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MASTER THESIS

Impacts of Climate Change on Food Security in Zambia

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Declaration

I do hereby declare that this thesis titled impacts of climate change on food security in Zambia is the result of my own investigation. All the work of other researchers used to support this study has been duly acknowledged.

I remain fully responsible for any limitations, errors and short comings in interpretation of literature.

In Prague 2015

William Nkomoki

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Abstract

In Zambia, climate variability and related events have serious consequences on food security for majority of small scale farmers' who depend on rain fed agriculture for their livelihood .The main objective of this study is to establish and examine the effects of climate variability on food security in Northern province (Kasama) and Southern Province (Choma) of Zambia.

The methodological approach uses the questionnaire as the primary instrument to gather baseline information comprising of questions divided into demographic sections, farmers' perception on climate variables, agriculture adaptations and coping strategies. Data processing and analysis is done in the SPSS statistical tool using regression, chi square tests, correlation and descriptive statistics.

The results indicate that farmers are aware of the changes in climate across the study area. Climate variability has contributed to decrease in crop yield (maize). However, some farmers have adapted to these changes by adopting different strategies such as crop diversification and conservation farming .In times of food shortages, major coping strategies include dependence on food aid, asset sales, reduction in meals consumed per day, food and cash borrowing.

It is recommended that despite the farmers been aware of climate variability, there is need to strengthen the efficient in disseminating of agriculture and climate extension information for better planning purposes. With the projections of climate effecting decline in food production, improvement in food situation can be achieved by creating specialized growing zones across the country where crops are grown according to suitability of area. Formulation of local based polices at farm level and national level to respond and maintain production is imperative to minimize escalating levels of food insecurity.

Key words: Adaptation, Agriculture, Climate change, Impacts, Food security, Perception, Zambia

Abstrakt

V Zambii nestálost klimatu a s tím spojené události vedou k mnoha důsledkům na potravinovou bezpečnost většiny malých farmářů, kteří jsou závislí na deštěm dobře zásobeném zemědělství, pro své živobytí. Hlavním cílem této práce je ustanovit a prozkoumat efekty nestálosti klimatu na potravinovou bezpečnost v severní provincii (Kasama) Jižní provincie (Choma), v Zambii.

Při zpracovávání práce bylo použito dotazníků, jako primárního nástroje, ke shromáždění základních informací, obsahujících otázky rozdělené na demografické sekce, na názory a pohledy farmářů na proměnlivost klimatu, zemědělské adaptace a vyrovnávající strategie. Zpracování dat a analýzy jsou provedeny v programu SPSS s využitím regrese, chí-kvadrát testu, korelace a deskriptivní statistiky.

Výsledky ukazují, že farmáři se obávají změn klimatu napříč celou studovanou oblastí. Výkyvy klimatu přispívají k poklesu výnosů plodin (kukuřice). Avšak někteří farmáři se těmto změnám přizpůsobili tím, že si osvojili různé strategie, jako různorodost pěstovaných plodin a záchovné hospodaření. V období nedostatku potravin hlavní vyrovnávací strategie zahrnují závislost na potravinové pomoci, prodávání majetku, snižování denního příjmu potravy, potravinové a peněžní půjčky.

Navzdory tomu, že se farmáři obávali výkyvů klimatu, se doporučuje posílit rozšiřování informací o zemědělství a klimatu, pro účely lepšího plánování. S předpokladem, že klima ovlivňuje pokles produkce potravin, může být zlepšení v potravinové situaci dosaženo vytvořením specializovaných pěstebních zón napříč celým státem, kde plodiny budou růst podle vhodnosti oblasti. Formulace místní politiky na úrovni farmářů i na té státní k reagování a k udržení produkce je důležitá k minimalizaci zvyšující se úrovně potravinové nejistoty.

Klíčová slova: adaptace, zemědělství, změna klimatu, dopady, potravinová bezpečnost, pohled, Zambie

Abbreviation

CEEPA - Centre for Environmental Economics and Policy in Africa

CFS - Crop Forecast Survey

FAO - Food and Agriculture Organisation

FFSSA - Forum for Food Security in Southern Africa

GDP - Gross Domestic Products

GRZ - Government of the Republic of Zambia

IFAD - International Fund for Agriculture Development

IFRC - International Federation of Red Cross

IPCC- Intergovernmental Panel on climate Change

MACO - Ministry of Agriculture and Co-operatives

MAL - Ministry of Agriculture and Livestock

NMHS-National Meteorological and Hydrological Services

PEWS - Provincial Early Warning System

UNFCCC - United Nations Framework for the Convention of Climate Change

WB - World Bank

WMO -World Meteorological Organization

ZMD - Zambia Meteorological Department

ZNAPA - Zambian National Adaptation Programme of Action

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CHAPTER ONE: INTRODUCTION

1.1 Background

Climate change is a worldwide problem and in Sub Sahara Africa it has negative impacts in terms of agriculture productivity and food security. Intergovernmental Panel on Climate Change (IPCC, 2001; IPCC, 2007) reports reveals that there has been little climate change impact assessments carried out in developing countries. The study by Hulme et al (2001) on climate assessments for Southern Africa indicated that the region will be drier and warmer with IPCC (2001) estimating a rise in temperature of 2-5 $^{\circ}$ C in coming decades. Throughout the twenty first century the global temperatures are expected to continue to increase and variations in rainfall pattern (IPCC, 2007). The analysis of 32 meteorological stations over the last 30 years indicates that the rate of increase of summer temperatures in Zambia is at 0.6 $^{\circ}$ C per decade three times more than the acceptable rise (Jain, 2006). According to FAO (2012), climate change and food insecurity are among the two major challenges for humanity.

Agriculture serves as a basis for people's livelihood in terms of food security and economic sustainability (FAO, 2009). According to Ludi (2009) various factors such as social, economic, political instability and environmental degradation continue to hinder food production and access, which is expected to worsen the global food in coming years. The variability in climate causes a significant challenge for most African countries. This is due to the continents dependence on rain fed agriculture and this uncertainty is aggravated by global climate change. Agriculture is intimately linked to climate and this makes it more vulnerable economic sector to changes in climatic conditions (Kandlikar and Risbey, 2000).

Southern Africa is faced with several challenges that are related to environment and climate change. According to Boko et al (2007) and Collier et al (2008), it is projected that there will be a rise in temperatures and increase in flood frequency as a result of extensive precipitation while in other countries the occurrence of droughts and dry spells will be on the increase. The effects of the extreme changes will result in decrease in agricultural production, which will affect the small scale farmers in Southern Africa.

In Zambia, most of agricultural production is rain fed dependant and mainly practiced by small scale farmers who are the major producers of national food basket hence more vulnerable to the adverse effects of climate variability and change. These farmers are constrained with low capacities to adapt which increases vulnerability. Among the major challenges faced are environmental related such as soil degradation, erratic rainfall pattern and unfavourable temperatures.These parameters have a strong linkage with agriculture production and food security at large (Clark et al., 2002).This is critical for livelihood as a larger population depend on local supplies that are highly sensitive to climate variations posing an effect on food and water resources (Nhemachena and Hassen, 2008). According to World Bank (2008), the agriculture sector in Zambia is impacted by floods and droughts that cause adverse damage in crop production.

In times of climate changes, better understanding on the negative effects impacted on agriculture and food security by small scale farmers is imperative in formulation of adaptation measures. According to Erikson et al (2008), with high poverty levels the vulnerability to climate and food system is high. The high levels of vulnerability to climate change are attributed to increase in populations who are trying to make a living amidst marginal resources, poor coping and adapting strategies as a result of lack of technology. The limited availability of resources in terms of social, economic technical and political means further undermines the capacity to adapt.

1.2 The Problem

Zambia is faced with challenges of floods and droughts, which are predicted to increase in frequency and severity resulting from climate change. Food insecurity and poverty severely affect the rural Zambian communities, which comprise mainly small-scale farmers. Dependence on rain-fed agriculture has led to variability in crop production and this has led to income reduction. A large number are particularly vulnerable because of their dependence on natural resource-based livelihoods, lack of adaptive capacity, unclear policies ,institutions and lack of technology .It follows, therefore that the most direct and effective means of raising standards of living and alleviating poverty, hunger and malnutrition is through increasing the productivity and incomes of smallholder agriculture. Since food availability in the country is often affected by shocks on local production attributed to weather related phenomena, a good understanding of weather and climate through forecasts, food security and agriculture is crucial in the efforts of small-scale farmers to manage impacts of climate extreme.

1.3 Significance of Study

Climate variability and change does reduce food security and sustainable livelihood for small-scale farmers in Zambia. Recent advances in understanding climate variability and change effects on food security have not necessarily been followed by a parallel development in the ability of society to manage risk. The introduction of agriculture adaptation measures and seasonal rainfall forecasts enables the farmers to develop low risk, profitable and sustainable management strategies that allow them to respond to risks arising from climate variability.The study aims to contribute to the improvement in understand the hot and challenging topics of climate change and food security among the small scale farmers that lacks many documented examples.

CHAPTER TWO: REFERENCE ANALYSIS AND THEORETICAL CONSIDERATION

2.1 Climate Change and Climate Variability

The World Meteorological Organisation (WMO, 2004), defines climate as the statistical description of variability and mean of relevant variables such as rainfall, wind and temperature at a period of 30 years. In summary, it is the average conditions of the atmosphere observed over a long period of time at a given place, regardless of natural variability or anthropogenic activity (IPCC, 2007). According to Clarke et al (2002), climate change refers to complex and interdependent environmental problems. The potential repercussions are two way focusing on physical and socio-economic dimensions. Various biophysical impacts have been observed including the rise in sea water, droughts, precipitation among others (Mendelsohn and Dinah, 2005). Socio-economic impacts are characterised with linkages with the biophysical and environmental degradation such as food security and poverty reduction (Koch et al., 2006).

Climate variability is change in climate conditions due to natural changes in atmospheric process. Climate variability and Climate change have been recognised as serious global phenomenon providing challenges to human development. The Inter-Governmental Panel on Climate Change (IPCC, 2007) re-affirms its findings in various reports since 1990 to date. Climate induced changes to physical and biological systems are already being felt and are exerting stress on vulnerable sectors.

2.2 Climate of Zambia and its Characteristics

Zambia is a landlocked country located in the central parts of Southern Africa between latitudes 8° S and 18° S, and longitudes 22° E and 34° E. It covers an area of approximately 752,614 km^2 and bordered by eight countries. To the south bordered by Botswana and Zimbabwe; to the east by Malawi; Mozambique to the south east; to the north Tanzania and the Democratic Republic of Congo; and to the west by Angola and Namibia to the south west (Zhu et al., 2008).

The climate of Zambia is generally moderate that is divided into three seasons namely rain season (November to April), cold season (May to August) and hot season from September to October. The summer temperatures go up to maximum of about 35˚Celsius with variations in the annual distribution in temperatures and precipitation (Thurlow et al., 2008). The primary impacts of climate change are expected to be an increase in the mean annual temperature of 1.2-3.4°C by 2060 .Secondly, a decrease in rainfall during the September to November period and an increase during December to April, along with accompanying increases in high intensity rainfall and 1-5 day total rainfall. These changes are predicted to result in seasonal droughts, dry periods within the rainy season, intense rainfall, heat waves, increased temperatures in valleys, floods, flash floods and changes in growing season as a result of delayed onset of rainy season or shortened growing period (ZNAPA, 2007) and that eventually leads to food insecure and poverty among the communities.

2.3 Agro Ecological Region

Zambia's land mass of 752, 620 square kilometres is divided in three Agro ecological regions namely I, II and III. The Figure 1 below illustrates the division of Zambia's Agro ecological regions.

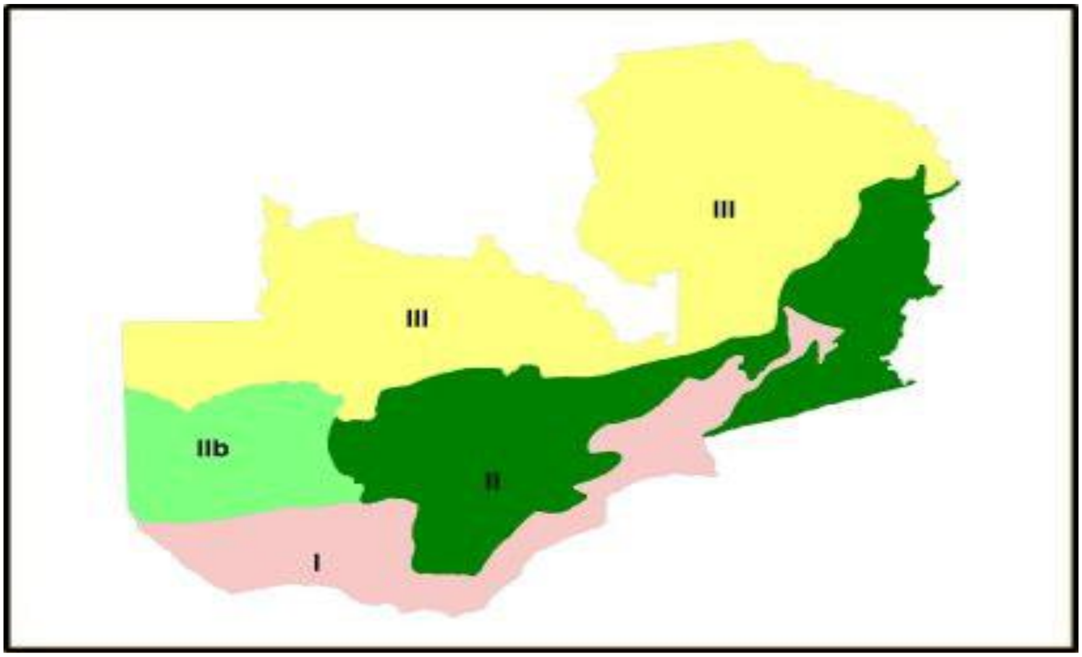


Figure 1- Zambia Agro Ecological Regions: Source: (CEEPA, 2006)

The areas that are covered in region 1 includes the Eastern, Western and Southern part of Zambia with mean annual rainfall below 800mm.The land area covered is about 12 % of the country's total land. Main agriculture activities include cattle raring and mostly cultivate crops resistant to drought such as sorghum and millet. The pedological aspect consists of fine and shallow soils on escarpment and loamy to clay soils in the valley. In Region two, the land consists of 42 % of the country, receiving mean annual rainfall range of 800mm to 1000 mm. This zone constitutes mainly crop production such as maize and groundnuts. The provinces included are Lusaka, Southern, Central and Eastern fertile plateau. It is further divided into 2a and 2b.The third region is the largest in terms of land area with 46%.The annual mean rainfall goes up to 1500mm. It constitutes of Northern, Northern Western, and Luapula provinces (MACO, 2004).

2.4 Agriculture in Zambia

Agriculture production is central in the economy of Zambia and contributes to reduction in poverty levels .According to IFAD (2013) many small scale farmers depend on agriculture for livelihood with more than 70% of the population of 13 million. The contribution of the agriculture sector in terms of Gross Domestic Product (GDP) stands at around 22 % (Mucavele, 2009). Findings from the research by Jain (2006) carried out in Zambia show that extremes in climate events contributes to a decrease in GDP as a result of low productivity and indicated that this can be attributed to negative effects on the rise in temperatures especially at the start of the cropping season .The study by Thurlow et al (2008), with focus on economic growth and climatic events in Zambia reveals that the influence of climate variability was strong and highly notable during the drought years and this has direct implication on agriculture GDP. Over the past three decades, floods and droughts have already cost Zambia approximately US$ 13.8 billion, equivalent to a 0.4% loss of annual economic growth. It is estimated that rainfall variability alone could keep an additional 300,000 Zambians below the poverty line and cost Zambia US$ 4.3 billion in lost Gross Domestic Product (GDP) over the next decade, reducing annual GDP growth by 0.9% (Thurlow et al., 2009). The researcher supports that global poverty is more pronounced with climate change as the poor small scale farmers are more vulnerable and limited means to adapt.

The Government of the Republic of Zambia (1994) classifies the agricultural sector at three different levels with respect to advancement in technology and size of farm. These classes of division are small scale farmers, medium-small scale farmers and commercial farmers. The small scale farmers are the characterised with mean farm size of about a hectare and till the land manually using hoes or hired oxen. The study by Siegel and Alwany (2005) conform that, the small-scale farmers are the main producers who use simple technology such as hand hoes and Oxen. In support of the small scale farmers been majority, Thurlow et al (2008) study reveals these cultivate an area with more than 76% of the total cropped land ,constituting about 96% o farming households. These apply the indigenous way of farming, lacking in technology and focus on subsistence production for home consumption. The second level consists of medium scale farmers who are advanced in technology with draught power and use medium level technology in terms of inputs. The highest level comprises of commercial farmers who utilise advanced technology and mechanisations in production .The animal breeds reared are improved and production is market oriented.

2.4.1 Crop Production

Crops production constitutes the part of the total agriculture output in Zambia accounting for more than 60%. Maize (*zea mays L*) is the predominantly cultivated crop which comprising more than 54.3%, with other cereals other than maize such as millet, sorghum and rice covering for 12.7%, Cassava at 13.1 % oil seeds accounting for 13%, and others at 6.6% (Kimhi and Chiwele, 2000). However, the results from Crop forecast survey (CFS) 2001 to 2010 growing season shows that maize accounts for more than 82 % with other major production from cassava and groundnuts (Sitko et al., 2011).

Zambia's main staple food, (maize) production faces huge yield variations .These variations are visible in that in times when the country receives normal rainfall, produce is more and surplus for national consumption and export. However, in drought times, the opposite occurs failing to meet the demands of national consumption (Dorosh et al., 2007).The small scale farmers usually plant the maize by mid November at the onset of the rain season and first harvests around mid-March (Thurlow et al., 2008). For developing countries, maize plays as an important role in providing food and nutritional security. Challinor et al (2009) reveals that variations in crop production regionally cannot solely be linked to the biophysical parameters, but also to the socio economic and crop management factors as these also affect food security.

The researcher has in mind that global poverty is more pronounced with climate change as the poor small scale farmers are more vulnerable and limited means to adapt. The situation calls for more resources been allocated to eradicating food security by the affected government. The 4th assessment report of IPCC (2007), projects a rain fed crop reduction yield of 50% by 2020 in some African countries. The major constraints are decrease in land suitable for agriculture, change in growing season length and potential yield due to climate change. In support , the study on the effects of climate change in Southern Africa by Lobell et al (2008) shows that by the year 2030 maize grain production will decline by 30%. Al Aim et al (2010), further supports the notion that climate related activities induce agricultural shocks which may have an effect on agricultural production and yields on grains particularly in tropics and sub-tropics posing threats on food security. One alternative to address this challenge according to Robertson et al (2000) is food production to be achieved by producing more crops from less land. This is supported by Gregory et al (2005) indicating that to meet the required food needs there is need for agriculture intensification.

According to Shiferaw et al (2011), maize is mostly used for human consumption in developing countries and they are wide variations in terms of calories share for different regions, noting Southern Africa's share at 45 %. For Zambia, the amount represents more than 50% of total calories. However, literature of McCain (2005) shows that lack of some nutrition supplements in maize as a concern for food utilization as it provides vitamins A and E and leucine blocks the human body adsorption of niacin causing deficiency in proteins. The researcher argues that this can be minimized by crop diversification to other grains such as sorghum or wheat.

Livestock plays an important role in agriculture in provision of food, draught power and as a source of financial security. It can make huge contributions to food security needs and income (Mooney, 2002).Unfortunately, the livestock sector faces many challenges with diseases, lack of grazing land as a result of degradation caused by environmental changes among others (Ruane and Sonnino, 2011).

2.4.2 Land use

Land tenure in Zambia is dualistic comprising of statutory and customary systems. For small scale farmers land is acquired using customary system through traditional rulers (Martin, 2003). According to MACO (2009), majority of Zambia's agricultural land is unexploited; with suitable land estimated to be covering about 48 million hectares while only nine million is used for arable agriculture and about 10 million for livestock production.

2.5 Food Security

Food security is a situation in which all people have access to adequate, safe and healthy food to meet their dietary requirements for a productive and healthy life at all times (FAO, 1996).The main dimensions in food security are Availability, Access, Utilisation and Stability.

The first dimension is food availability that involves means such as production, purchase and importation of food. The International Federation of the Red Cross (2007) describes food availability with meaning that food is physically present. FAO (2008).notes that the food available must be nutritious and of good quality regardless of sources whether local, regional or international

The second dimension is food access that represents to the way in which different people obtain available food.Some ways may be through home food production, purchase, borrowing and food relief or food aid (IFRC, 2007). At times, food can be available but people may have difficult to access it, making them food insecure .Food access refers to the physical and economic aspects for an active and healthy life. Some of the constraints to food access include marketing, poor transport infrastructure, food distribution system and purchasing power (Ruan and Sonnino, 2011).

Food utilization is the third dimension that refers to the ways how people use food. It depends on a number of factors among them the quality of the food ,the ways it is stored and the nutritional knowledge of the individual consuming the food. This deals with the healthy utilisation and safety of the food. Pretty and Hine (2001), highlights the contents that go in line with healthy diet such as carbohydrates, fat, proteins ,vitamins and minerals. At household level the food must be a variety to meet demands to meet food secure needs which is measured in Kcal

Finally the fourth dimension represents food stability, which means individuals or households at large having access to food all the time and not being at risk to lose it due to any sudden shock for example climatic change (FAO, 2006). This dimension is much of a challenge in developing countries.The effects associated with food insecurity are different depending on needs and communities.The classes of people may be categorised according to demographic, social (female headed households and disabilities) and geographic which deals with rural or urban population. (FFSSA, 2004).

2.5.1 Food Security Situation in Zambia

According to Sitko et al.,(2011) the food security research project in Zambia highlights that only 36% of households have adequate food to eat while about 19% are chronically food insecure who never have enough to eat. This shows why food insecurity is the major cause of malnutrition in Zambia. There are wide variations in per season access to food as a result causes significantly detrimental in food quality, intake of energy and nutrients required for healthy life. The results extendedly show that in sub Sahara Africa 53 % of people live below the poverty line while in Zambia it shows 64% (Sitko et al., 2011).

2.6. Linking Climate change, Agriculture and Food security

Climate variability and change have huge negative impacts on the developing countries (IPCC, 2007). The evidence is predominate in Africa as the continent depends much on rain fed agriculture and poses as a challenge to food security (Haile, 2005). Climate change does not affect countries in a similar way; some regions like the Sub Saharan Africa are expected to have huge impacts. This implies more challenge to feed people in this region who are already facing high levels of food insecurity (Ahmad et al., 2011).

In terms of agro environmental aspects, the areas of concern are temperature, precipitation and greenhouse gas emissions. According to Rosenzweig (2002), the projected rise in temperatures will bring huge benefits to agriculture in that the suitable areas for cropping will increase, the growing period length will be prolonged which, may cause an increase in crop yields. However, climatic models from IPCC (2007) predict otherwise, indicating a rise in temperatures leads to soil moisture reducation due to an increase in evapotranspiration. This will affect the suitability of cropping land which may become highly arid. This is coupled with rise in the range of agricultural pest which will adversely attack crops.

Any variability in climatic factors that govern crop growth such as temperature, humidity and rainfall will have direct impacts in terms of quality and quantity of food produced. Indirect impacts are related to the catastrophic events which lead to crop loss, leaving arable land unsuitable for cultivation such as floods and droughts which cause food security threats (Chaudhry and Aggarwal, 2007). Deschutes and Greenstone (2009) reveals that climate change would directly affect the agriculture sector with specific variables temperature and precipitation. The two variables are crucially for small scale farmers whose livelihood is dependent on systems sensitive to climate.

In the past decade global crop production has been affected as a result of changes experienced in the climate (Lobell et al., 2011). This change has resulted in high temperatures, sea rise level, changes in weather events and patterns which are expected to be severe and worse in the coming decade (Schmidhuber and Tubiello, 2007). The effects of this has been the reduction of agriculture yields on numerous crops caused by expanding range of, temperatures, water stress and crop diseases. Jarvis et al (2010), notes that this severity will negatively impact food security on a local and global scale.

Climate change affects agriculture food production and availability. The effects on food production can be divided into direct and indirect. These effects cause a demand for agricultural produce. Direct effects implies changes in conditions of the agro-ecological while the indirect affects through growth and distributions of incomes (IPCC, 2007). Fischer et al (2002) estimated that changes are expected in agriculture production, potential yields and land suitability given the crop cultivars that are available today. With these estimates one important consideration is to improve the adaptations measures using crops and management techniques that are available excluding new cultivars or biotechnology. In the study of household food security conducted in southern Africa by Misselhorn (2005), revealed that various different factors contribute to the effects of food security and climate was just among the 33 reasons stated by the householders. This statement is endorsed by Scholes and Biggies (2004) citing the food crisis problems that was experienced in Southern part of Africa in 2002 to 2003 not only as a result of droughts. In agreement to the highlighted, the researcher further stresses that key conditions such as government policies both on local and regional level, change in food prices and many more economic factors plays a role in food systems. Table 1 shows some of the drivers identified in Southern Africa as Key to food security in terms of access and production at the specific percent ratio.

Table 1 : Food Security Drivers

Food security drivers	Access ratio (%)	Production ratio (%)
Climate and environmental	33	67
Poverty	72	28
Increase in food prices	100	0
Absence of land access	15	85
Unemployment	93	7
Lack of education	92	8
Poor market access	100	0
Crops & livestock Diseases	44	56

Source: Misselhorn 2005

2.6.1 Climate Change and Food Availability

According to Burke and Lobell (2010), there is complexity to understand the effects that climate change may have on food security. Depending on one aspect for example crop yields to determine the impacts is not adequate as food security is a product linked to social and natural dimensions. This means that understanding the causes behind food insecurity such as low yields in agriculture and low income and key causes of poor economies like lack of markets and institution and educational levels are fundamental.

Apart from climate change having impacts on food availability from the food production side, some studies show that it can also have effects on food supply. Burke and Lobell (2010), indicates the importance of taking into account the current realities and trends in global and regional supplies of food on discussions of the effects of climate on global food supply. Gregory et al (2005) reports that a gap in the assessment of climate change on food security focuses on the cropping system like land use suitability, variations in crop yields and less focus is given to other dimensions of food security like food access and food utilization.

Eicksen et al (2008) describes the food system that contributes to food security of consisting of four activities. These activities include food production which focuses on use of technology and inputs and other natural resources. The second activity deals with food processing which involves packaging, use of raw materials and storage, Distribution and retailing is the third activity and deals with transportation and marketing .The fourth activity is food consumption dealing with acquisition and preparation. Figure 2 below illustrates the concepts of food security and the relationship between food availability, food access and food utilization and what each encompasses. However in this study, focus is given to food availability and how food production fits in the challenge of food security.

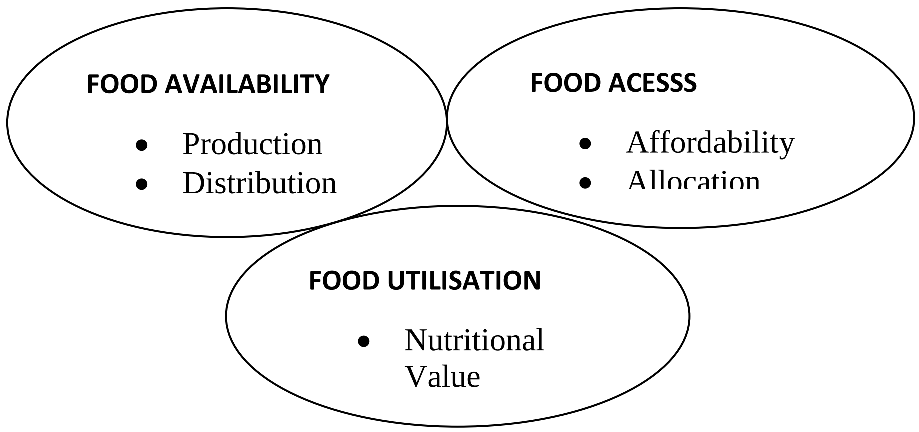


Figure 2: Food security Concept.

Source: Smith and Gregory (2013)

Smith and Gregory (2013) argue that the problem of food security is not only as a result of food production but rather income per capita and agricultural productivity. The linkage strongly exists as the food production is one way to help achieve food availability which is characterized by distribution and exchange. The food availability plays a major role in linking to food access and food utilization.

2.6.2 Impacts of Climate Change on Access to Food

Food access is defined as the ability to purchase adequate or enough qualities and quantities of food by individuals, communities or countries. In terms of food access, improvement to reduce vulnerability is widely varied. As reviewed by Arntzen et al (2004) Southern Africa categories the means of food access three approaches. First approach indicates that polices and pricing should focus on the producer's interests providing incentives and consumers having access to food. The second approach is to promote specialization of food production and trade regional to facilitate access to food. The third approach is a means of increasing income and employment which can be achieved through economic growth. Burke and Lobell (2010) describe the impacts of climate change with focus on four major questions. The first is to understand how different households generate their income. This means that for agriculture dependant households for income generation the effects are exacerbated by climate change. The second aspect asks the question of food prices, the third focuses on the integrations of markets at global and regional level and finally on the prospects to livelihood improvement in the long run. Jayne et al (2007) notes that maize is widely grown by small scale farmers in Zambia, however the amounts that are sold are minimal with reference to the 1999/2000 and 2002/2003 growing season accounting for only 25%.The research further indicates that marketing is a crucial to develop access to food in rural areas in time of climate shocks.

2.6.3 Impacts of climate change on Food Utilization

The effects of changes in climate in terms of food utilization is quantified in line with issues of food safety .The challenge is on how the food is used by different individuals to ensure that it is healthy and beneficial to the body (Schmidhuber and Tubiello, 2007). With increase in rainfall for instance the results in increase in food and water borne diseases that escalate the spread of various diseases that affect people as a result of poor sanitation. The levels of most of food vectors are facilitated by changes in temperature with an upward trend rise. This compromises the quality of food consumption.

2.6.4 Impacts on the food stability and supplies

The IPCC (2007) ,projects continued changes in weather conditions with observable variability and increase in floods and droughts .The evident effect are fluctuations in crop yields that means that stability aspect and food supplies been undermined thus food security situation. The phenomena of climate change or variability in terms of agriculture is not new to various regions, however the worry comes in, in that the effects and areas are expected to expand and potentially exceed the past experiences (IPCC, 2001). Furthermore, Sub Sahara African land a poor region will experience high highest levels of under malnutrition and food instability in terms of production. According to Schmidhuber and Tubiello (2007) these fluctuations can be minimized by investments in better food storage or higher food imports.

2.7 Extension activities on climate change and agriculture

2.7.1 Seasonal Climate Forecast

The application of seasonal climate forecast produced by the National Meteorological and Hydrological Services (NMHSs) is a recent and rapidly evolving field of research (White, 2000). The research conducted by Chen et al., 2002; Jochec et al., 2001; Mjelde and Penson 2000; Hill et al., 2000) support the importance of seasonal climate forecast contribute to the economic effects on crop yields. The researchers conclude that climate variability for instance precipitation anomalies leads to revenue decrease through loss of production.

With advances in knowledge of seasonal climate forecasting, the situation is now ripe to test the use of this new knowledge as a means of improving agricultural management for food security, Although, significant worldwide progress has been made in the last decade regarding generation of seasonal climate forecasts, still applications of these forecasts are not yet developed, and it remains unclear what limitations may hamper the adoption of forecast information in decision making processes, both at local and national levels (Phillips et al., 2001).

Field studies carried out in many countries in Africa suggest that the gap between information requirements of small-scale farmers and that provided by climate experts is narrowing through constant interactions. Hammer (2000) notes that seasonal forecasts have no eventual value. The key assertion to argument was that the information in itself does not carry value but the improved decisions that are accompanied .The researcher supports this with a view in that if a decision maker fails to incorporate their goals in the whole management system the information will never yield productive results.

In Zambia, the farming community may have limitation in the interpretation and lack of appreciation of the forecasting system as well as effective utilization of it to reduce impacts associated with extreme climate events. It is envisaged in this study to ensure that climate products are converted into productive economic use for sustainable development. The researcher supports the idea that reliable forecast information is a useful tool in crop management and yield optimization strategies. These strategies may include selection of appropriate crop cultivars and varieties, input acquisition levels and timing of agricultural operations. However, socioeconomic conditions and attitudes may inhibit employing of seasonal climate forecasts in which case adjustments or assistance time from external sources would be necessary to guarantee adoption.

2.7.2 Dissemination of Seasonal Climate Forecasts

Walker (2001) indicates that it has been clear that the application of seasonal climate forecast in agriculture by farmers is directly dependent on their understanding of it; however, problems of effective dissemination and communication exist in Africa. Paull (2002) said that communication aspects of seasonal climate forecasts plays a pivotal role to benefit from using seasonal climate forecasts were to be realised.

Studies carried out by Nanja (2001) attempted to investigate the extent at which seasonal climate forecast information was being disseminated and used in rural areas in southern Province of Zambia, by setting up Provincial Early Warning System (PEWS). Its purpose was to provide as much climate forecast information as possible to small-scale farmers using radios. From this study it was also clear that radios played a significant role in communication between forecasting system providers and the end users of the information. Surveys conducted in, Zimbabwe and Zambia by Unganai (2001), and Nanja (2001) indicate the radio as the most frequent used source of seasonal climate forecasts. The findings of the researchers conform each other that appropriate media and channels of communication of seasonal climate forecast information to small-scale farmers are already well established. However, it has been sadly noted that the majority of the small-scale rural farmers do not have access to these standard media channels. The researcher supports the statement that radios play a significant role in communication between the producers of the forecasting system and the small-scale farmer which must be integrated into the decision-making process (Meinke and Hochman, 2000). A study by Mellart, (2001), looked at the usefulness of the seasonal climate forecasts for the rural small-scale farmers in South Africa shows that there was a big difference in management practices of the farmers. For the poor farmers the seasonal climate forecast was seen to be ineffective. The poor farmers unlike the richer farmers in the (Mellart, 2001) study did not appreciate the forecasts because there was little consideration on another measure of long-term success apart from immediate profit. The researcher observes that poor farmers in the study (Mellart, 2001) had shown resistance to change. Resistance to change is the normal and most common reaction when people are confronted with a proposed change. Resistance is a fact of Human Nature. The researcher strongly supports this in that the way in which the vision has been defined has a strong influence on the level of resistance encountered. For instance, if the vision is a result of considerable input from the small-scale farmers who are most affected by change, their resistance may be very weak or non-existent. Culture is also critical in the effectiveness. The strength of the culture reflects directly on the relationship between forecasting system and small-scale farmers' effectiveness. Nevertheless, for the individual concerned, their perceptions represent the truth.

2.7.3 Agriculture Extension

The Ministry of Agriculture and cooperative in Zambia is one major institution that coordinates Agriculture and Food security issues. It employees extension workers and provide agricultural related information on television ,radio and organising of the agriculture shows at district, provincial and national level.Agriculture extension is important as this helps farmers to decide on whether to choose new technologies and increase production. Small scale farmers in low income countries express high levels of interests and management response but one major constraint is the communication failure (Hasen et al., 2011).Shiferaw et al (2007) highlights the key components in provision of extension to include: disseminating of information on new innovation, to provide improved management system to adapt and develop innovation system and gather information from interaction with farmers to facilitate research work. The research argues that in most cases extension service is limited and not very effective in some regions as the skilled labour to offer services opt to work for private sector as the remuneration is higher than the government

2.8 Climate Change and Agriculture Adaptations

Adaptation is key term that is fundamental in the debate of climate change. Adaptation is defined as the adjustment to a human or natural system to a new or changing environment. The IPCC (2007) defines climate adaptation as the ability to adjust a system in response to climatic stimuli actual or expected and the effects, to moderate potential damage to cope with the consequences that or exploit the beneficial opportunities. Adaptations can be categorized in different types including private and public, autonomous and planned, and proactive or anticipatory and reactive. The reason to implement adaptations in agriculture is to help minimize the effects and damage to food production. The ability of the agricultural sector to handle climatic variability is important and greatly assists in stabilizing the country's food security performance. According to Pretty and Hine (2001), adopting various adaptation practices contribute positively to local livelihoods socially, economically and environmentally.

Studies that have been done on adaptation to climate change indicate that understanding of the farmers perception on climate change is vital to better formulate strategies and response on African countries (Nhemachena and Hassen, 2008; Deressa et al., 2008).This is to say that their perception influence whether to adapt and cope to changes. Urama and Ozor (2011) with focus on climate change on adaptation and food security in western and central Africa recommends the application of innovative adaptive measures specifically for the small scale farmers who are the major food producers to improve livelihood. Among the major approaches cited are focused on food production. This include the use of high yielding disease tolerate seed, sustainable agricultural practices and irrigation technology to ensure food security. In terms of agriculture adaptations Gebrehiwot and Veen (2013), classifies modifications in two categories of production systems. The first is diversification which focuses on production aspect such as use of tolerate, resist and early maturing varieties to withstand harsh conditions. The second deals at the farm management practices that will look at issues in terms of time of planting to ensure it does not collide with critical or hash conditions of climate. In a study carried out in Uganda by Orindi and Eriksen (2005), adaptations measures that were pronounced in the area include, growing early maturing varieties to alter the period of growth and resistant varieties temperatures and drought tolerant. Gregory and Ingram (2005), argue that implementation of adoption focused on higher seed quality and yield is an ongoing activity for farmers to maintain or restock seed and this is relatively expensive on them. However, the adaptation measures in a study in Ethiopia by Gebrehiwot and Veen (2013), indicates change of planting dates, agro forestry principles and soil conservations such as pot holing to help capture water as the major practices. The research has in mind that the degree of adaptation measures are heterogeneity not specific with a country or regional but mainly depend on what extreme the agriculture food production is affected. The efficacy of adaptations can be released at local level and largely depend on economic, social and political related activities if to be adopted. Research conducted by Lobella et al (2008), reveals that crop diversification can help farmers to adaptation to climate change. Other pillars of food security must be incorporated to effectively comprehend the adaptive measures (FAO, 2008). According to Brown et al (2008), dimensions of food security require policy, political will and economic muscle to address. In agreement, Loo (2014) highlights the importance of considering social, economical, cultural and political to strengthen adaptations.

2.9 Farmers Perception and Barriers to Adoption

Different research conducted on adaptation to climate change indicate that understanding of the farmers perception on climate change is vital to better formulate strategies and response on African countries (Nhemachena and Hassen, 2008; Deressa et al., 2008). This is to say that their perception influence whether to adapt and cope to changes. However, assertion to argument Weber, 2008 perception to climate change occurrences is not guarantee to acceptance of adaptations. Eastling et al (2007) indicates that the existing limitations in terms of finances and human capital have adversely contributed to climate change and minimize the chances to reduce the chances. In the study on farm level adaptations by Gebrehiwot and Veen (2013), highlights that awareness of farmers on climate change is crucial to the respond to the impacts. This indicates how important it is to understand the perception of the farmers towards climate change effects and food security before formulation of successful adaptive measures. This will provide a better orientation as to factors that undermine the choice of adaptations. The literature of IFAD, (2008) contends that adaptive capacity is influenced by assess, perception, knowledge on climate change and technology act as important factors for effective adaptation that the perception of farmers to climate change is crucial to the study area in that despite the scientific research and knowledge on the importance of adaptations towards climate change, the study are lacks information in this context.

In Zambia, the farming community may have limitation in the interpretation and lack of appreciation of the forecasting system as well as effective utilization of it to reduce impacts associated with extreme climate events. It is envisaged in this study to ensure that climate products are converted into productive economic use for sustainable development. The researcher supported the idea that reliable forecast information is a useful tool in crop management and yield optimization strategies. These strategies may include selection of appropriate crop cultivars and varieties, input acquisition levels and timing of agricultural operations. However, socioeconomic conditions and attitudes may inhibit the utilisation of seasonal climate forecasts in which case adjustments or assistance time from external sources would be necessary to guarantee adoption. Walker et al (2001) investigation on the small-scale farmers' receipt of seasonal climate forecasts, understanding the terminologies used in the forecasts, ways of information dissemination and identification of problems of communication between forecasting system and users of the climate information. The study highlighted that there was lack of skills among producers of forecasting system and agriculture extension officers to communicate clearly to the small-scale subsistence farmers for them to make use of the information in their decision making.

CHAPTER THREE: THESIS OBJECTIVES AND HYPOTHESES

3.1 Main Objective

The overall objective of the study is to establish and examine the effects of climate variability and change to food security witnessed by small scale farmers in Zambia.

3.1.1 Specific Objectives

- ❖ To investigate and identify the perception of the farmers on awareness of climate variability and change
- ❖ To examine and discuss the influence of climate variability and food security phenomenon with particular focus on maize production.
- ❖ To identify the adaptation measures adopted by small scale farmers to avert climate variability in response to food security across the study area

3.2 Hypotheses

On the basis of analysis of available references it was possible to formulate the following hypotheses which, if materialized, could contribute to improving the social Situation of Zambian rural poor;

- ❖ Hypothesis 1: Small scale farmers' are capable to positively perceive climate variability
- ❖ Hypothesis 2: Climate variability contributes to reduction in crop production
- ❖ Hypothesis 3: Household, farm characteristics and institution positively influence farmers' choice of adaptation

CHAPTER FOUR: METHODOLOGY

4.1 Description of Study Area

The study areas are two namely; Choma which lies to the south and Kasama situated to the north of Zambia Choma fall in region 1 which is a low rainfall area that receives annual cumulative rainfall less than 800 mm in the season. The region that has the best soil that is fertile for agriculture production. Traditionally keep livestock. The cultivation is predominately done by the oxen. The livelihood activities include selling of millet beer; farm labour .The major crops grown are maize, sweet potatoes and finger millet (Ndiyoi and Phiri, 2010).

Kasama falls in region 3 which is the high rainfall area that receives annual cumulative rainfall more than 1,000 mm in the season. The soils are loamy, leached and acidic due to high rainfall and not very fertile. Major crops include maize and cassava in the rain seasons with farmer also growing vegetables such as tomatoes and cabbage in dambo areas after rain season. conservation practices are focused only on maize and traditionally the people do not keep livestock (Styger,2014).The farming practices in this region are citemene system (extensive shifting cultivation) by 90 % of the small scale farmers .The source of livelihood include fishing and selling of maize to generate income (Ndiyoi and Phiri, 2010)

4.2 Map of study area

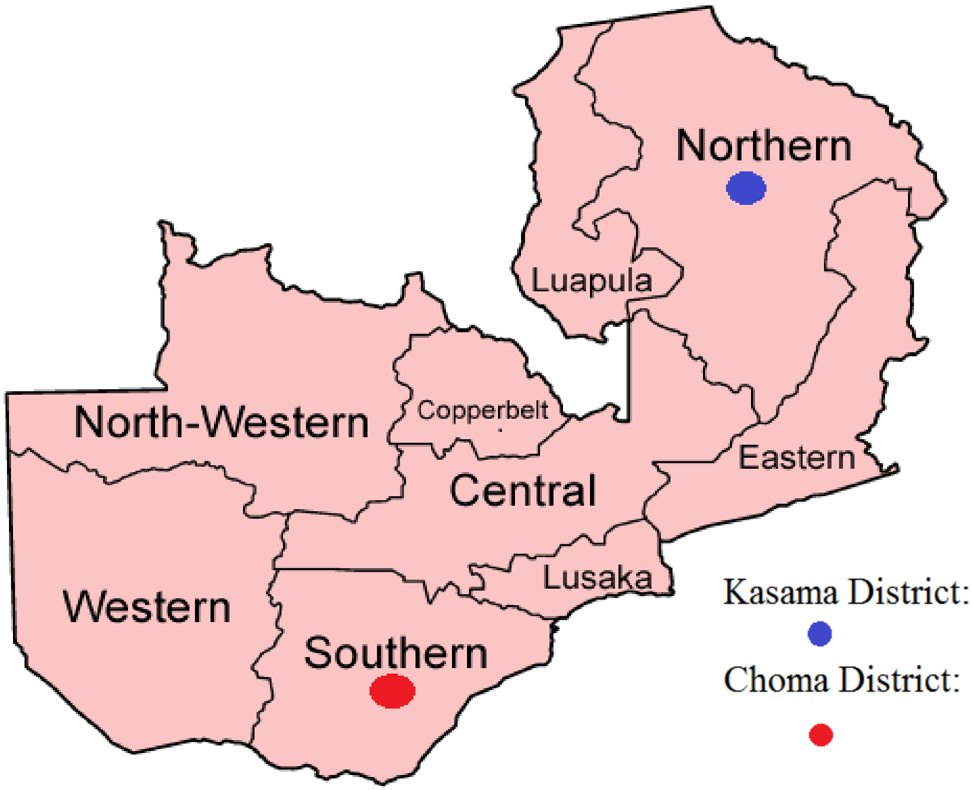


Figure 3: Study Area Location

4.3 Target group

In this study the target group was the one hundred and seventeen (117) small-scale farmers of Choma district in Southern Province and Kasama district in Northern Province 57 and 60 respondents respectively.

4.4 Sampling

The overview of the study was to have two districts in Zambia one from the Northern part and another in the southern part. The districts fell in two different agro ecological regions to make it more representative. After the selection of the two districts, two agriculture

The category of the sampling design uses a multi-stage sampling. Firstly, the districts were purposefully selected based on differences in the climatic condition with Choma falling in agro ecological region receiving less than 800 mm in terms of rainfall and Kasama receiving more than 1,000 mm of rainfall. This was significant to enable highlight on similarities and differences in terms of impacts and adaptations between the two districts. The second stage involved the selection of agricultural camp and in this stage systematic sampling was employed and one key consideration was the presence of a meteorological station that was important in providing climatic data for a longer period of time. Finally on the selection of households, Simple random selection was employed. This is a selection procedure that ensures that each element of the population is given an equal and independent chance of selection. This involved identifying the population and ensured that it was representative of the small-scale farmers. The sampling is calculated using the formula below.

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

Where: n is sample size, N is population and e is level of precision (Israel, 1992)

4.5 Data Collection

4.5.1 Primary data collection

The structured questionnaire (Appendix 1) designed with coded responses is the Instrument tool that was used in the primary data collection, in addition to in-depth interviews with the head of household. The questionnaire had a list of 18 questions both semi-structured and open ended questions. Each question was worded exactly as it was asked. The questionnaire is divided into four segments namely the demographic survey focusing on household characteristics, socio-economic survey in terms income sources, features in terms of awareness and perception information on climate change, agriculture practices survey including farm size, impacts, crops grown and the farm management survey segment with themes on adaptation, source and dissemination of agriculture and climate information.

Climate data for the two districts was obtained from the Zambia meteorological Department (ZMD) focusing on annual mean precipitation and temperatures from 1987-2013.

The crop yields (maize) for the period 1987 to 2013 for the study area was obtained from ministry of agriculture and Livestock (MAL).

4.5.2 Administration of Questionnaire

The questionnaires were distributed by the researcher with the assistance of 2 Agricultural extension officers one from each district who are familiar with the area of study. Questions were asked in local languages to the respondents who did not understand English for precise and confident responses. The questionnaire attempted to gather baseline data for the farmers involved in the study. The survey questionnaire was used to interview the head of household in each case, but where that person was not at home, the second adult; usually the wife of the head of household was interviewed.

4.5.3 Secondary data sources

A review of published and in press literature, books, government official documents from various relevant departments and Ministries ,reports ,journals and articles patterning to the study topic were reviewed to compliment and comprehend the information .

4.6 Data processing and analysis methods

The processing of collected data involved coding the responses to provide some easy structure to handle the large amounts of the responses with the help of spread sheets. This provided the aid of cleaning the data. Cleaned data collected from the field by the use of the questionnaire was subjected to quantitative analysis by the use of descriptive statistics, correlation, regression statistics modelling and Chi-square testing.

4.7 Justification of method (s) eemployed

The methods of interview and questionnaire administering applied had some advantages. These included:

- ❖ Provided face-to-face interaction between the respondent and interviewer were questions would be clearly explained.
- ❖ Provided a more flexible technique as more information beyond the questionnaire was obtained as it was more participatory approach.

4.8 Limitations of the Study

Various constraints were encountered with the major ones summed up as follows:

- Challenges for farmers to give actual data on income and yields as small scale farmers thought it would influence the receiving of inputs or food aids. The data on longitudinal income was not collected but only for 2013 season.
- Created artificial situation were farmers not willing to release information at no cost. However, the researcher managed to sample the required size.

CHAPTER FIVE: RESULTS AND DISCUSSION

This chapter presents the findings of the study. The analysis includes the farmer characteristics, the perception of the farmers in line with food production and climate variability. Other sections present the perception of the farmers on climate variability and the adaptations measures practiced as farm management strategies. It further, indicates the coping strategies undertaken by households in times of food shortages. The limitations and constraints in terms of adopting practices are also highlighted.

5.1 Socio-economic characteristics of Small Scale farmers

Table 2 below gives an overview of the description and findings of various variables from the respondents across the two districts of study.

Table 2 : Farmer characteristics in Choma and Kasama Districts

Variable	Definition	Choma District		Kasama District	
		Mean	SD	Mean	SD
Age	Years	44.81	11.7	47.55	11.04
Farming experience	Years	17.63	10.6	18.48	8.12
Size of farm	Hectares	1.60	1.02	1.68	0.93
Household size	Number	6.32	1.67	6.53	1.43

5.1.1 Age Distribution of Farmers

The age of the farmers, range from 21 to 72 and 23 to 72 in Choma district and Kasama district respectively. The predominate age group in both districts indicate 40 to 50 years with Choma having 44 years and Kasama 47 years as the mean age. The largest number of farmers in both districts falls in the age group 25 to 50 years with Choma having 60% and Kasama 63 %.This age is more productive that can promote and realize agriculture productivity. This further implies that amidst climate variability and facilities these may face the hardship to produce food and necessities for their households despite with their requisite energy. The implication in terms of adaptation of new technology and measures could be positive. However, the lowest numbers are seen among the age group less than 25 years as most of them are still under the custody of parents. The other reason is that majority of the youths less than 25 years do not see farming as a first priority. This can be interpreted or imply that the younger generation does not enthusiastically see faming as a source of livelihood unless when faced with unforeseen challenges such as losing a bread winner of the family through death. The numbers above the age of 50 years start to decline .This is attributed to majority of the farmers experiencing ill health and becoming a liability in the household. Table 3 below illustrates the segments of age range groups with frequency and percentages.

Table 3 : Age distribution of farmers in study area

Age	Choma District		Kasama District	
	Frequency	(%)	Frequency	(%)
Under 25	4	7	2	3.3
25 to 50	36	63	36	60
Above 50	17	30	22	36.6
Total	57	100	60	100

5.1.2 Gender distribution

Results in the two districts show dominance of male household heads consisting with Choma districts constituting 70% and Kasama district almost 10% lower at 61%. The Majority of the women are widowed who have settled in these areas specifically for agriculture purposes to generate income for the family and for livelihood. Other reasons surrounding the female headship include the divorced or the married but not living with their husbands who have mobile type of work such as military personnel. The female headed are the most affected in terms of lack of resources, income and highly vulnerable to food insecurity. Adisa and Okunade (2005) contend the need to foster programs that intend to increase women participation in agriculture related ventures to increase food production as they provide good farm labour and food processing ventures. In the study conducted in Zimbabwe by Horell et al (2006) reveals that female headed households are more vulnerable in agriculture. Figure 4 graphically illustrates the sex of farmers in the study area. Nevertheless, the female shows positive and significant impact in adopting adaptation strategies apart from the conservation farming if compared to male respondents on Table 14. The key policy message is that targeting women can have significant impact of adopting to various adaptation strategies.

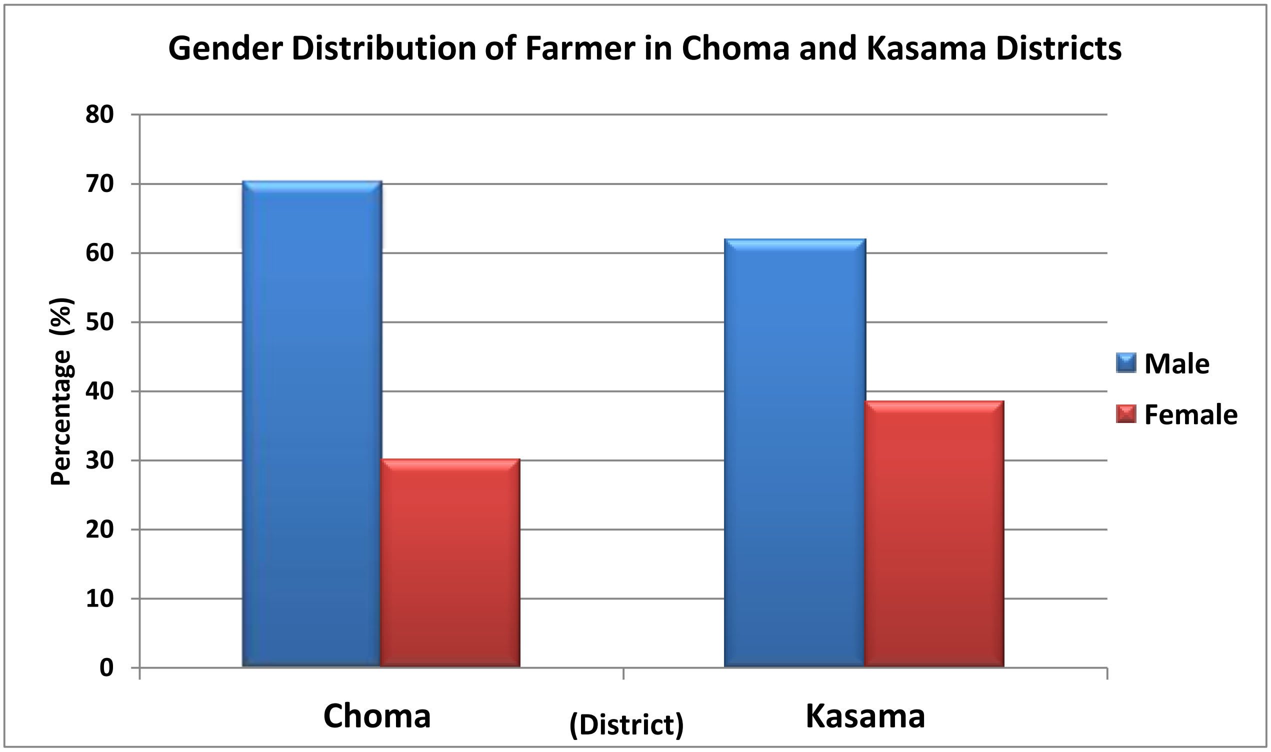


Figure 4: Sex distribution of farmers in study area

5.1.3 Education Qualification

The literacy levels across both districts follow a similar pattern which may be attributed to the national education system which shows a larger number been enrolled for primary education and later increase in dropouts due to different factors among them lack of financial capacity to continue funding personal education at huge costs. Generally, the literacy were high with Choma district revealing 24.6 % of the farmers without a form of education and slightly higher levels in Kasama district at 30 %.Results show that majority of the farmers has primary education with slightly higher percentage in Choma district at 42% and Kasama district at 40%.The literacy levels must be serve as a vital empowerment tool in implementing agriculture production, food accessibility for households and acquaintance of knowledge on adaptation. The assumption taken is that an illiterate person will not be able to make informed decision from obtained information. The findings across the two districts on adaptations table xx show significant impact on shifting cultivation strategy and negative correlation to non-adaptations. This implies that education is vital in terms of adopting a strategy, however on the contrary on other strategies the correlation was negative. This is supported by Ozor and Nnaji, 2010 who indicates that climate change adaptation options can be enabled by literacy levels of the farmers. According to Gebrehiwot and Van der Veen (2013) literature indicates that education increases the levels of obtaining and application of information relevant to climate and agriculture. Masud et al (2014) contend that the level of education is central as focus is given on adaptation of new techniques in order to yield positive results. Figure 5 shows the education status of the farmers across the two districts.

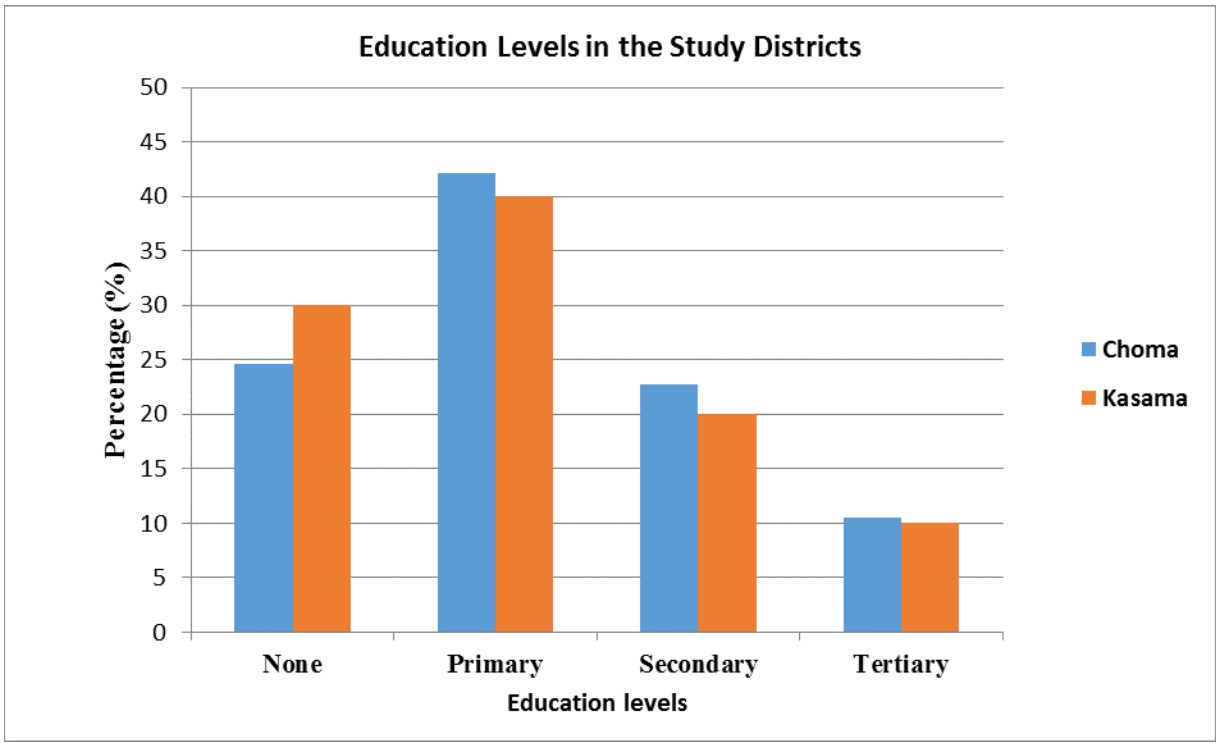


Figure 5: Education status of farmers in Study area

5.1.4 Farm Size

Results on farm size indicate that on average the respondents in Choma district have 1.6 hectares of land and in Kasama 1.64 hectares. In the study area the land belongs to the state and under the leadership of the chief in specific areas who have the mandate to distribute land to their subjects. Majority of the farm areas for small scale farmers is less than one (1) hectare in Choma accounting for 36.8% of the respondents while in Kasama majority of the respondents have consisting of 41.7% have farm area between 1 to 2 hectares . The larger farm area in Kasama district can be attributed to larger land in the district with lower population. In relation to food production and income generation, the assumption related to farm size is that the farmers with larger land areas will have more farm production. Regression results in table 14 on factors influence adaptations show a positive and significant impact on farm size and change of planting date. The researcher contend that majority of the farmers opt to change to sowing dates as their fields are limited and pessimistic on another measures that may require more investment such as crop diversification and conservation farming. However this can be limited by the application of a specific farming practice despite the farmers having been in same region with similar environmental surrounding. In the study by Nyangema (2008) in Kenya reveals that small farm sized farmers invested more in soil conservation practices compared to larger farmers falling under the conservation type of farming.

Table 4 : Farm size in study area

Farm size (Ha)	Choma		Kasama	
	Frequency	%	Frequency	%
Less than 1	21	36.8	23	38.3
1to 2	18	31.6	25	41.7
2 to 3	10	17.5	10	16.7
Above 3	8	14	2	3.3

5.1.5 Farmers Household Size

In terms of household size across the study district does not show much of a difference with Choma recording a mean of 6.32 with value range of 4 to 10 dependents and Kasama district 6.53 with value range from 4 to 9 dependents. Higher percentages of the respondents have a household size of between 5 to 10 across both districts with Choma constituting 86% and Kasama at 93.4%.Larger households are attributed to increased labour force required to produce food, with a connection of higher possibility of taking up demanding adaptations measures required in farms to maximize production. However, there are variations in literature, for instance support in terms of venturing in labour intensive adaptations is highlighted by Anley et al., (2007).The results in the study area (Table 14) reveals that shifting cultivation impact is significant and positive .The change in sowing days shows positive relation. In contrast, Deressa et al (2009) in the study in Ethiopia did not show any significance in relation to adaptation. Another dimension to look at the household is in terms of consumption of food. This entails that in cases of larger family with small farm size and producing less food, these household maybe more vulnerable to food insecurity unless other income generating ventures are under taken to cushion the effects. On another hand, another assumption is that larger households are less likely to adapt in terms of food production but would rather focus on other strategies off farm. Yigra (2007) affirms the assumption, stating that larger household's easy pressure on consumption by attempting to earn income on off farm activities. Table 5 shows the household size distribution.

Table 5 : Household size of farmers in study area

Dependents	Choma District		Kasama District	
	Frequency	%	Frequency	%
> 5	8	14	4	6.6
5 to 10	49	86	54	93.4

5.1.6 Farming Experience

The result of the farming experience refers to how long each farmer has been involved in agriculture production. For Choma district the mean experience stands at 17 years while in Kasama district it is 18 years. The assumption is that farmers with more years in the farming are able to easily understand and identify the changes in climate as they have spent more years in those specific regions and indigenous. This in turn will improve their chances of the means to adapt to the changes and manage food stocks for households as a result of wealth knowledge. Considering age in table 14 to refer to farming experience, the finding reveals that a positive relation experience and adopting strategies expect for conservation farming. To affirm to the above findings, the researcher associates this to the knowledge that the farmers have on the indigenous area and easy to articulate issues pertaining to their cropping and food acquiring skills. This endorsement implies that majority of the older farmers saw the need to adopt strategies. In consistence on adaptations, Nhemachena and Hassan (2007) indicate that the probability to adapt to climate change is enhanced by experience in farming.

5.1.7 Access to credit

The findings on the question of access to credit show that, in both districts the farmers had limited access to credit. The major reason attributed to the scenario, are limitations in the number of financial providers willing to offer services to the small scale farmers. The few that have access to credit usually are members of the farmer organization who access it through the organizations. In Choma district, 67 % had no access to credit while in Kasama the percentage was even higher at 82 %. Similar study by O'Brien et al (2000) in Tanzania reveals that lack of adequate funds constrained farmers to adapt to the various challenges to improve food security. In relation to adaptations the researcher hypothesizes that farmers' access to credit increases their chances to adaptation. The findings in Table 14 indicate, positively correlation to conservation farming, with change in sowing calendar and crop diversification indicating impact significance. The implication of the result entails the importance of financial institutional promotion to enhance adaptations. Kandlinkar and Risbey (2000) confirm that access to credit is a vital determinant promoting numerous technologies adoption. Credit serves an important means to allow farmers to purchase food, to acquire different technologies to adapt to climate variability .The results from Pattanayak et al (2003), shows positive relationship between adoption and access to credit. Deressa et al (2009) using the multinomial logistic regression findings show positive and significant impact on crop diversification, change in planting dates and use of irrigation. Attention on access to credit is imperative as it covers on a wide range of socioeconomic factors that farmers require hence the need to make the financial accessibility more affordable.

5.1.8 Membership to farmer Organization

Memberships to farmer's organization show that the numbers were low with only 35% in Choma and 45% in Kasama. The contention to lower numbers is that most of them do not see huge differences whether to belong to one or not. Secondly with monthly contributions to these farmers organization acts as a barrier to belong to such organization and opts to use the money on other pressing needs within the household. Table 14 results show significance in crop diversification adaptation strategy. The reason is attributed to farmer groups promoting the crop diversification more than other strategies

5.1.9 Source of income for farmers in study area

Despite all the respondents been farmers, various forms to source income for survival existed. Numerous means were indicated as some of the major means to source income. Table 6 illustrates the findings across the two districts and how significant these approaches are. The assumption is that these sources of income are the same in both districts. Crop sales are the major source of income in both districts with a frequency of 24 in Choma and 20 in Kasama. However, in Choma livestock sales serve as one large source of income with a frequency of 34.This is related to the strong tradition ties the southern part of Zambia has of raring cattle and other animals. On the contrary, this is not the case for the Northern part where mostly fishing activities are more pronounced. For Kasama back yard gardens supplement as the main alternative for sourcing income with 50% of the farmers indicating carrying out the activity. The reasons are the river streams banks and the wetlands that enable gardening to be carried out unlike in Choma district which is usually dry soils. Informal work is another one that is significantly different between the two districts at 24% and 36 % in Choma and Kasama respectively. The major informal works include bricklaying, part time construction activities, and part time (casual) working on commercial farms. Remittance differences were not statistically significant in both districts and this was observed from elderly farmers who receive some up keep from their relatives. In Choma districts 4 of the farmers had retired from formal work and are receiving pension benefits in installments and this serves as the major source of income. The case was similar in Kasama with 3 of the respondents citing the same. Formal employment was least in both districts. This can be attributed to fewer opportunities to find formal employment across the whole country.

Table 6 : Source of income in Choma and Kasama Districts

Source of Income	Districts		Chi Square Test	
	Choma	Kasama	Chi value	P value
Crop sales	42 % (24)	33% (20)	0.96	0.33
Livestock sales	60% (34)	13% (08)	27.25	0.00*
Remittances	16% (09)	27% (16)	2.06	0.15
Retirement Benefits	07% (04)	05% (03)	0.21	0.65
Backyard gardening	18% (10)	50% (30)	13.69	0.00*
Informal employment	24% (14)	36% (22)	2.01	0.16
Formal employment	12% (07)	13% (08)	0.03	0.86

*Significance level at 5%: Parentheses indicate number of respondents

5.2 Assessing Farmers perception to climate Variability

The perception of farmers on climate variability serves as an important prerequisite for formulation of substantial adaptation measures. Various studies have considered the perception of the farmers in relation to crop production in specific local area and climate data. Esham and Garforth (2013) focused on inter and intra annual rainfall and crop production. Gbetibouo (2009) looked at the correspondence between local climate data and farmers perception .Madisson (2006), assessed the perception of farmers on climate change in different African countries by comparing the probability of how climate parameters have changed to the response of the farmers. In another study in china, Hageback (2005) uses local rainfall and temperature to compare with farmers responses. In this study, the perception of farmers is viewed in comparison to climatic data of the study are with focus on rainfall and temperatures. The question during the survey was the respondents' observation on the amount of rainfall,

rainfall variability in terms of onset and temperature over the past 5 years. The scale with increase, decrease and no change is used to gauge the responses.

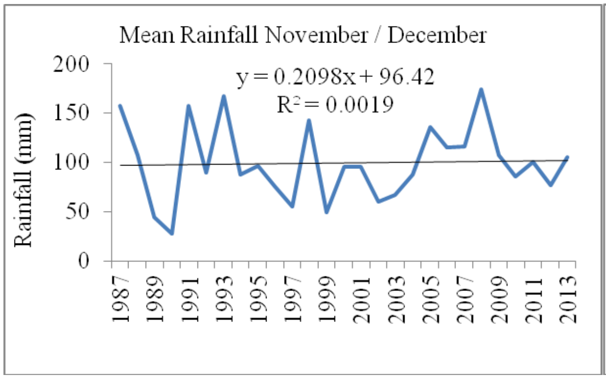
The results of the survey on amount of rainfall indicate that many of the respondents did not see any change with Choma at 54% with least of the respondents indicating increase in amount of rainfall at 8%. The respondents in Kasama district viewed no change in amount of rainfall at 50%, while only 4% notice decrease. In terms of variability with focus on onset of the rains, in Choma 84% percent indicate that the onset of the rains were now late and ended earlier. The rains would start as early as October through to April while now the rains start in November through to March indicated the respondents. Another observation from the farmers was the increase on frequency of dry spells in the rain season. In Kasama districts it was a different case with 47 % of the respondents perceived no change on the onset of the rains. In the case of temperatures, respondents in both districts indicate an increase with Choma having 43 % and Kasama at 50%. Table 7 presents the climate perception responses.

Table 7 : Farmer's perception on climate parameters in study area

Parameters	Increase		Decline		No Change	
	Choma	Kasama	Choma	Kasama	Choma	Kasama
Rainfall (amount)	09% (05)	43% (26)	37% (21)	07% (4)	54% (31)	50% (30)
Early onset of rains	05% (03)	35% (21)	84% (48)	18% (11)	11% (06)	47% (28)
Temperature	75% (43)	50% (30)	07% (04)	18% (11)	18% (10)	32% (19)

Parentheses indicate number of respondent

For verification purposes historical climate data is used on trends of rainfall and temperatures. The results are presented according to the Zambian cropping season which starts in November and ends in April. The Figure 6, Figure 7, Figure 8 and Figure 9 show the rainfall trend for Choma district. The findings show an increase in the amount of rainfall in November / December period when preparation and germination of the maize season is done. Thereafter the rainfall trend shows a decline in January /February which becomes critical for plant growth. The March / April and the November to April shows amounts of rainfall deceasing.



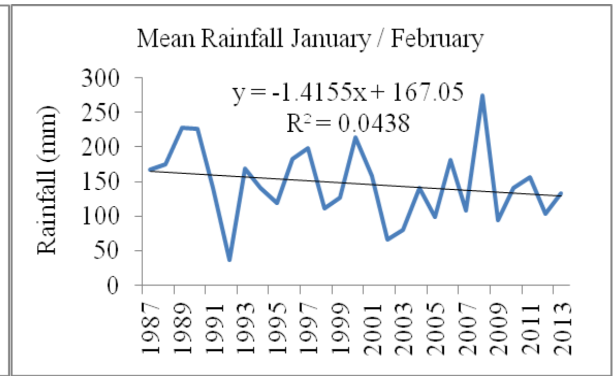
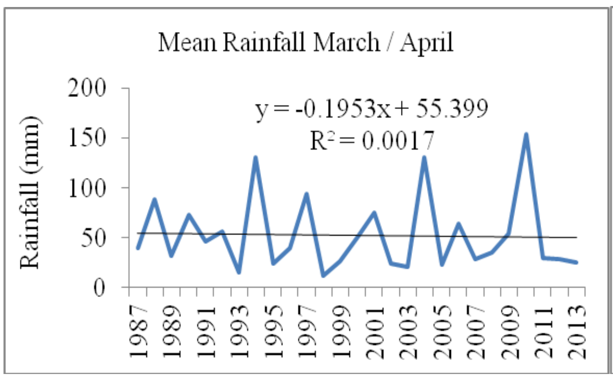


Figure 6 Mean Rainfall January / February

Figure 7: Mean Rainfall November / December



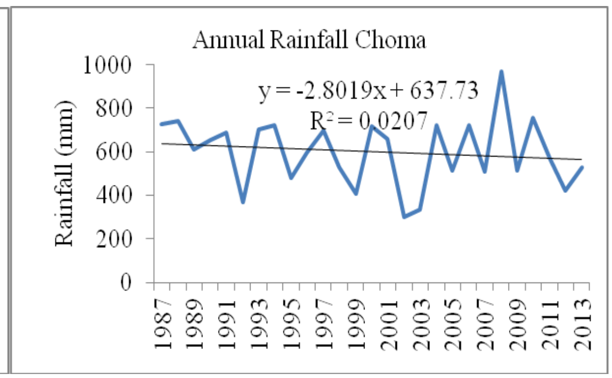
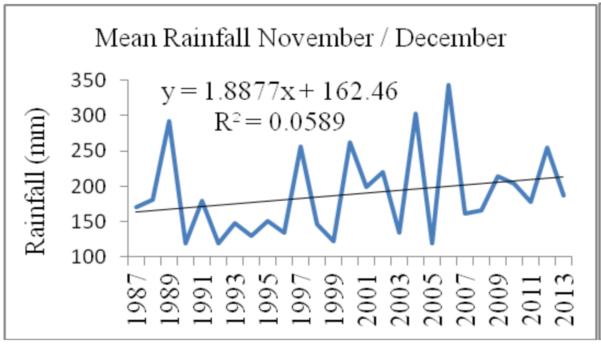


Figure 8: Mean Rainfall November to April

Figure 9 : Mean Rainfall March / April

In Kasama district the amount of rainfall shows an increasing trend in November /December, January /February, March /April and the November to April mean rainfall increase is not significant and the reasons why 50 % of the respondents not seeing the change and 43 % of the respondents perceiving increase. Illustration of observed data is shown in figures 10 to 13.



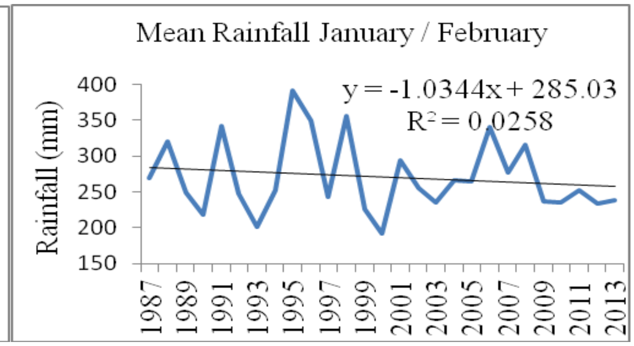
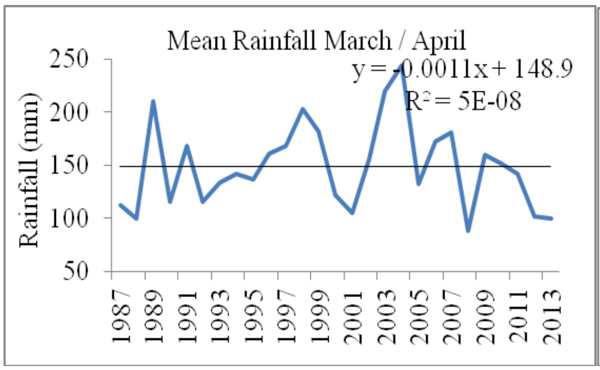


Figure 10: Mean Rainfall January /February   Figure 11: Mean Rainfall November /December



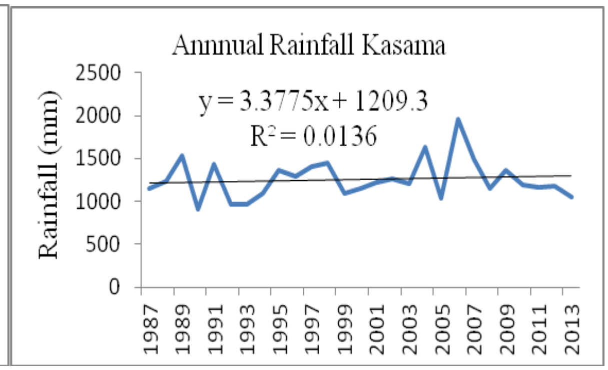
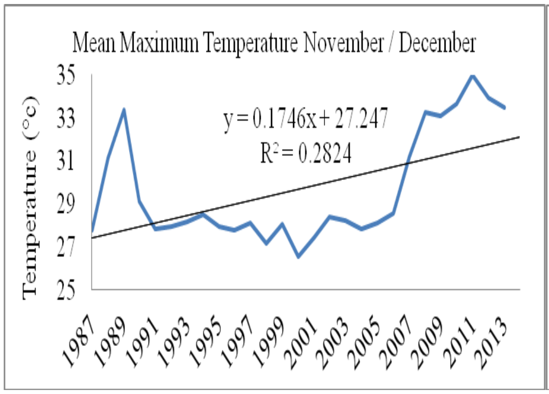


Figure 12: Mean Rainfall March /April   Figure 13: Mean Rainfall November /April

Choma temperatures show an increase in trends throughout the season. The vital observation from the farmers view revels that climate variability are in correspondence with the climate parameters of the area with 75 % of the respondents in Choma viewing an increase in temperature. Figures 14 to 18 illustrate the findings of observed meteorological data.



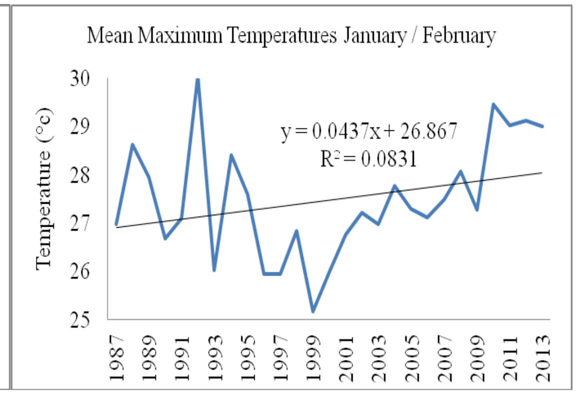
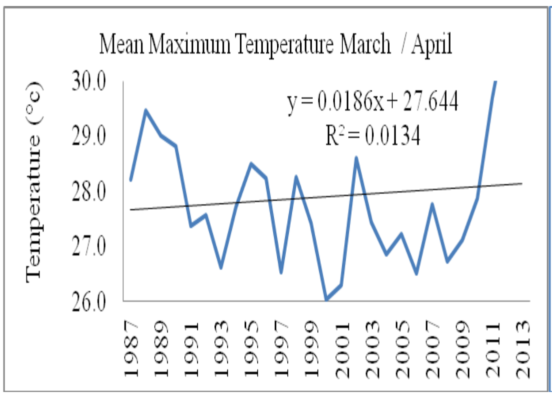


Figure 14: November / December Temp.

Figure 15: January February Temp.



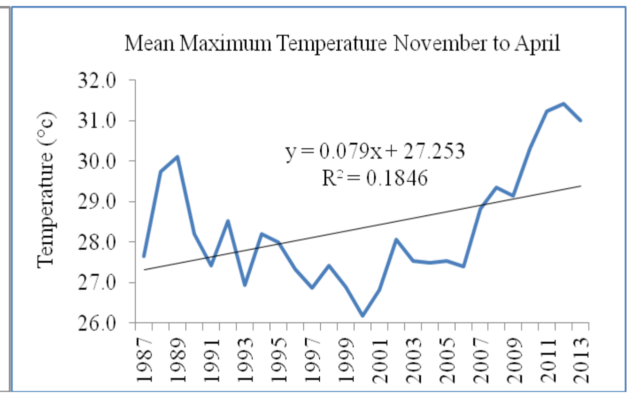
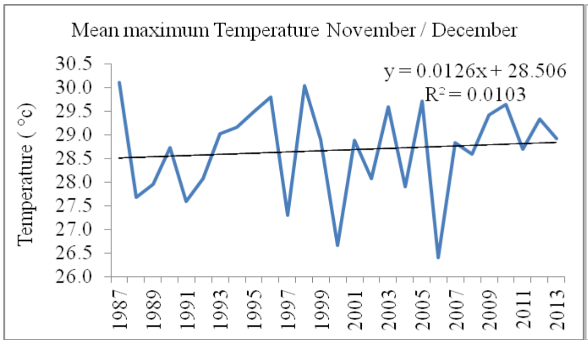


Figure 16: November to April Temperatures

Figure 17: March /April Temperatures

Similarly for Kasama the respondents perceive and increase in temperatures with 50%.The perception of majority of the farmers conforms to observation from climate data illustrated in figures 18 to 21.



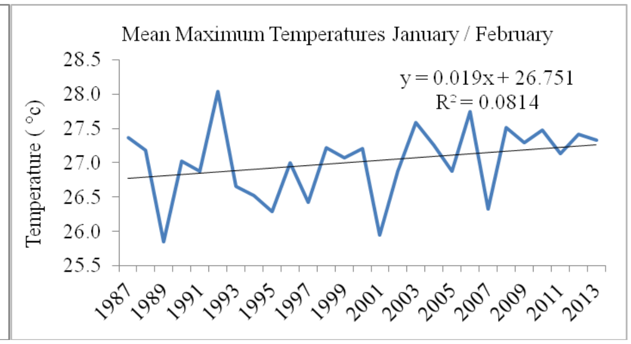
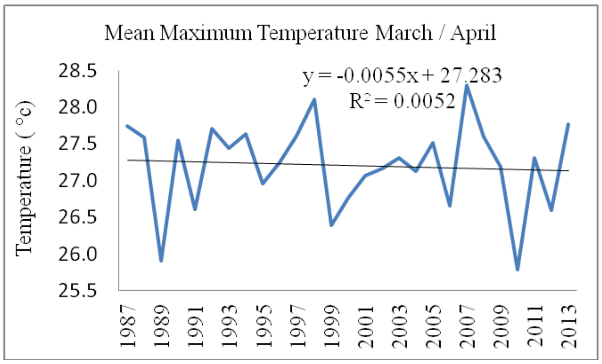


Figure 18 : November / December Temperatures   Figure 19 : January /February Temperatures



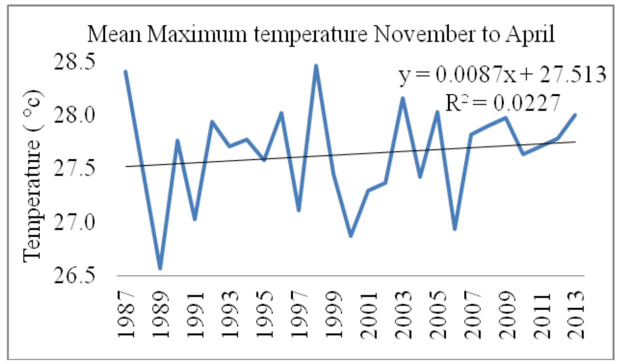
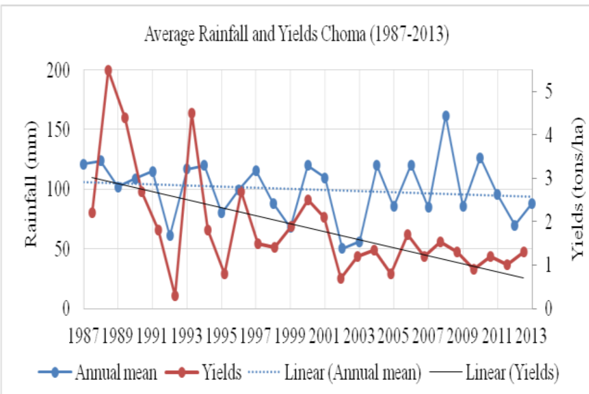


Figure 20 : March /April Temperatures   Figure 21 : November to April Temp

Maddison (2006) in an attempt to compare farmers' perception and climate data notes that farmers' consideration on the changes was based on recent information than efficient. The literature of Christensen et al 2007, predicts an increase in already high temperatures and no increase in the rainfall across most of the developing countries in comparisons to high latitude regions.

5.3 Climate variables and Maize Yields

Maize is the predominate cereal grown in Zambia. In this section relationship between the maize yields and climatic data is presented. The mean maize yields stand at 1.8 and 1.1tons per hectare for Choma and Kasama Districts respectively. Figure 22 and Figure 23 shows the relationship between the average rainfall in the growing season from November to April and the maize yields from 1987 till 2013 in Choma and Kasama district respectively.



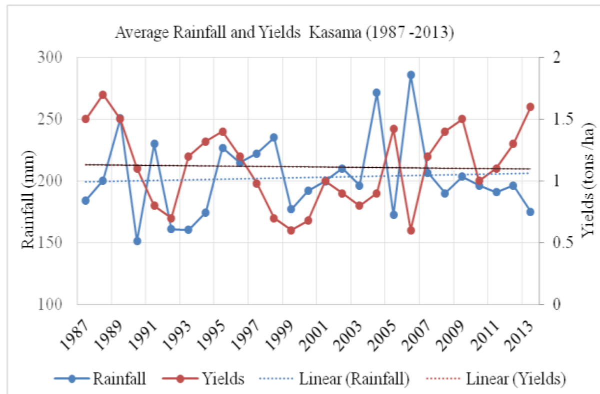


Figure 22 : Rainfall / maize yields 1987-2013

Figure 23 : Rainfall / maize yields 1987-2013

5.3.2 Effects of climate on crop yields

The determination of the effects of rainfall and temperature on crop yields has been employed by various researchers Lobell and Field ,2007, Lobell and Burke 2008 , Schlenker and Lobell 2010, Rowhani et al ., 2011.In this study the evaluation of impacts of climate variability on maize yields was regressed by the use of the average rainfall and temperatures. The findings in table 8 Choma district results shows that an increase in rainfall will result in an increase in yields and on the contrary with the amount of rainfall increase experienced in Kasama shows a decrease in yields. In the case of temperatures, a decrease in Choma will result in yield increase while for Kasama an increase in temperature leads to yield increase.

Table 8 : Maize yields and climate variables for Choma and Kasama District

Variable	Coefficient	P-Value	Mean
Choma District			
Rainfall	0.415	0.016*	99.7515
Temperature	-0.06	0.383	28.3579
Kasama District			
Rainfall	-0.228	0.113	202.773
Temperature	0.241	0.126	27.635

At 5% significant level *

The non climatic variables were regressed with the yields across the study area and shows that the cost of production ,household size , extension,gender and farm size are significant in yields and are strongly correlated.The findings are presented in Table 9.

Table 9 : Non climatic variable regressed with Maize yields

Variable	Coefficient	P value
Cost_Production	0.986	.000*
Household size	0.987	.000*
Extension	0.989	.000*
Gender	0.99	.002*
Farm size	.866	.000*

At 5% significant level *

5.3.3 Farmers income

Table 10 and 11 indicate the findings of the income from Choma and Kasama districts respectively.The costs of production are higher in Kasama than in choma district.This can be associated to the locality and inputs are higer while choma lies in the line of rail with easy transportation.However ,the net income is higher in kasama .One factor to this is that the rainfall is better than choma which experience frequent dry spells and resulting in yield decrease.

Table 10 : Net farm income per hectare Choma District

Variables	Unit	Mean (n=57)	Std. Deviation
Production cost	USD	224.00	155.00
Total Income	USD	405.20	265.00
Net Income	USD	180.00	112.70
Consumption	kg/capita	342.57	238.27

Table 11: Net farm income per hectare Kasama District

Variables	Unit	Mean (n=60)	Std. Deviation
Production cost	USD	306.00	234.80
Total Income	USD	638.00	441.70
Net Income	USD	331.80	211.70
Consumption	kg/ capita	494.31	334.22

5.4 Farmers Adaptation to Climate Variability and Food Insufficiency Copying Strategies

With majority of the farmers perceiving change in one way or another on climate parameters, adaptation measures become priority to implement. Strategic measures that farmers have adopted are categorized into various groups. However, despite some farmers perceiving some change, they have not adopted any strategy in their cropping plans. Bryan et al (2009) supports by expressing that discordance between the way farmers perceive climate change and adaptation of measures to minimize effects are pronounced. Crop diversification is the most prevalent strategy and positively significant in both districts covering 28 % for Choma district and 32% for Kasama district. The consideration in crop diversification for Choma includes drought tolerant varieties of maize. Other consideration involves growing of other crops such as sorghum and millet in Choma district while for Kasama district most of the small scale farmers have diversified to planting cassava. The crop diversification appears as an ease to approach for the farmers and with low expenses.

The results conforms to studies by Kurukulassuriya and Mendelssohn (2008) in South Africa, Hassan and Nchemachena (2008) and Gebrehiwot and Van der Veen (2013) in Ethiopia. With response to change in onset of the rains, farmers in Choma have opted to alter planting calendar .The aim is to ensure that there is no overlap between critical stages of crop growth and dry spells. The conservational farming practices are focused on reduction of moisture loss. Among the practices include mulching, the crops and planting shade trees. Kasama district has a traditional farming system of cut and burn (citemene system in Bemba a Zambian language) but due to limitation of land allocation by the chiefs, the practice is slowing fading out with only 7% of the respondents practicing it. Difference was significant for change in sowing calendar with Choma at 28% and 13% in Kasama (Table 12).

Table 12 : Farmers adaptation strategies

Strategy	Districts		Chi square test	
	Choma	Kasama	Chi value	P value
Crop diversification	28 % (16)	32% (19)	0.18	0.67
Change in sowing calendar	28% (16)	13% (08)	3.89	0.05*
Conservation farming	12% (07)	10% (06)	0.45	0.50
Shifting cultivation	2 % (1)	7 % (4)	1.72	0.19
No adaptations	28 % (16)	38 % (23)	1.39	0.24

*Significance level at 5%: Parentheses indicate number of respondents

5.4.1 Extension services and source of information

The frequency of extension refers to the respondents' access to agriculture service. To analyze this, the frequency which indicated the number of times was used at a scale with zero (0) showing that the respondent had not visited any extension meeting, with those that have been to extension as once or twice in the cropping calendar. The extension meetings are conducted by district extension workers employed by the Government of the republic of Zambia. The results show that in Choma 95% of the farmers had visited extension meeting while 43 % in Kasama attended the meetings .The assumption is that the attendance of these meetings helps the farmers to make informed decisions on farm management practices. Apart from the farmers relying on agriculture extension, radio and television programs, farmer to farmer and district agricultural shows held annually have also contributed to awareness and knowledge on farmers. In Choma district 42% of the farmers rely on Agriculture Extension officers. In Kasama districts radio served as the dominant way of farmers' receipt of information with 35 %. The mode of using the Agriculture extension officers is labour intensive and requires resources for the officers to travel from one point to the next to meet the small scale farmers and given the road network system this pose as a major challenge.

Other surveys carried out in Zimbabwe and Zambia by Unganai (2001) and Nanja (2001), indicate the radio as the most frequent used source for receiving information concerning agricultural . Similar results are reported by Urama and Ozor (2011) were majority of the rural farmers in Western and Central Africa used radios as major source of receiving information. Table 13 describes the results on farmers' respondents on frequency on agriculture extension and information on climate change. In Table 14, frequency of extension has positive relations and significant to change in sowing calendar and shifting cultivation as adaptation strategies. The researcher connects the result to the notion that the more contacts the farmers have with the extension officers the more chances to selection of an adaptation measure. The policy on government is to increase awareness through extension will definitely increase the awareness needed for adaptation.

5.4.2 Information on climate

Information on climate is an important aspect how farmers react and respond to their practices on the fields and respond to cases of food insecurity. In Choma the access to information on climate is prevalent at 79 % while in Kasama it was low at 45 %. The result in Choma is attributed to farmers frequency contact with agricultural extension officers who also disseminate any predictions on climate as obtained from Zambia Meteorological department. From the low numbers in Kasama the research connects this to farmers' reluctance to pay attention to climate change information that many perceive as not effective to their growing calendar planning. This is in support of a study carried out in South Africa (Mellart, 2001), who looked at the usefulness of the seasonal climate forecasts for the rural small-scale farmers in Maleketu, Thulumahashe and Mangondi districts which showed lower percentage of farmers access to information on climate. The relation between adopting of strategies to access to information on climate is positive for almost all adaptation strategies Table 14. Similar results were obtained by Herath and Takeye (2003) in Sir Lanka, showing positive relation and significance between information on climate and intercropping.

Table 13 : Agriculture extension and information on climate

Variable	Description	Districts	
		Choma (%)	Kasama (%)
Frequency of agriculture extension	0 (None)	5.3	57
	1 (Yes)	68.4	27
	2 (Yes)	26.3	16
Information on Climate	Yes (%)	79	45

Source of information on agriculture extension and climate change

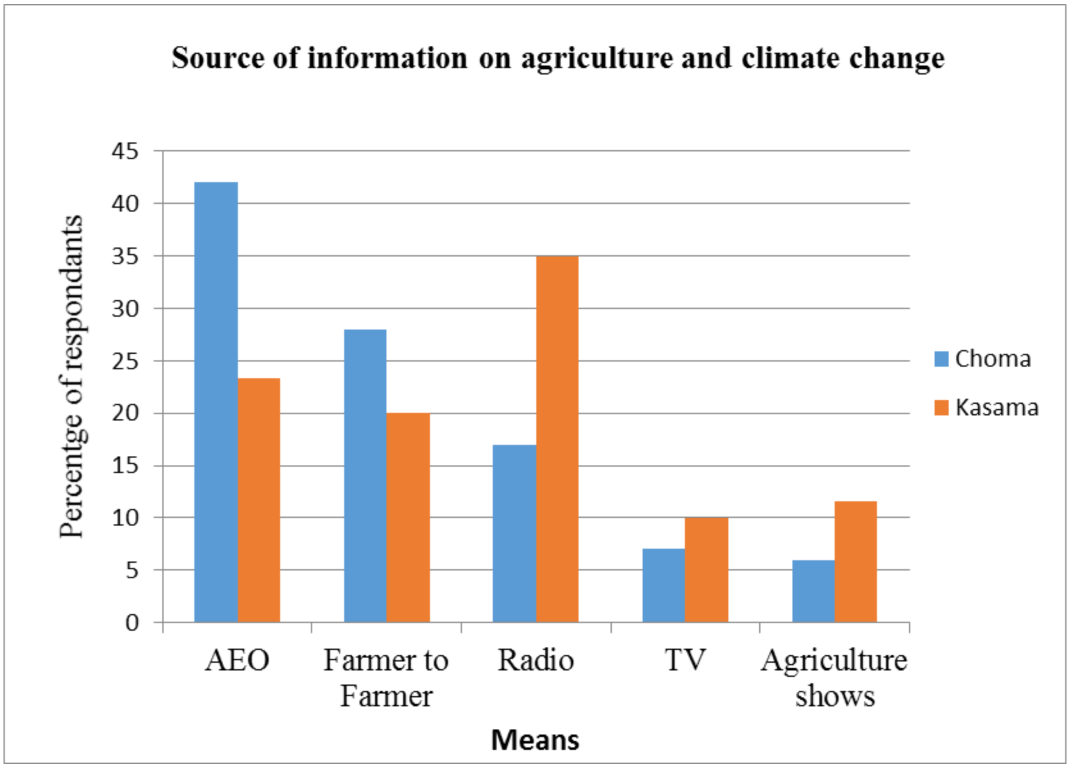


Figure 24 : Means of sourcing information

5.4.3 Factors influencing level of adaptation

In order to determine the factors that influence level of adaptations, various hypothesis where tested using the stepwise multiple regression analysis. The model dependent variable is the choice of adaptation engaged by the farmers in the study area. The relationship existing between the variables and their significance is highlighted in Table 14.

Table 14 : Stepwise multiple regression model on adaptations

Explanatory Variables	Crop diversification		Change in sowing calendar		Conservation farming		Shifting cultivation		No adaptation	
	Coefficient	Sig.value	Coefficient	Sig.value	Coefficient	Sig.value	Coefficient	Sig.value	Coeff.	Sig.value
Age	0.053	0.286	0.002	0.493	-0.260	0.002*	0.039	0.339	-0.192	0.019*
Gender	-0.288	0.001*	-0.012	0.448	0.256	0.003*	-0.119	0.103	-0.055	0.279
Extension frequency	-0.002	0.491	0.138	0.070	-0.020	0.415	0.092	0.162	0.204	0.014*
Information on climate	0.138	0.070	0.041	0.331	-0.051	0.293	0.082	0.191	0.158	0.05
Access to credit	0.255	0.003*	0.200	0.016*	0.046	0.314	-0028	0.381	-0.413	0.000*
Household size	-0.058	0.267	0.046	0.312	-0.201	0.016*	0.162	0.041*	-0.195	0.018*
Education	-0.034	0.359	-0.106	0.130	-0.120	0.100	0.120	0.100	-0.115	0.110
Farm Size	-0.124	0.092	0.076	0.208	-0.025	0.394	0.466	0.000*	0.043	0.323
Membership to Farmer Org	0.158	0.045*	-0.005	0.477	-0.117	0.106	0.175	0.030*	0.075	0.212

At 5% significance level *

5.4.4 Strategies in response to food availability changes

In times of food insufficiency, households resolve to numerous strategies to minimize the predicament as a result of various shocks. The study attempts to report of numerous short term food insecurity copying strategies. Among the notable ones is the reduction in number of meals that are consumed per household. In normal times families consume 3 times a day on average in both districts. Subsequent, eating foods that were less preferred by the households to other foods that was more comparable. In the case of Kasama district instead of only using maize meal farmers resorted to use of cassava mean as well. In Choma district the other crops that were consumed are wheat, sorghum and millet. Under reduction in meals, respondents identifying cutting or reduction in portion size as a means to maintain prolong food stocks. The approaches to achieving this vary widely. Borrowing food was another significant practice among the farmers in both districts. This a typical practice that many households have been practicing since time in memorial, where food is borrowed from relatives and friends and payback once the family has harvested its food stocks. The researcher finds such a practice as leading to permanent indebtedness of the households. In the longer term this short term copying strategy will can become a livelihood option and make the households more vulnerable. The other common copying strategy is the dependence of the households on relief aids that the government supply to disaster affected areas. This is seen as a good opportunity for almost all households to obtain extra food and store for future use or resell. In Choma district the sale of livestock such as cattle was a common strategy at 47%, in which in turn households purchased the necessities from the income generated. Migration and charcoal sales were the least strategies adopted by farmers.

Table 15 : Coping Strategies in food times of food shortages

Strategy	Districts		Chi Square test	
	Choma	Kasama	Chi Value	P Value
Asset sales	47% (27)	30% (12)	9.85	0.00*
Reduction in meals per day	45% (26)	50% (30)	0.23	0.63
Relief food aids	63% (36)	70% (42)	0.6	0.43
Migrations	3.5% (02)	6.7% (04)	0.6	0.22
Borrow cash	30% (17)	20% (12)	1.51	0.22
Borrow food	32% (18)	37% (22)	0.34	0.56
Charcoal sales	16% (9)	30 % (8)	3.33	0.07

At 5% significance level *: Parentheses indicate number of respondents

5.4.5 Barriers to adaptation to change

Farmers had several reasons for their failure to adapt to climate change despite experiencing food insecurity as a result of lower yields. In the questionnaire farmers were asked on the challenges faced in adapting to climate change .The results Fig 25 shows that in both districts economic constraints is the major difficult with 88% and 75% in Choma and Kasama districts respectively. The results conforms to the study by Esham and Garforth on agriculture adaptations to climate change in Sri Lanka were more than 70% of the farmers cited economic constraints as the major hindrance. The economic constraints include the lack of finances to enhance investment in farm inputs such as seed and practices in crop management. The second popular response that was mentioned is the farmers' perception on the effectiveness of the different adaptation measure. Most of the farmers had a pessimistic view found and were not prepared to take risks on trying other ways of cropping and preferred to stick to the same traditional way with both districts reporting more than 40 %.The researcher on the contrary sees the fear of the farmers to try or risk on new practices deprives themselves of the opportunity to learn practices that may prove sustainable in terms of food production. Other constraints defined include the lack to information both agriculture and climate information. The researcher views this as an important aspect with which lack of it leads to situation in deprivation of knowledge which is assumed that may have positive impacts to respond to challenges. However, most of the farmers highlight lack of trust of the information on climate by the national meteorological service and rely on traditional knowledge to forecast change.

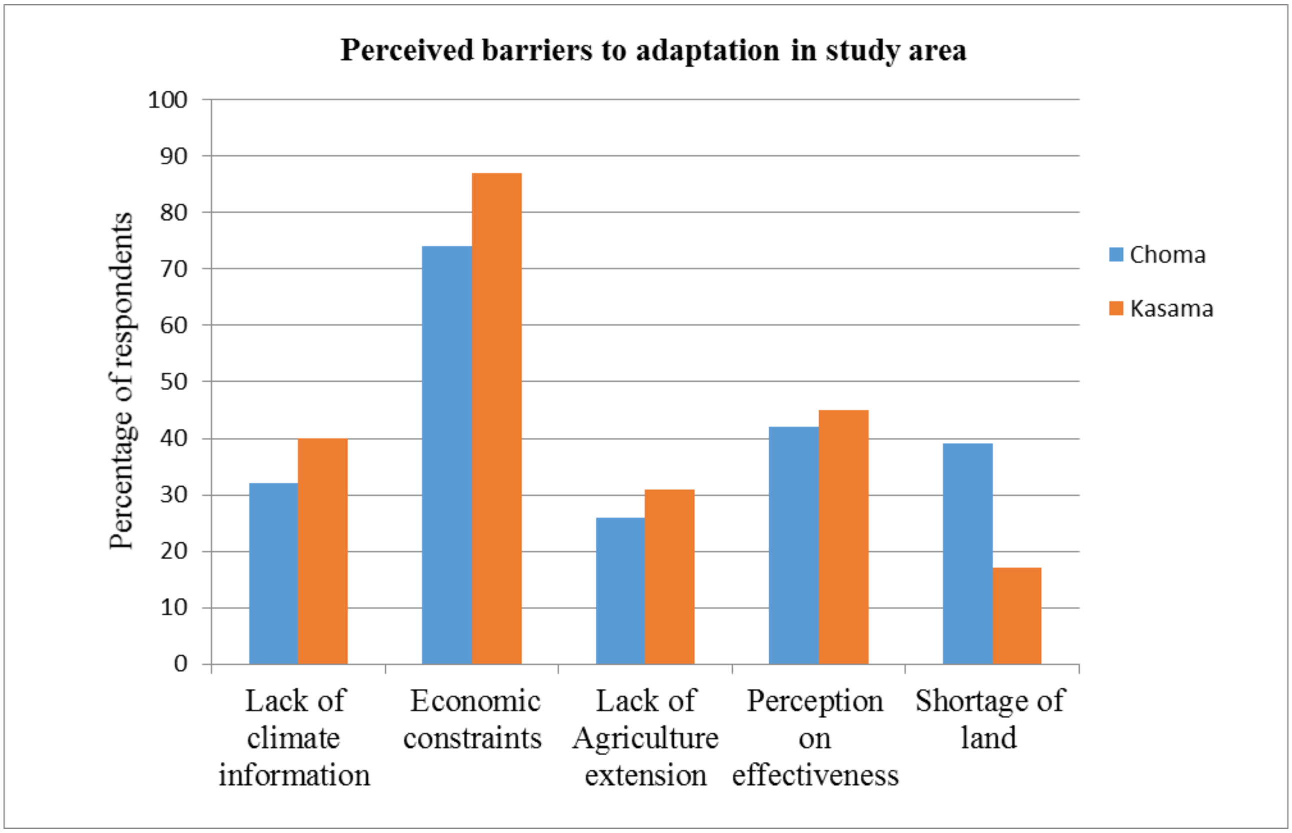


Figure 25 : Perceived Barriers to Adaptations

CHAPTER SIX: CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusion

The conclusions are formulated in accordance to specific objectives and hypotheses.

Objective One: To investigate and identify the perception of the farmers on climate variability. The results on perception of the farmers on climate data are verified with the observed meteorological data on temperatures and rainfall. The aspect on amount of rainfall proved to be a challenge to quantify as many farmers accredited this to wide variability in terms of onset of the rains and at what stage of the cropping season response was based. In Choma district 54% of the farmers did not perceive change while 37 % highlighted a decrease in the amount of rainfall (Table 7). The meteorological data shows annual rainfall decrease from November to April the cropping season for maize (Figure 8). In the case of Kasama district, 50 % the farmers perceived no change and 43% perceiving an increase (Table 7).For verification purpose, meteorological data shows a slight increase in annual rainfall (Figure 13).The second response on temperature perception is concurrence with the observed meteorological data indicating an increase in both districts. Figure 16 and 21 affirms the hypothesis that farmers are capable to perceive change and are aware of the variability.

Objective Two: To examine and discuss the influence of climate variability and food security phenomenon with particular focus on maize production. The findings in table 8 Choma district results show that an increase in rainfall will result in an increase in yields. On the contrary with the amount of rainfall increase experienced in Kasama shows a decrease in yields. In the case of temperatures, a decrease in Choma will result in yield increase while for Kasama an increase in temperature leads to yield increase. The decline in Choma rainfall contributes to decline in yields from 1987 to 2013 characterized by to increase in dry spell, droughts and low rainfall during crop production. In Kasama district the decline in maize yields is lower in comparison to Choma the cases attributed are floods and water logging of fields in most cases. The above confirms that climate change contributes to decline in crop yields.

Objective Three: To identify the adaptation measures adopted by small scale farmers to avert climate variability in response to food security across the study area. The major adaptations measures employed in the study area were crop diversification, change in sowing calendar, conservation farming and shifting cultivation with crop diversification dominate across both districts while additional change of sowing date is vital in Choma district. The results in table 14 addresses the hypothesis that non climate factors among them age, household size ,gender, access to credit influence adopting adaptation strategies .Despite, some farmers adopting strategies 28% and 38 % have not adopted any measure in Choma and Kasama respectively (Table12). Small scale farmers were employed copying strategies in times of food shortages such as asset sales, reduction in meals per day, relief aids borrowing cash and food (Table 15). Some perceived barriers to adapting to other practices include economic constraints, perception on effectiveness, and lack of extension and lack of information on climate (Figure 25).

6.2 Recommendations

Despite farmers perceiving change in climate and cropping pattern, there is need strengthening the efficient dissemination of agriculture and climate extension for better farmers' awareness and planning purposes. Strengthening the capacity of farmers and relevant stakeholders on extension and climate variability is critical as this will result in farmers to adapt to long term strategies as compared to the common short time copying.

With the projections of climate effecting decline in food production, improvement in food situation can be achieved by creating specialized growing zones across the country where crops are grown according to suitability of area. This will supplement farm level means such as crop diversification while at national level provision of rural credit accessibility will foster farmers to be able to purchase required inputs. The above are pivotal to minimize escalating food insecurity.

6.3 Conclusion on Future Research

Future research is needed to determine the magnitude of the effects economically using farmers' revenues, bio- physical approaches employing climate models for assessment of present and future effects of climate parameters across agro ecological regions of the country. Focus on other pillars of food security and attempt to quantify the effects. Further research on comparative climate variable effects on different crops is imperative. This will enable the researchers to determine the effects across all both economic and physical dimensions.

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APPENDICES

QUESTIONNAIRE: IMPACTS OF CLIMATE CHANGE ON FOOD SECURITY IN CHOMA AND KASAMA DISTRICTS OF ZAMBIA.

Assignment Record: Researcher………………Date completed: ……

Camp/Locality Name:…………………………………………………………

A: SOCIAL AND DEMOGRAPHIC CHARACTERISTICS

Please tick in an appropriate box or fill in provided spaces

1.1. Sex : *Male* ☐ *Female* ☐

1.2. Age: *Please specify…………*

1.3. How long have you been farming (experience)? ....

1.4. Are you a member of a Cooperative or farming group? Yes ☐ No ☐

1.5. How many members belong to your household? ....

1.6. What is the highest level of education?

None ☐ Primary ☐ Secondary ☐ Tertiary ☐

B. AGRICULTURE PRODUCTION

1. What is the size of your arable land?...
2. What are the major crops grown?..
3. What types of livestock do you rare?...
4. What implements do you use to cultivate your field?............................

   Hoe ☐ *Oxen* ☐ *Tractor* ☐ *Other (Specify)*……….

5. Where do you sell your produce?

   Retail sale ☐ *Farmer's Market* ☐ *Government agency* ☐ *4.Other*

6. *How long does the food last after harvest:*

   a) *Less than 3 months* ☐ *b) 2. 3-6 months* ☐ *c)More than 6 months* ☐

7. What are the major sources of income?

Source	
Crop sales	
Livestock sales	
Formal employment	
Informal employment	
Remittances	
Retirement Benefits	
Back yard gardens	

8. What were your maize yields in last growing season?

Description	Amount
Yields	
Cost of production	
Price per 50 kilograms	

9. Do you have access to credit facilities? Yes No

C. FARMER PERCEPTION AND FARM MANAGEMENT

10. Have you noticed any significant changes in climate? Yes No

11. What changes have you noticed?

State	Rainfall (amount)	Temperatures	Early onset rains
Increased			
Decreased			
No change			

12. Have you noticed any significant changes in the agriculture yields?

Increased Decreased No change

13. Do you have access to climate information?

Yes ☐ No ☐

14. How often do you attend Agriculture extension meetings during growing season?

…………

15. By what means did you get this information from MACO in rain season?

Radio ☐ *TV* ☐ *Agriculture Ext. Officers* ☐ *Other (Specify)*

16. Which of these practices, if any, have you adopted in your farming?

Practice	**Tick box**
Crop diversification	
Change in planting date	
Conservation farming	
Shifting cultivation	
No Adaptations	

17. How do you respond in times of food availability shortages?

Response	**Tick here**
Asset sales	
Reduction in meals per day	
Relief food aids	
Migrations	
Borrow Money	
Borrow food	
Charcoal sales	

18. What are some of the challenges you face in adapting to climate change?

Barrier	**Tick here**
Lack of climate information	
Economic constraints	
Lack of Agriculture extension	
Perception on effectiveness of adaptations	
Shortage of land	

Thank you