had moderately adequate food and 3.1% had adequate food. Among those who were not adapting to climate change, none of the households had adequate food throughout the year. 71.2% had moderate food availability while 28.8% had inadequate food availability. Therefore, while those who had inadequate food availability among adapters were at 1.2% the figure was 28.8% for those who had not adapted to climate change. This shows that adapters were better off in terms of food availability than the non-adapters.

To ascertain whether there was a significant difference in food availability between adapters and non-adapters, a chi square test was run and the results were shown in table 4.11

Table 4.11: chi square test

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	90.304[a]	2	.000
Likelihood Ratio	58.647	2	.000
Linear-by-Linear Association	63.458	1	.000
N of Valid Cases	375		

The Pearson chi square reveals that the significance value is 0.000 which shows that there is a significant difference between adapters and non-adapters in terms of food availability since it is below the significance level of 0.05%.This therefore indicates that adapters and non-adapters differ in terms of food availability. The null hypothesis which states that there is no significant difference between adapters and non-adapters in terms of food availability is therefore rejected.

4.4. Climate Change Adaptation Practices and Food Access

The households were asked about their ability to get enough food, eating preferred food, eating a variety of food, eating desired food, eating adequate food, having enough resources, sleeping hungry at night and spending a whole day and night without food. Each response was given a highest score of 3 if the response is yes and a minimum of 0 if the response is never. Households with scores of 0 to 9 have sufficient food access; households with scores of 10-18 have moderate food access while households with scores of 19 to 27 have insufficient food access. The results obtained from the household's responses were presented in the table 4.12.

Table 4.12: Climate Change Adaptation Practice and Food Access Cross Tabulation

		FOOD ACCESS			
CCAP		Sufficient food access	Moderate food access	Insufficient food access	Total
Early planting	Count	11	60	37	108
	%	10.2	55.6	34.3	100.0
New crop varieties	Count	27	42	3	72
	%	37.5	58.3	4.2	100.0
Fertilizers	Count	1	1	0	2
	%	50.0	50.0	.0	100.0
Drought resistant	Count	5	48	8	61
	%	8.2	78.7	13.1	100.0
Operation of shops	Count	0	8	2	10
	%	.0	80.0	20.0	100.0
Motor cycling	Count	1	16	3	20
	%	5.0	80.0	15.0	100.0
Brick lying	Count	1	1	2	4
	%	25.0	25.0	50.0	100.0
Small scale irrigation	Count	15	7	0	22
	%	68.2	31.8	.0	100.0
Market vending	Count	0	4	0	4
	%	.0	100.0	.0	100.0
Crop diversification	Count	2	15	1	18
	%	11.1	83.3	5.6	100.0
Rain water harvesting	Count	0	2	0	2
	%	.0	100.0	.0	100.0
Total	Count	63	204	56	323
Percentage	%	19.5%	63.2	17.3	100.0

The data in table 4.12 shows that 10.2% of those who practiced early planting had scores of 19-27 hence had sufficient food access, 55.6% households had scores between 10 and 18 hence have moderate food access while 34.3% had scores of 0-9 hence had insufficient food access. It can therefore be seen that most of the households had moderate to sufficient food access. The use of early planting enabled the households to sell the excess produce hence obtain money that increased their liquidity.

Out of the 72 households practicing the use of new crop varieties, 37.5 % had sufficient food access, 58.3% had moderate food access while only 4.2% had insufficient food access. The households involved in this practice had moderate to sufficient food access. This practice was able to address food access because it increased the supply of the crops that were sold hence increasing their purchasing power.

Among the households who were practicing the use of fertilizers as a climate change adaptation practice, 50% had sufficient food access while 50% had moderate food access hence they had moderate to sufficient food access. This is because the use of fertilizers was able to increase the crop yields for those involved and some of it was sold thus making the households to be in position to buy the preferred foods.

The use of drought resistant crops had 8.2% households who had sufficient food access, 78.7% households who had moderate food access and 13.1% households who had insufficient food access. The majority of the households had moderate to sufficient food access. The use of drought resistant crops enabled the farmers to get money that is used to buy other food that they prefer to eat. This was especially true when high crop yields obtained from the farms were sold.

There were 10 households involved in operation of shops. Out of this, 80% had moderate food access while 20% had insufficient food access. It can therefore be seen that most of the households had moderate food access. The operation of shops was associated with the advantage of earning cash for the households involved hence they were able to purchase food of preferred taste and in sufficient quantities

The data revealed that 5% of the households using motorcycling had sufficient food access, 80% had moderate food access while 15% households had insufficient food access. Therefore, most of the households had moderate to sufficient food access because the use of motor cycling provided income to the households involved hence they were able to obtain food from other sources such as the market.

Out of the 4 households who were practicing brick lying, 25% households had sufficient food access, 25% households had moderate food access while 50% households had insufficient food access. This is because this activity is only carried out from December to March hence households

do not get cash during the remaining period of time which accounts for the big percentage of households who had insufficient food access.

The use of small scale irrigation farming had 68.2% households who had sufficient food access and 31.8% households who had moderate food access. Therefore, households involved in this practice had moderate to sufficient food access. The use of small scale irrigation farming avails crops such as vegetables throughout the year hence the households involved sell these crops and get money which increases their ability to purchase sufficient quantities of food that they desire.

All the households using market vending and rain water harvesting had moderate food access. The households using market vending had moderate food access since they were able to sell their crop produce and got money to purchase what they did not have while the households involved in rain water harvesting had moderate food access because the water obtained enabled them to grow crops that they sold hence increasing their ability to obtain the food that they do not have.

The use of crop diversification had 11.2% households who had sufficient food access, 83.3% households had moderate food access while only 4.2% households had insufficient food access. Therefore, the majority of the households had moderate to sufficient food access since the use of crop diversification enabled the farmers to get two or more crops that were sold to earn money that was used to obtain other crops and animal products from the market and other sources.

4.4.1 Food access among adapters and non-adapters

The study conducted a comparison between the adapters and non-adapters and the results were displayed in table 4.13. This was carried out so as to find out which of the two groups was better off in terms of food access.

Table 4.13: Cross Tabulation of Food Access and Adaptation Status

			ACCESS			
			Sufficient food access	Moderate food access	Insufficient food access	Total
Adaptation status	adapters	Count	63	204	56	323
		%	19.5%	63.2%	17.3%	100.0%
	non-adapters	Count	5	20	27	52
		%	9.6%	38.5%	51.9%	100.0%
Total		Count	68	224	83	375
		%	18.1%	59.7%	22.1%	100.0%

The cross tabulation between food access and adaptation status shows that 19.5% of the adapters had sufficient food access, 63.2% of the households who had moderate food access while 17.3% households had insufficient food access. There were 9.6% of the non-adapters had sufficient food access, 38.5% households had moderate food access while 51.9% households had insufficient food access. This indicates that the adapters of climate change adaptation practices were able to have food access while most of the households who did not adapt to climate change were not able to attain food access. This therefore shows that adaptation is better than non-adaptation in terms of food access. The cross tabulation was then tested using the chi square test in table 4.14 in order to find out whether there is a significant difference between adapters and non-adapters of climate change adaptation practices in terms of food access.

Table 4.14: Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	31.195[a]	2	.000
Likelihood Ratio	26.670	2	.000
Linear-by-Linear Association	22.031	1	.000
N of Valid Cases	375		

The significant value is 0.000 which shows that there is a significant difference between adapters and non-adapters in terms of food access. This indicates that adapters and non-adapters differ in terms of food access. The null hypothesis which states that there is no significant difference between adapters and non-adapters was therefore rejected.

4.5. Climate Change Adaptation Practices and Food Utilization

The study adopted Ndyepoya's (2013) Household Dietary Diversity (HDDs) which finds out the food utilization status of the households by asking whether the households have eaten any of the 12 food groups in table 3.2 within the last 24 hours. Each food group is given a score of 1. Total scores close to 12 shows a greater dietary diversity while scores close to 1 shows less dietary diversity. The 12 scores classify the households into 3 major groups that is households who had great dietary diversity with scores of 9 to 12, households with moderate dietary diversity with scores of 5 to 8

and households who had less dietary diversity with scores that were less than 4. This is shown on table 4.15

Table 4.15: Cross Tabulation of Climate Change Adaptation Practice and Food Utilization

CCAPs		Food utilization status			
		Less dietary diversity	Moderate dietary diversity	Great dietary diversity	Total
Early planting	Count	40	64	4	108
	%	37.0%	59.3%	3.7%	100.0%
New crop varieties	Count	23	47	2	72
	%	31.9%	65.3%	2.8%	100.0%
Fertilizers	Count	1	1	0	2
	%	50.0%	50.0%	.0%	100.0%
Drought resistant	Count	26	32	3	61
	%	42.6%	52.5%	4.9%	100.0%
Operation of shops	Count	6	4	0	10
	%	60.0%	40.0%	.0%	100.0%
Motor cycling	Count	6	14	0	20
	%	30.0%	70.0%	.0%	100.0%
Brick laying	Count	0	4	0	4
	%	.0%	100.0%	.0%	100.0%
Small scale irrigation	Count	11	11	0	22
	%	50.0%	50.0%	.0%	100.0%
Market vendor	Count	3	1	0	4
	%	75.0%	25.0%	.0%	100.0%
Crop diversification	Count	4	10	4	18
	%	22.2%	55.6%	22.2%	100.0%
Rain water harvesting	Count	1	0	1	2
	%	50.0%	.0%	50.0%	100.0%
Total	Count	121	188	14	323
Percentage	%	37.5%	58.2%	4.3%	100.0%

Among the households involved in early planting, 37% had less dietary diversity, 59.3% had moderate dietary diversity and 3.7% had great dietary diversity. A great number of households therefore had moderate to great dietary diversity and this was attributed to the fact that early planting ensures a stable crop yield under a changing climate hence some of the crops were sold and used to purchase animal products and other crops not grown by the households.

For households undertaking the use of new crop varieties, 31.9% had less dietary diversity, 65.3% had moderate dietary diversity while only 2.8% had great dietary diversity. This therefore pointed out that most of the households had moderate to great dietary diversity. This was because the use of new crop varieties ensures increase in crop production amidst a changing rain pattern hence some crops were sold to obtain cash that was used to purchase other food crops.

The data revealed that 50% households practicing application of fertilizers and small scale irrigation farming had less dietary diversity and 50% had moderate dietary diversity hence they had less to moderate dietary diversity. The use of fertilizers led to increased crop yields and money obtained from the sale of the crops was used to purchase other food groups. At the same time, untimely application of fertilizers led to wastage when the rains delayed to arrive hence leading to a decrease in crop yields and income earned thus less dietary diversity. Small scale irrigation farming ensured that more than one food group is harvested hence the moderate dietary diversity. However, most of the farmers at times sold most of their produce and remained with less than two crops hence less dietary diversity.

The use of drought resistant crops had 42.6% households with less dietary diversity, 52.5% with moderate dietary diversity and 4.9% with great dietary diversity hence the majority had moderate to great dietary diversity. This was because the use of drought resistant crops availed two or more crops in a year therefore provided the households with more food groups since these seeds withstood harsh conditions of unreliable rains and hot temperatures.

For the households involved in operation of shops, 60% had less dietary diversity while 40% had great dietary diversity hence most of the households had less dietary diversity. This was because the households involved in this practice aimed at making profits and these profits were ploughed back into the business so as to expand it hence less food groups were bought for the family.

Among the households involved in motor cycling, 30% had less dietary diversity while 70% had moderate dietary diversity. This indicated that most of the households had moderate dietary diversity since those involved earned income from their activities and bought other food crops to top up on what they get from the small scale farms.

All the households involved in brick laying had moderate dietary diversity. This was because this practice earned income to the households involved especially when the rains delayed to arrive.

Some of the households kept the money and used it to purchase various food groups hence making them to be able to eat more than one food crop.

For those involved in market vending, 75% had less dietary diversity while 25% had moderate dietary diversity hence most of the households had less dietary diversity. Market vending was associated with the selling of mainly perishable crops whose supply is unstable in nature. This therefore indicated that the households did not have stable income hence could not afford to buy many food crops. This was made worse by the desire of the market vendors to expand their business in order to make more money.

Among the households involved in crop diversification, 22.2% had less dietary diversity, 55.6% had moderate dietary diversity while 22.2% had great dietary diversity. This therefore showed that most of the households had moderate to great dietary diversity. In comparison to other CCAPs, those involved in crop diversification had the highest percentage of households with great dietary diversity. This is because crop diversification provides a variety of crops to the households in one season hence they were able to eat more groups of food.

For the households using rain water harvesting, 50% households had less dietary diversity while 50% households had great dietary diversity. This gave a very big gap between those with less dietary diversity and those with great dietary diversity. This is because the timely application of water increased crop and excess crops were sold to purchase animal products and other crops while untimely application of fertilizers leads to low crop yields hence less food groups were consumed.

4.5. Food Utilization among Adapters and Non-Adapters

A comparison between the food utilization among adapters and non-adapters was carried out and the results were displayed in table 4.16.

Table 4.16: Cross Tabulation between Food Utilization and Adaptation Status

			Food utilization			
			Less dietary diversity	Moderate dietary diversity	Great dietary diversity	Total
Adaptation status	adapters	Count	121	188	14	323
		%	37.5%	58.2%	4.3%	100.0%
	non-adapters	Count	27	23	2	52
		%	51.9%	44.2%	3.8%	100.0%
Total		Count	148	211	16	375
		%	39.5%	56.3%	4.3%	100.0%

The cross tabulation between food utilization and adaptation status showed that 4.3% of the adapters had great dietary diversity, 58.2% of the households were moderate dietary diversity while 37.5% had less dietary diversity. About 3.8% of the non-adapters had great dietary diversity, 44.2% were moderate dietary diversity while 51.9% had less dietary diversity. This indicated that the adapters of climate change adaptation practices were able to consume food from difference food groups while most of the households who did not adapt to climate change using any of the practices ate food from few food groups. This therefore showed that adaptation was better than non-adaptation in terms of food utilization. The cross tabulation was then tested using the chi square test in table 4.17 in order to find out whether there was a significant difference in food utilization between adapters and non-adapters of climate change adaptation practices.

Table 4.17: P Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.953[a]	2	.139
Likelihood Ratio	3.878	2	.144
Linear-by-Linear Association	3.185	1	.074
N of Valid Cases	375		

The Pearson chi square has a significance value of 0.139 which is above the significance level of 0.05% which showed that there was no significant difference between adapters and non-adapters in terms of food utilization. This reveals that adapters and non-adapters do not differ in terms of food utilization. The null hypothesis which states that there is no significant difference between adapters and non-adapters in terms of food utilization is therefore accepted.

4.6. Climate Change Adaptation Practices and Food Stability

The household hunger scale (HHS) recommended by Vhurukumu (2014) was adopted in finding out the food stability status of the households. The households were asked whether one or all of their household members had spent a whole day without eating because there was not enough food to eat or if one or all of the household members went to bed hungry due to lack of food. If they experienced any of the two conditions then they have unstable food system but if they did not experience any of the two conditions then they had a stable food system. The data collected was displayed in table 4.18

Table 4.18: Climate Change Adaptation Practices and Food Stability Cross Tabulation

villages		food stability		Total
		Stable food system	Unstable food system	
Early planting	Count	6	102	108
	%	5.6	94.4	100.0
New crop	Count	4	68	72
	%	5.6	94.4	100.0
Fertilizers	Count	0	2	2
	%	.0	100.0	100.0
Drought resistant crops	Count	6	55	61
	%	9.8	90.2	100.0
Operation of shop	Count	0	10	10
	%	.0	100.0	100.0
Motor cycling	Count	0	20	20
	%	.0	100.0	100.0
Brick lying	Count	0	4	4
	%	.0	100.0	100.0
Small scale irrigation	Count	0	22	22
	%	.0	100.0	100.0
Market Vending	Count	0	4	4
	%	.0	100.0	100.0
Crop diversification	Count	0	18	18
	%	.0	100.0	100.0
Rain water harvesting	Count	0	2	2
	%	.0	100.0	100.0
Total	Count	16	307	323
Percentage	%	5.0%	95.0	100.0

The households involved in early planting, new crop varieties and use of drought resistant crops had a few households with stable food systems while the rest had unstable food systems. There were 9.8% of the households practicing the use of drought resistant crops had stable food system while 90.2% of the households had unstable food systems. For those involved in early planting and the use of drought resistant crops, 5.6% had stable food system while 94.4% had unstable food system.

All the households involved in application of fertilizers, operation of shop, motor cycling, brick laying, small scale irrigation farming, market vending, crop diversification and rain water harvesting had unstable food systems. This therefore indicates that all the households had at one time gone a whole day without food, spent a night without food or experienced both conditions. This shows that all these practices were incapable of enabling the households attain food stability.

4.6.2 Food Stability between Adapters and Non-Adapters

The adaptation status and food stability status were cross tabulated as indicated in table 4.19 in order to carry out the chi square test.

Table 4.19: Cross Tabulation of Adaptation Status and Food Stability

Adaptation status		food stability		Total
		stable	unstable	
adapters	Count	16	307	323
	%	5.0	95.0	100.0
Non-adapters	Count	1	51	52
	%	1.9	98.1	100.0
Total	Count	17	358	375
	%	4.5	95.5	100.0

The cross tabulation between adaptation status and food stability status indicates that the adapters had more food stable households compared to the non-adapters. The adapters had 5.0% stable food system and 95.0% had unstable food system while non-adapters had 1.9 % households who had stable food system while 98.1% had unstable food. These statistics therefore show that adaptation has the ability to achieve food stability more than non-adaptation. The cross tabulations were further tested using the chi square in order to find out whether there is a significant difference between adapters and non-adapters of climate change adaptation practices in terms of food stability. The chi square test is shown on table 4.20

Table 4.20: Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.950[a]	1	.330
Continuity Correction	.379	1	.538
Likelihood Ratio	1.164	1	.281
Linear-by-Linear Association	.948	1	.330
N of Valid Cases	375		

The Pearson chi square test showed a significance value of 0.330 which is above the significance level of 0.05%. This shows that there is no significant difference between adapters and non-adapters in terms of food stability. It therefore revealed that adapters and non-adapters do not differ in terms of food stability. The null hypothesis which states that there is no significant difference between adapters and non-adapters in terms of food stability is therefore accepted. However, the cross tabulation shows that adaptation is better off than non-adaptation since adaptation has more food secure households compared to non-adaptation. Therefore, much as there is no significant difference between adapters and non-adapters in terms of food stability, adaptation is still better than non-adaptation as shown by the cross tabulations in table 4.19.

4.7 Discussion of Results

The results of the data presented and analyzed were discussed in relation to the existing literature under this sub section as follows;-

4.7.1 Climate Change Trends

The annual rainfall of Lamwo for the last 25 years show that the lowest rainfall was received in 2005 and the heaviest rainfall was received in 2013. This agrees with Mwongera et al (2014) who noted that the heavy rainfall received in 2013 disrupted the agricultural activities.

The temperature of Lamwo has changed over time. The hottest temperature was experienced in 2009 and it kept decreasing continuously up to 2016. This is not in line with ACCRA (2011) which noted that the temperatures have become hotter than before.

4.7.2 Characterization of Climate Change Adaptation Practices

Early planting was the most dominant CCAPs in Lamwo district. It involved the sowing of seeds a week early before the arrival of the rains. Most of the households said that they had chosen early planting because of the encouragement from the CDO. However, this does not relate to climate change. Some farmers said that they were using early planting as it is associated with advantages such as being good for the rains that fall for a short time, enabling to tap and utilize rains as well as encouraging the crops to mature within the rain season. This is in line with Burke and Lobell (2010) who wrote that the advantage of early planting lies in the tapping of the entire rain season which supports the growth of the crops within the rain season especially in areas that have short rain periods.

The second most dominant on-farm climate change adaptation practice was the use of new crop varieties. The use of new crop varieties involved planting of seeds that were fast maturing. Most of the households were using new crop varieties said that they had chosen this practice because it was good for the rains that fall for a short time. This is in line with Smith and Skinner (2002) who noted that the new crop varieties were suitable for the current climate since even when the rains disappear, the seeds will still germinate, mature and give a good harvest amidst a challenging weather.

The use of drought resistant crops was the 3rd most dominant CCAPs in Lamwo. The use of drought resistant crops involved planting of fast maturing seed varieties. The data collected revealed that the households who had chosen the use of drought resistant crops did so because it was good for the rains that fall for a short time. This is in line with Mubatsi (2013) who pointed out that drought resistant crops survive under very little rainfall that is inadequate to support plant growth. Some of the households said that the seeds mature within the rain season and can even survive with a sort rain season yet still yield good harvest. This is in agreement with CGIAR (2009) which noted that these crops yield immediate benefits in terms of food security. Some households explained that the use of drought resistant crop varieties enabled the seeds to thrive even with little rains and that the crops gave a high yield. This agrees with CGIAR (2009) which pointed out that the drought resistant crops can tolerant extreme weather conditions and still produce high crop yields. Some households said that they wanted to have access to food since drought resistant can survive under harsh conditions and still provide food. This is also in agreement with CGIAR (2009) that pointed out that the drought resistant crops can tolerant extreme weather conditions and still produce high

crop yields while other households explained that they had adopted the practice because it gives them more yields compared to the indigenous seeds since the drought resistant crops survive even when the rains disappear. This is in line with CGIAR (2009) that noted that these crops produce better yields during drought conditions and at the same time do not compromise yields in the situations that were unstressed.

The fourth most dominant CCAPs was small scale irrigation farming. Small scale irrigation is the artificial transfer of water from the rivers to the farms. Most of the households using this practice explained that they had chosen it because it enabled them to get double benefits that is two or more crops a year given the prolonged drought. This connects with Awulachew (2005) who wrote that irrigation enabled the farmers to get more than one crop in a year.

Crop diversification was revealed as the 5thmost dominant on-farm CCAPs. Crop diversification involves planting two or more crops on the same farm. Most of the households who were practicing crop diversification said that they had chosen it because it catered for crop failure due to changing rain patterns. This is in line with CGAIR (2005) which stated that crop diversification enabled a farmer to avoid dependence on one crop as a source of food and income since it moderates crop failure. Some households explained that the practice gives them double benefits since they can get good harvest for both crops. This agrees with (UNFCC 2007) which noted that crop diversification has got various economic returns and the farmer gets foods of nutritious values. This connects with Stewarta and Roberts (2012) who wrote that the fertilizers improve the quality of the land leading to an increase in crop yields.

The least dominant on-farm CCAPs in Lamwo district was the use of fertilizers. The use of fertilizers involves the application of organic and inorganic manure .All the households using this practice said that their choice was due to the fact that fertilizers add fertility to the soils and therefore encourage constant high yields. This connects with Stewarta and Roberts T (2012) who wrote that the fertilizers improve the quality of the land leading to an increase in crop yields.

Motorcycling was the most dominant off-farm CCAPs. This involved riding the motor cycle in order to get cash. Most of the households who had adapted to climate change using motorcycles that their choice was mainly influenced by the advantages of getting double benefits from farm and from motorcycling. This is in agreement with Pandey et al (2007) and Kimty (2015) who noted that

the people who adopt off-farm activities can use income from the non-agricultural sources to access food.

The data collected shows that operating the shops was the second most dominant off-farm CCAPs. This involved selling of items in a shop in order to get money. Most of the households who had adapted operation of the shop said that they chose it because it enabled them to get access to food since cash from the operation was used to obtain food in times of crop failure associated with climate change. This is in line with Kimty (2015) who stated that the involvement in off-farm activities enabled the farmers to use the income that they had to buy food.

The third dominant off-farm CCAP was found to be brick laying. This involved the making of bricks which was then sold to obtain cash. Most of the households who had adapted operation of the shop said that they chose it because it enabled them to get access to food since cash from the operation was used to obtain food in times of crop failure associated with climate change. This is in line with Kimty (2015) who stated that the involvement in off-farm activities enabled the farmers to use the income that they had to buy food.

Just like brick laying, market vending was the third dominant off-farm CCAPs. Market vending involves selling of mainly crops in the market stalls. Most of the households using market vending said they wanted to reap double benefits from the practice through selling the excessive perishable foods to purchase food later in cases of crop failure as a result of climate change. This is in line with Kimty (2015) who stated that involvement in off-farm activities enabled the farmers to use the income that they had to buy food.

The least dominant off-farm adaptation was the rain water harvesting. The households involved in this practice linked their choice to the benefits of having double benefits and using of the water for crop growing in cases were the rains delayed to arrive. This agrees with UNAP (2007) and Lakew (2004) who noted that rain water harvesting provided water for crops and animals in the dry season.

4.7.3 Climate Change Adaptation Practices and Food Availability

Households using small scale irrigation farming had the highest percentage of participants who had adequate food availability. This therefore indicates that it was the most effective means of attaining food availability in Lamwo district. This is in line with EDO (2014) and Mengistu (2008) who

noted that irrigation provided two or more crops in one year because of the presence of soil moisture which increased production hence increases food availability of a farmer.

All the households involved in use of fertilizers, operation of shop, brick laying, market vending crop diversification and rain water harvesting had moderate food availability. The households using fertilizers said that the practice had enabled them to get food for more than half a year. This connects with Benton (2016) who pointed out that the use of fertilizers facilitate increase in crop production hence food availability. The households involved in operation of shop, market vending and brick laying associated these off-farm activities with the advantage of obtaining money which is used to buy food in case of crop failure as a result of weather changes. This is in line with Kimty (2015) who noted that the farmers who practice off-farm activities use the income to purchase food hence reducing their vulnerability to climate change. The households practicing crop diversification had enough food to eat for more than half a year given that two or more crops were obtained as a result of the practice. This agrees with Lin (2011) who noted that planting of different crops enabled the farmers to have food throughout the year. The participants involved in rain water harvesting were also able to attain food availability for more than half a year since water was available for both plants and crops in circumstances when the rains delayed to arrive. This agrees with UNAPA (2007) and lakew (2004) who pointed out that rain water harvesting provided water for crops and livestock in the dry season hence promoting food availability.

Most of the households using early planting, new crop varieties and drought resistant crop varieties had moderate food availability. For those involved in early planting, the participants associated the practice with its advantage of availing stable food supply. This is in line with ACCRA (2011) which noted that early planting makes it possible for the farmers to have a stable yield because it reduces the negative impact of hotter temperatures since the plants have a lengthen season of growth which makes the plants to grow, flower, mature before the temperatures become very hot hence the farmers harvest and dry the crops when the temperatures were hot thus food availability. The households using new crop varieties said that the practice had enabled them to have more food crop than using the indigenous crops. This is in line with Thompson (2017) who noted that new crop varieties have the ability to increase crop production hence food availability. The households involved in the use of drought resistant crops said that the practice enabled them to attain food availability through increasing the crop yields. This agrees with CGIAR (2009) which noted that

the use of drought resistant crops in some cases produce twice the amount of yields in semi-desert to tropical climates hence providing food for the farmers who practice it.

Motorcycling had the highest percentage of households who had inadequate food availability. It also had households with moderate food availability. In comparison to other CCAPs, motorcycling is the most ineffective CCAP in attaining food availability given that it had the biggest number of households who did not have enough food to eat. This disagrees with Pandey et al (2007) who noted that the farmers who practice off-farm activities use the income to have purchase food.

4.7.4 Climate Change Adaptation Practices and Food Access

All the households involved in operation of shop, small scale irrigation farming, market vending and rain water harvesting had moderate to sufficient food access. The households practicing operation of shop were able to have access to food and did not experience severe conditions of HFIAS. This therefore pointed out that operation of shop was successful in achieving food access. This is in line with Kimty (2015) who noted that off-farm activities enable the farmers to get income that they use to buy food of preferred choices in desired quantities. The households using small scale irrigation farming were able to obtain food that they preferred. This is in line with EDO (2014) and Mengistu (2008) who wrote that small scale irrigation reduces crop failure hence increasing food production so the excess food can be sold and money obtained is used to purchase what the households desire. The households involved in market vending had all the households having access to food. This agrees with Burke and Lobell (2010) who noted that the farmers use the money obtained from non-agricultural sources to have access to food. All the households using rain water harvesting were able to meet the food demands of their households. This agrees with UNAPA (2007) and Lakew (2014) that pointed out that rain water harvesting promotes food access by aiding off-farm activities.

Most of the households using early planting, new crop varieties, fertilizers, drought resistant crops, motor cycling and crop diversification had moderate to sufficient food access. More than half of the households using early planting were able to have access to food. This is not in line with Wyffels (2011) who noted that early planting is associated with crop failure when the rains take longer to arrive than expected hence exposing the seeds to unfavorable conditions like inadequate soil moisture which leads to crop failure hence reducing output which in turn affects the farmers ability

to attain food access. Given that most of the households using new crop varieties were able to have access to food; this indicates that the practice was successful in attaining food access. This connects with Thompson (2017) who pointed out that new crop varieties increase production hence the excess output is sold and the farmers were able to buy what they prefer in required amounts. Among households involved in the use of fertilizers, half households had moderate food access and the remaining half had sufficient food access. This shows that the use of fertilizers was successful in achieving food access. This agrees with Stewarta W and Roberts T (2012) who noted that the use of fertilizers increases crop yields so the farmers sell the extra output and purchase the crops that they prefer and in desired quantities. The households using drought resistant crops had sufficient quantities of preferred food for their households. This relates to CGIAR (2009) which pointed out that drought resistant crops produce twice the amount of yields compared to other crops thus the extra crops were sold and used to buy what the farmers prefer in sufficient quantities for all the households. The households using motor cycling were able to get cash that they used to purchase food for their households. This relates to Kimty (2015) who noted that off-farm activities enabled the farmers to get income that they use to buy food of preferred choices in desired quantities. The households using crop diversification were able to have access to food since the practice gave them double yields from the crops planted. This is in line with UNFCC (2007) that noted that crop diversification yields various economic returns to the farmers hence they were able to acquire the preferred foods.

4.7.5 Climate Change Adaptation Practices and Food Utilization

Half of the households using rain water harvesting had great dietary diversity and half had less dietary diversity. Given that it had the third highest percentage of households with less dietary diversity, it was therefore ineffective in addressing food access in comparison to other CCAPS. This disagrees with Onyango and Imbai (2017) who noted that the communities who had adopted rain water harvesting were having better nutrition than those who did not adopt this practice.

More than half of the households using early planting, new crop varieties, drought resistant crop, motor cycling and crop diversification had moderate dietary diversity. The households using early planting had stable yields and sold out excess food so as to obtain the food they did not have hence had moderate food access. This is in line with ACCRA (2011) which noted that early planting makes it possible for the farmers to have a stable yield. The households using new crop varieties

were able to eat various food crops hence had moderate dietary diversity. This is in line with Thompson (2017) who wrote that the new crop varieties have the ability to improve the nutrition of the households. Among the households involved in the use of drought resistant crops, most of them had moderate dietary diversity. This connects with ICRISAT (2017) which noted that the farmers who had adopted the use of drought tolerant crops were already realizing its role in ensuring food and nutrition security. The households using motor cycling were able to obtain money that they used to purchase various foods. This is in line with Rapheal and Matin (2016) who stated that the farmers who have adopted the use of off-farm activities have better nutrition when compared to those who were not involved in this activity. The households involved in crop diversification were able to harvest more than two crops from their gardens which gave them more food groups to eat. This is in line with UNFCC (2007) who noted that the farmers who adopt crop diversification were able to get food crops of different nutritious values.

For those involved in the use of fertilizers, operation of shop, small scale farming and market vending, more than half of the households had less dietary diversity. The households practicing application of fertilizers were not able to have more food groups hence had less dietary diversity. This does not connect with Dejoia (2011) who wrote that the fertilizers add nutrients like potassium, calcium, iron, phosphorus and nitrogen to the soils and when absorbed by the crops, the people who eat such crops get up getting these nutrients and that fertilizer facilitates growth of many crops hence the farmers were provided with various nutritious foods. Most of the households using operation of shop and market vending had less dietary diversity which indicates that the use of these off-farm activities were ineffective in achieving food utilization. This contradicts with Rapheal and Matin (2016) who stated that the farmers who have adopted the use of off-farm activities have better nutrition when compared to those who were not involved in this activity. For the households using small scale irrigation, half had less dietary diversity while the remaining half had moderate dietary diversity. This pointed out that the use of small scale irrigation was moderately effective in achieving food utilization since half of the adapters had less dietary diversity and no household had great dietary diversity. This agrees with Mekuria, (2003) Burke and Lobell, (2010) who wrote that irrigation enabled the farmers to have more than one crop in a year hence have many foods to eat in a year.

4.7.6 Climate Change Adaptation Practices and Food Stability

Less than quarter of the households involved in early planting, new crop varieties and drought resistant crops had stable food system while the rest had unstable food systems. Although most of the households using early planting had unstable food system, early planting is the second most effective CCAPs of achieving food stability in comparison with other CCAPs in Lamwo district. This is not in line with Wyffels (2011) which pointed out that a delay in the arrival of rains results into uneven crop growth and crop failure hence low crop yields which is an indication of food instability. Most of the households using new crop varieties had the same percentage of households just like early planting hence it is also the second most effective CCAPs of attaining food stability. This agrees with Benton (2016) who noted that fast maturing crops increase yields in a sustainable way.

All the households using fertilizers, operation of shop, motor cycling, brick laying, small scale irrigation, market vending, crop diversification and rain water harvesting had unstable food system. For those involved in the use of fertilizers, the output from the farms was not sufficient for the households since incorrect application of fertilizers lead to a low output. This contradicts Stewarta and Roberts (2012) who said that the use of fertilizers leads to an increase in crop yields hence promoting food security. The households involved in operation of shop, motor cycling, market vending and brick laying sometimes lack customers for a whole day which indicates that these households cannot have money to purchase food for their households in such circumstances hence at one time or more, they had to go without food at night which explains the unstable food system. This is not in line with Burke and Lobell (2010) who noted that farmers who adopt non farm income sources use the income obtained to purchase food from other sources hence have stable food systems. For the households involved in small scale irrigation farming, the desire for more cash made them to sell most of their produce especially rice and as they waited for the other crops to mature, they spent a night or whole day without food. This is not in line with Awulachew (2005) who wrote that small scale irrigation enabled households to get more than one crop a year hence increasing the number of crops obtained from the farmland per year. The households involved in crop diversification had unstable food system due to the fact that the delay in arrival of rains led to low crop yields hence little of both crops grown is harvested. For the households involved in rain water harvesting, shortage of rain water due to a delay in the arrival of rains created a problem of

food shortage hence the unstable food system. This contradicts UNAPA (2007) and Lakew (2004) who wrote that rain water is crucial in food security through promoting food access and food availability which are aspects of food stability.

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

5.0 Introduction

This chapter contains the discussions of the findings, conclusions from the finding, recommendations for action as well as recommendations for further research.

5.1 Conclusions

The study found out that the rainfall amounts, seasons, the number of rain days and the temperatures all showed a fluctuating trend. The rainfall amounts increased from 2007 and reached a climax in 2013. It then decreased continuously up to 2016. The mean number of rain days increased greatly from 2002-2006 to 2012-2016 indicating that the area has become wetter than before. The numbers of rain months have been ranging between 6 and 10 and the data for the last 3 years that is 2014 to 2016 shows that the numbers of rain months were decreasing. The study found out that the temperatures in the area have been decreasing for the last 6 years that is from 2010 to 2016 indicating that the area has becoming cooler that before.

The findings showed that early planting was the most dominant on-farm climate change adaptation practice in Lamwo district. This was followed by the use of new crop varieties, drought resistant crop varieties, small scale irrigation farming and crop diversification with 6 while the least dominant on-farm climate change adaptation practice was the use of fertilizers. The most dominant off-farm climate change adaptation practice in Lamwo district was motorcycling, followed by operation of shop, brick lying and market vending while the least dominant was rain harvesting.

The findings revealed that small scale irrigation was the most effective practice of attaining food availability in Lamwo district since it had the highest households who had enough food to eat for 10-12 months. The 2nd most effective climate change adaptation practice was the use of drought resistant crops, followed by early planting and the use of new crop varieties. The least effective climate change adaptation practice of accomplishing food availability was motor cycling. All the other practices had all the households with moderate food availability status.

The findings revealed that small scale irrigation farming was the most effective climate change adaptation practice of achieving food access in Lamwo district, followed by the use of fertilizer, the use of new crop varieties, crop diversification, and the use of drought resistant crops. The least

effective climate change adaptation practice of attaining food access was brick lying followed by early planting, operation of shop and motor cycling. The chi square test showed that there was a significant difference between the adapters and non-adapters in terms of food access hence adaptation was better than non-adaptation.

The findings revealed that crop diversification was the most effective climate change adaptation practice of achieving food utilization, followed by brick lying. The least effective climate change adaptation practice of accomplishing food security was market vending followed by operation of shop, use of fertilizers, use of drought resistant crops, early planting and the use of new crop varieties.

The cross tabulations revealed that the use of drought resistant crops was the most effective climate change adaptation practice of attaining food stability. New crop varieties and early planting were 2nd most effective climate change adaptation practices. All the other adaptations had unstable food stability. The cross tabulations shoed that adaptation was better than non-adaptation. However, the chi square test revealed that there was no significant difference between adapters and non-adapters in terms of food stability hence adaptation and non-adaptation were equal in attaining food stability.

5.2 Recommendations

The study found out that the temperatures in the area was becoming cooler than before and that both the rain days and number of rain months were decreasing. The amount of rainfall in the area was also decreasing. The people should therefore be taught to use adaptation practices such as the use of new crop varieties that were fast and quick maturing so as to overcome the effects of a decreasing rainfall amounts.

The findings revealed that small scale farming was the most effective adaptation practice for achieving food availability and food access. The households using small scale farming had enough food to eat for more than 4 months. The households involved in small scale irrigation farming also had the ability to attain food allocation, affordability and food preference which were the main aspects of food access. Therefore, the farmers in Lamwo district who live near rivers and streams should therefore use small scale irrigation.

The use of drought resistant crops was the most effective climate change adaptation practice of attaining food stability which combines the three other aspects of food security. The agricultural officers and non-government organizations concerned with food security issues should teach and encourage the farmers to use drought resistant crops so as to attain food stability in the area.

The use of crop diversification was the most effective climate change adaptation practice of attaining food utilization in Lamwo district. Therefore the policy makers, political leaders and agricultural officers should teach the farmers the benefits of new crop diversification as well as the crops that can easily be intercropped with another without competing for the same food nutrients.

The households should be advised to carry out off-farm activities that are less prone to climate change besides the on-farm activities. This was because the on-farm activities can act as a source of cash for purchase of food in case there was crop failure as a result of delayed arrival of the rains.

5.3 Further research

This research focused on comparing the effectiveness of climate change adaptation practice in addressing food security. It would also be necessary for a research to be carried out to find out the role of different agents in promoting the adaption of various climate change adaptation practices.

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APPENDICES

Appendix 1: Questionnaire for household heads

Good day, I'm Alonyo Sharon, a student of Kyambogo University pursuing a master's degree in Art in Geography. I am currently conducting research on climate change adaptation and food security in Lamwo. Your participation is voluntary and you may only answer questions that you are comfortable with. I humbly request that you answer each question as honestly as possible.

Bio data

Sex (tick the appropriate)

Female ☐ Male ☐

Level of education (tick the appropriate)

Primary ☐ Secondary ☐ Tertiary ☐ Non formal education ☐

Climate change trends

Do you agree that climate change has taken place? Yes ☐ No ☐

If yes, what in your view shows that it has taken place?

_____

_____

Climate change adaptation practices

Have you adopted practices to neutralize climate change? Which one of the following?

NO	Climate change adaptation practices	Tick one	Reason for the practice	how are you doing it
1	Early planting			
2	New crop varieties (fast maturing)			
3	Use of fertilizers			
5	Drought resistant crops			
6	Off-farm activities			
7	Small scale irrigation			
8	Rain water harvesting			

Food availability

How does your household obtain food? _____

If you produce, what proportion? A Small ☐ medium ☐ C big ☐

Do you sometimes borrow food? Yes ☐ No ☐

From who? _____ Which type of food? _____

Do you pay back? Yes ☐ No ☐

Do you sometimes purchase food? Yes ☐ No ☐

Which type of food? _____ Who gives the money? _____

How much does it cost? _____

Have you even run out of food? A Yes ☐ B No ☐

If yes, in which month(s)

Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec

Food access

The following questions require memory of what happened in the 30 past days, indicate whether it happened, never, rarely (once or twice), sometimes (about 3 to 10 times) or often (more than 10 times) in the past 30 days.

No.	Household Food Insecurity Scale	Never	Rarely	Sometimes	Often
1.	Did you worry that your household would not have enough food?				
2.	Were you or any household member not able to eat the kinds of foods you preferred because of a lack of money?				
3.	Did you or any household member have to eat a limited variety of foods due to a lack of money?				
4.	Did you or any household member have to eat some foods that you really did not want because of lack of resources to obtain other types of food?				
5.	Did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?				
6.	Did you or any household member have to eat fewer meals in a day because there was not enough food?				
7.	Was there ever no food to eat of any kind in your household because of lack of resources to get food?				
8.	Did you or any household member go to sleep at night hungry because there was not enough food?				
9.	Did you or any household member go a whole day and night without eating anything because there was not enough food?				

What is your source of income?(tick the appropriate)

Formal ☐ Informal ☐

If formal, how much do you spend on food in a month?

Below 25,000 ☐ Between 25,100 and 50,000 ☐

Between 50,100 and 75,000 ☐ Between 75,100 and 100,000 ☐

Above 100,000 ☐

How much is your total household expenditure in a month?

Below 25,000 ☐ Between 25,100 and 50,000 ☐

Between 50,100 and 75,000 ☐ Between 75,100 and 100,000 ☐

Above 100,000 ☐

What proportion of your income goes to food? _____

If informal, what is your source of food? _____

How many bags of food crops do you harvest? _____

What food? _____

How many do you sell? _____

What proportion of the money from the sales goes to food? _____

What food? _____

Food utilization

Did your household eat any of the food groups in the table yesterday or in the past seven days?

NO	FOOD GROUPS	Ate yesterday		Ate in the past 7 days
		NO	YES	
1	Any (local food) bread, millet, sorghum, maize, rice			
2	Potatoes, yams, manioc, cassava or any other foods made from roots and tubers			
3	Vegetables			
4	Fruits			
5	Beef, pork, lamb, goat, rabbit, wild game, chicken, other birds, liver, kidney, heart, or other organ meat			
6	Eggs			
7	Fresh or dried fish or shellfish			
8	Foods made from beans, peas or nuts			
9	milk or milk products			
10	Foods made with oil, fat or butter			
11	Sugar/ honey			
12	Tea/coffee			

In case of food shortage, which members of the household eat less food such that others have enough to eat?

Children	
Women	
Men	

Which of the following meals does your household have daily?

Breakfast	
Lunch	
Supper	

What does your household have for?

Breakfast	
Lunch	
Supper	

What would you prefer to have for?

Breakfast	
Lunch	
Supper	

What is the commonest illness your household suffers from? _____

What is your source of food? _____

Are there foods you are not supposed to eat? Yes No

Who decides on the food to be cooked? _____

Do you all eat the same food? Yes No

Do you eat at the same time? Yes No

Food stability

In which season do you experience food shortage? _____

How does your household act in response to food shortage?_____

_____

Who chooses the actions to be taken in case of food shortage? Yes No

How does the community react to the actions taken by your household?

_____

_____

Do you store food during surplus? Yes No

Does the stored food sustain you up to the next harvest? Yes No

If not, how long does it last? _____

Where do you store food in times of surplus harvest? _____

Appendix 2: Interview guide for the metrologist

How do you explain the current climate state?

Have you recorded any change in temperature and rainfall from 1985 to 2016?

Apart from the change in temperature and rainfall, which other changes have you observed?

Have these changes been communicated to the farmers?

How has the weather station helped the farmers to cope up with the climate change?

Will there be a further change in climate in future?

Are there ways of preventing future climate change?

Appendix 3: Interview guide for the agricultural officer and CDO

Have you noticed any change in temperature and rainfalls over the past 30 years?

How have these changes affected the farmers?

Which practices have you taught the farmers to cope up with the changes in climate?

Have these practices been successful? If yes, how? If not, why?

Have all the farmers adopted these practices?

Which measure dominates? Why?

Which is the least used measure? Why?

Appendix 4: Annex tables

Table 4.22: Average annual rainfall, rain days

Year	Average annual rainfall	Number of rain days	Number of wet months
1992	767.6	101	8
1993	869.6	104	8
1994	1650.4	129	9
1995	1247.5	117	9
1996	1185.9	126	9
1997	1274.3	127	8
1998	1424.6	109	8
1999	1363.2	124	8
2000	1120.5	105	8
2001	1208.7	117	9
2002	1393.1	134	9
2003	1155.7	101	9
2004	1168.9	113	9
2005	950.7	98	9
2006	1328.7	121	9
2007	1219.6	114	9
2008	1311.8	113	9
2009	1170.9	122	6
2010	1338.8	119	8
2011	1086.1	117	7
2012	1262.4	126	8
2013	1764	128	9
2014	1373.5	122	10
2015	1358.1	125	9
2016	951.8	108	8

Source: Kitgum weather station statistics

Table 4.23: temperature statistics

2006	16.4
2007	17.9
2008	17.6
2009	18.3
2010	18.6
2011	18.2
2012	18.1
2013	17.8
2014	17.8
2015	17.5
2016	16.4

Source: Kitgum weather station statistics