FACTORS INFLUENCING THE GROWING OF GANKATA AND KAFWAMBA AS ALTERNATIVE MAIZE VARIETIES TO CLIMATE CHANGE ADAPTATION IN MAZABUKA DISTRICT OF ZAMBIA

Moonga Mostie Keezwa (201602276)

A research report submitted to Mulungushi University in partial fulfillment for the requirements of the award of Master Degree in Disaster Studies in the School of Agriculture and Natural Resources

August 2018

August 2018

CERTIFICATION

The undersigned certify that they have read and recommended this report to be submitted by Mostie Keezwa Moonga as a partial fulfillment for the award of the Degree of master of Disaster Studies in the school of Agriculture and Natural Resources at Mulungushi University.

DECLARATION AND COPYRIGHT

I, Mostie Keezwa Moonga, do hereby declare that this work is my own and all the works of other people used in this dissertation have been dully acknowledged and that this work has not been previously presented at this or any other university for similar purposes

Signature……………………………….. ……………… Date…………………………………..

Computer/NRC………………………………………………………………………………

Supervisor Signature…………………………………………….. Date………………………….

ACKNOWLEDGEMENTS

This research was successfully done with support from a number of people. Firstly, I would like to recognise the professional guidance I received from my supervisor Dr. Adrian Phiri my examiner Dr chansa Chomba, lecturers: Dr Mitulo Silengo, Mr. Mwale Joseph, Mr. Masautso Mwale, Mr. Daka, Mr. Munsanje, Mr. Sianga and others not mentioned but contributed to the production of this document for their insightful advice and guidance during the different stages of my research implementation process; from proposal development, data analysis to report writing. I also wish to sincerely thank Mr. Emmanuel P. Hamazakaza for editing my work as well as guiding me throughout; the Data Collectors: Robert Munamoonga and Mapenzi under the supervision of Ivan Hanyimbo who worked tirelessly to ensure that quality data was collected and put together in a meaningful manner.

The two Agricultural staff under Mwanachingwala and Munenga Agricultural Camps' unequaled hospitality and valuable time they willingly spent with me in putting together the data sets greatly inspired me and will remain a true eye opener to realities of research field experiences and challenges which surround the agricultural sector in Zambia.

It is my sincere hope that this report will help provide the desired state of affairs pertaining to the current factors that impact on maize production and food security among the resource constrained farmers.

DEDICATION

To my wife Esther Ngosa Moonga my mother Mrs. Patricia Kaala Moonga for taking care of me during my research in Mazabuka, Dad Mr. Oswell Mwiinga Moonga for educating me and finally I wish to thank my children; Mweemba, Keezwa, Joshua and Patricia for their understanding while I was away from them during research.

DESCLAIMER

The opinions presented in this report are of those the researcher and do not therefore not in any way represent the views of anyone else or those of Mulungushi university.

ABSTRACT

Smallholder farmers in Mazabuka district of Southern province of Zambia have been experiencing worsened climate change related shocks especially dry spells or drought, increased incidences of crop pests and diseases in the recent years. Farmers have had to cope with such shocks through the adaptation of local crop varieties in order to remain food secure. The overall objective of the study was to understand farmer perceptions and provide evidence on the role of local maize, particularly Gankata and Kafwamba in climate change impact mitigation among smallholder farmers. The study was conducted in Mazabuka district particularly in chief Mwanachingwala's area. Two agricultural camps Munenga and Mwanachingwala were purposively sampled on the basis of a high number of farmers who are still growing local maize varieties. Random samples of fifty farmers were interviewed from each camp in January to March 2018 for the study from a population of five hundred sixteen people. About one third of the sampled farm households in the area grew local maize in addition to hybrids. Land resource is a critical asset in crop production including diversification into non-improved local maize varieties. Local maize constitutes about fifteen percent share of the maize income and its production costs are relatively lower compared to hybrids and improved Open Pollinated maize varieties. Maize sales income was significantly higher giving an estimated K12, 107 annual incomes among farmers who planted local maize in addition to hybrids compared to K3, 668 for those who only grew hybrids. This finding supports the hypothesis that local maize growers have not only diversified maize varieties, but these varieties also provide more resilience to climate change shocks. Majority of the local maize growers have been growing Gankata and Kafwamba for over ten years as opposed to hybrid maize growers have not been continuously planting the same preferred varieties over the years.. Farmers reported that they prefer growing local varieties because of their ability to resist drought stress. The study gives the following recommendations; farmer training in maize seed production methods so as to maintain the purity of local maize varieties and avoid contamination with hybrids, need to improve on the local seed systems and seed banks, farmers sensitization on the importance of local maize in climate change impact mitigation as well as development of policy guidelines pertaining to plant genetic resource conservation in the context of poverty alleviation and climate change mitigation.

Keywords: ***Local Maize (Gankata and kafwamba), Hybrid maize, Climate change, Poverty, Food security, Smallholder farmers.***

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACRONYMS

AER I	Agro-Ecological Region I
CBD	Convention on Biological Diversity
CEO	Camp Extension Officer
DFID	Department for International Development
DTMA	Drought Tolerant Maize for Africa
FAO	Food and Agriculture Organisation
FISP	Fertiliser Input Support Programme
FSR	Farming Systems Research Approach
GDP	Gross Domestic Product
IFPRI	International Food Policy Research Institute
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
MOLNREP	Automated Programme for Molecular Replacement
MTENR	Ministry of Tourism, Environment and Natural Resources
NAPA	National Adaptation Programme of Action on Climate Change
NARS	National Agricultural Research System
OPV	Open Pollinated Variety
PPB	Planning Programme and Budgeting
SCCI	Seed Control and Certification Institute
SPSS	Statistical Package for Social Sciences
TK	Traditional Knowledge
UNEP	United Nations Environment Programme
UNFAO	United Nations Food and Agricultural Organisation
UNIP	United National Independence Party
USAID	United States Agency for International Development

CHAPTER ONE

INTRODUCTION

1.1 Background

Smallholder farmers in the Agro-ecological region I (AER I) of southern Zambia have in the past few decades been experiencing worsened climate change shocks. The climate change related shocks on crop production include among others the following; low crop yield, increased crop pests and diseases, reduced crop related income due to high incidences of dry spells or drought. These farmers have had to cope with climate change related shocks through the adaptation of their traditional crop production practices in order to remain food secure and survive.

Changes in climate affect food production and directly impinge on Africa's economic potential and ability to meet the MDG to reduce poverty and extreme hunger. The high costs associated with climate change and variability are closely related to poverty, poor health and dependence on agriculture, therefore measures that address these aspects and diversify the range of economic activities can be important in mitigating the effects of climate change (UNEP 2006:7).

Seed management of locally adapted crop varieties or seed is of crucial importance for food security among smallholder farmers. Seed management forms an integral part of farmers' crop production systems. Traditionally, it has been observed that for many centuries, farmers have developed and maintained their own plant genetic resources, based on local means of seed production, selection and exchange. In the southern region of Zambia, local maize varieties especially Gankata and Kafwamba have played a key role in maize production and food security in drought prone areas. Over the years, newly introduced varieties have been subjected to farmers' experimentation, and when adopted they become part of the local gene pool. In many cases this integration involves physical mixing of seeds and spontaneous crossing with other materials.

Crop diversity must be conserved and well-managed in order to achieve a sustainable planet, but also to provide a positive development path for some of the poorest people on the planet. Over the last 30 or 50 years, plant breeders have been trying to produce higher yielding varieties of crops. These varieties include hybrids and Open Pollinated Varieties (OPV). OPVs are varieties which when self-pollinated or are pollinated by another representative of the same variety; the resulting seeds will produce plants roughly identical to their parents. Each of these modern varieties is very uniform and often contains less genetic diversity than farmers' varieties. Why does this reduction in crop diversity matter? Uniform modern varieties do not resist diseases in the same way that landraces do (Long, 2000). Modern varieties need good land, a lot of Fertiliser and long terms adaptation to environmental conditions in order to yield well: they are not of so much use for poorer farmers on less fertile land which is characterized by harsh environmental conditions such as drought, pests and diseases.

Zambia has a tropical climate, with temperatures remaining relatively cool throughout the year due to the high altitudes of the East African Plateau. Mean annual temperature varies from 18-20°C. The hot summer months are very dry, and the country receives very little rainfall between June and August. The wet season rainfalls are mainly determined by the tropical rain belt, bringing rain between October and April of 150-300mm per month (McSweeney et al 2010; MOLNREP, 2014).The predominant climatic hazards are droughts, high temperatures and floods. All the agro-ecological regions are vulnerable to the mentioned hazards above but the most vulnerable ones are regions I and II, mainly covering Eastern, Central, Western and Southern provinces.

This description of climatic conditions and identification of areas most vulnerable to climate change can be described using the global agro-ecological zone developed by the United Nations Food and Agriculture Organization (UNFAO) with the use of digital global databases of climatic Parameters, topology, soil and terrains and land cover (ILUA 2008 database). The first agro ecological zone (AEZI) represents semi-arid soils with low rainfalls (less than 800 mm) and altitude of (400—900 m). Land falling within this agro-ecological zone accounts for highly vulnerable climate change shocks especially droughts and accounts for about 17 percent of the total land area of Zambia. The second largest proportion of the land (23 percent) falls in the second agro-ecological zone (AEZIIb), which is characterized with medium rainfall (800 - 1000mm) occupying the Zambezi plains and Barotse Kalahari sand plateaux. Zone three (AEZIII) is typically of high rainfall of greater than 1000 mm and is located on the northern part of the country and the plateaus with altitude ranging from 1100 to 1500 meters.

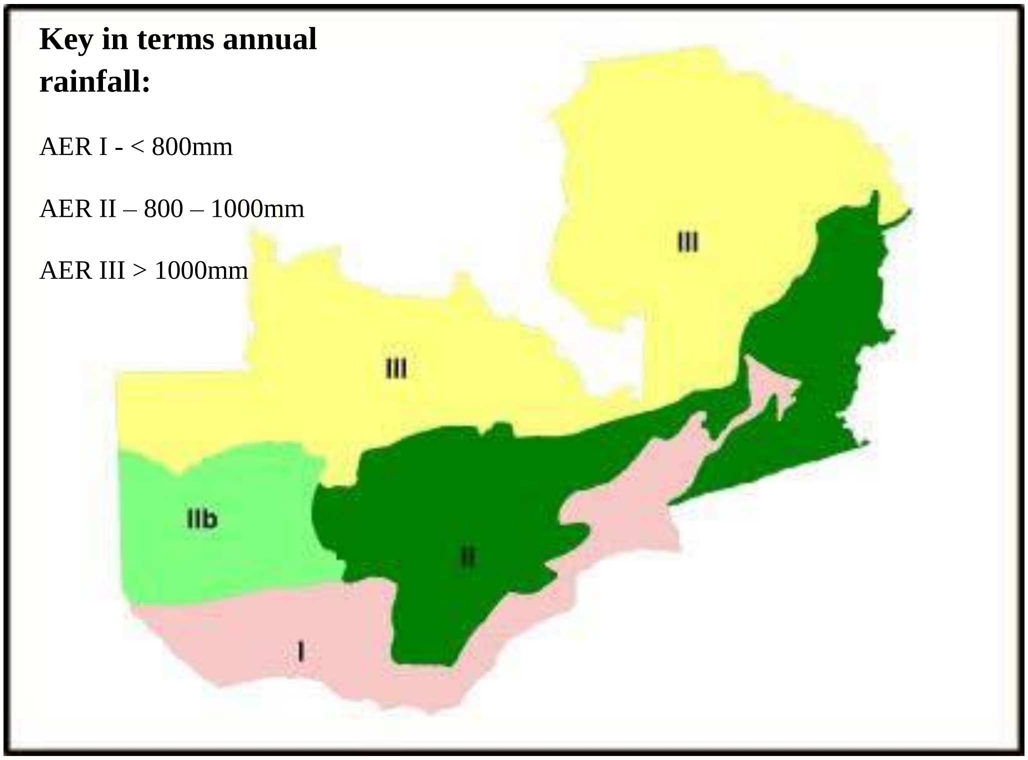

Figure 1. Agro-ecological regions of Zambia (Source: MoLNREP (2014)

The Southern Province of Zambia is particularly vulnerable to climatic hazards such as droughts, high temperature regimes and floods. Climate change vulnerability assessment undertaken by IUCN revealed that communities have experienced an increase in the number of droughts, rain intensity, and extreme heat conditions over the past decades (IUCN, 2007).

There seems to be too many varieties of crop seeds on the market. With the numerous varieties released onto the market without adequate farmer education, unfamiliar variety information and poor labeling create confusion for farmers eventually affecting brand loyalty. It has been observed that some unscrupulous traders engage in unethical advertising practices or simply paint grains in a color similar to existing seed color adopted by some companies and undercut prices. The danger here is not only that under such circumstances it becomes very difficult to sell the "actual" certified seed at competitive prices, but also it creates problems of brand loyalty (Langyituo,2004:9) where as Gankata and Kafwamba are easy to obtain as they are easily recycled. The household survey carried out by DTMA in 2013 revealed that Zambian farmers in the surveyed areas grew a total of 20 varieties during that year. The most widely grown varieties were SC513 (released in 1999), MRI 624 (1998), Gankata (landrace), MRI 614\ (1998), and SC601 (1997).

Zambia has over several decades experienced a number of climatic hazards and extreme events that represent significant departures from average state of climate system. These climatic hazards are associated with human-induced climate change and natural climate variability. The climatic indicators have shown that the country has experienced an increase in temperature and a decrease in rainfall over the past decades. Studies have revealed that over the past three decades temperature has been increasing at 0.6^{o}C per decade. There has also been an increase in the occurrence of extreme events along with their intensity and magnitude. The most serious ones have been dry spells, extreme temperatures, seasonal floods and flush floods (MTENR, 2007).

1.2 Problem Statement

Southern province which was once celebrated as the national bread basket of Zambia is terms of maize production, has in the recent years gone down in terms of production. The province has been the worst hit with the impacts of climate change. Recurrent drought, maize related pest and disease incidences have been the worst in the province compared to other maize growing regions in the country. The research component as reported in the Seed Control and Certification Institute report of 2014 in Zambia in the maize sector has so far introduced close to, if not more than 300 improved maize varieties most of which are high productivity hybrids. However, despite significant investment in the maize seed industry, most of the improved and recently introduced varieties are not well adapted to the environmental conditions in the province, are vulnerable to drought effects, are hybrids and cannot be recycled, and year to year readily availability of seed for the farmer preferred hybrid varieties is a challenge. These maize production challenges are also further worsened by the low financial resource endowment levels for most farm households who cannot afford to buy fresh seed every year.

Traditional farmers in southern province including Mazabuka district, have domesticated, improved and conserved a number of local maize varieties using their traditional knowledge. These varieties are increasingly becoming valuable for adaptation to climate change. Therefore, in light of vulnerability challenges associated with the use of hybrid maize varieties, there is growing evidence on the role of traditional knowledge and local crop varieties in responding to climate change. As a result, it is a common practice that most communities and households have resorted to maintaining the growing of traditional local varieties such as “Gankata and Kafwamba” as a response measure to climate change impacts especially drought. These varieties are well adapted to drought conditions as well as the major climate change induced maize diseases and pests, hence are able to withstand these shocks and still give some economical yield benefits compared to improved hybrids and open pollinated maize varieties. Lack of documented empirical evidence on the benefits of local maize in climate change impact mitigation has resulted in most farmers not taking these varieties seriously in their production. This study is meant to understand the contribution of traditional open pollinated maize varieties (OPV) in household food security among the resource constrained smallholder farmers in the drought prone district of Mazabuka in Southern province of Zambia.

1.3 Aim

The overall aim of the study was to understand the farmer perceptions and provide evidence on the role of Gankata and Kafwamba as alternative maize varieties to climate change adaptation in Mazabuka district of Zambia.

1.4 Specific objectives

The objectives of the research were to;

i. establish the advantages of growing Gankata and Kafwamba local maize varieties compared to hybrids under climate change impact related shocks.

ii. document farmer experiences on the reasons or challenges faced in adopting local maize varieties among resource constrained smallholder maize farmers.

iii. establish the proportion of farmers who are still growing local maize varieties and reasons why.

iv. explore the influence of household asset endowment levels to farmers’ willingness to grow local maize varieties in climate change impact mitigation

v. establish how much manure and artificial Fertiliser is used in local maize varieties per hectare as compared to hybrids

1.5 Research Questions

i. What are the perceived advantages of local maize cultivation and adaptation among the resource constrained smallholder farmers in the drought prone areas of Mazabuka district?

ii. What have been the critical challenges to the adaptation of local maize for climate change impact mitigation?

iii. What proportion of farmers is still engaged in local maize cultivation?

iv. What factors influence farmers to adapt local maize to climate change impact mitigation?

v. What measures can policy makers put in place in order to support the production of local maize varieties for climate change adaptation?

vi. Which variety between local maize and hybrids uses more manure and artificial fertilisers?

1.6 Research Hypotheses

Null Hypothesis (H_O): There is no significant relationship between growing of local maize varieties and improved productivity as well as income from maize sales.

Alternative Hypothesis (H_A): There is significant relationship between growing of local maize varieties and improved productivity as well as income from maize sales.

1.7 Significance of the study

Though this study may not have direct benefits to the study households, it will tremendously help government and rural development institutions involved in climate change impact mitigation to fully understand and appreciate how the current farmer traditional knowledge and maize production practices particularly the growing of local varieties are contributing to food security and income despite adverse weather conditions the farmers find themselves in. The study has also documented how Gankata and Kafwamba local maize varieties are contributing to household resilience to climate change induced food insecurity and show evidence rather than relying on speculative figures. This will also contribute to policy makers' ability to make informed decisions on climate change related programmes. The study will therefore contribute to the development of better climate change response strategies for rural development organizations and government and will lead to more efficient resource allocation in the context of plant genetic resource conservation.

1.8 Conceptual and Theoretical Framework

1.8.1 Theoretical Framework

The design of this study was based on the Sustainable Livelihoods framework to determine changes in household livelihood assets and food security associated with growing of landraces or local maize varieties and how this translates into resilience to climate change shocks. The livelihoods approach is a useful tool for understanding the opportunities and constraints that households face and for identifying practical priorities for action that are based on the views and interests of those concerned. The Sustainable Livelihoods Framework presents the main factors that affect people's livelihoods and their interrelationships. The research adopted a sustainable livelihoods approach in order to understand the impact of climate change on household food security, assets and the various responses adopted by different households particularly in terms of crop production practices. Data pertaining to changes in household food security particularly maize production and assets was collected in retrospective for a three year period from 2015 to 2017.

O'Donnell (2004) has argued recently that the sustainable livelihood framework can provide a clear basis for understanding how climate change can impact on various aspects of livelihoods in many different ways. Such an analysis should reveal intervention points for reducing the risk of food insecurity and mitigating the negative impact of climate change, so that preventive measures can be linked to mitigation efforts.

In this research, the researcher's main concern was to identify the differences in terms of climate change impacts on maize yield between the farm households (Users of local varieties) that have been using landraces or traditional maize varieties in addition to hybrids and those that only grow hybrids (Non-Users of local varieties). The study focused on a number of variables that included; Gender of household head, age, education level, household composition, years of residence, maize varieties, area under cultivation, yield, household asset pentagon (social, natural, financial, physical and human capital) .

1.8.2 Conceptual Frameworks

Livelihoods are defined as the capabilities, assets and activities required for a means of living (DFID, 2000). A livelihood is regarded to be sustainable when it can cope with, and recover from stresses and shocks and maintain its capabilities and assets both now and in the future, while not undermining the natural resource base. The characteristic features of the Sustainable Livelihood are therefore the livelihood assets, strategies and outcomes. Households are regarded as possessing different sets of livelihood assets essential to their livelihood strategies: human capital, natural capital, financial capital, social capital and physical capital. **Human capital** consists of the skills, knowledge, ability to labour and good health, which are important to pursue livelihood strategies. **Natural capital** consists of the natural resource stocks from which livelihoods are derived (e.g. land, water, wildlife, biodiversity). **Financial capital** includes cash and other liquid resources (e.g. savings, credit, remittances, pensions, etc.). **Social capital** comprises the social resources people draw upon in pursuit of livelihoods such as networks, membership in groups, exchange relations and access to wider institutions in society. **Physical capital** includes basic infrastructure (transport, shelter, energy, communications and water systems), production equipment and tools that enable households to maintain and enhance their relative level of wealth.

The **policies, institutions and principles** in the livelihoods framework are the institutions, organizations, policies and legislation that shape livelihoods. A variety of institutions (state, civil society, private sector), both formal and informal, may operate in the community and directly influence the livelihood outcomes of the population. Figure 3 below shows the various factors in the livelihood framework and how they relate to each other.

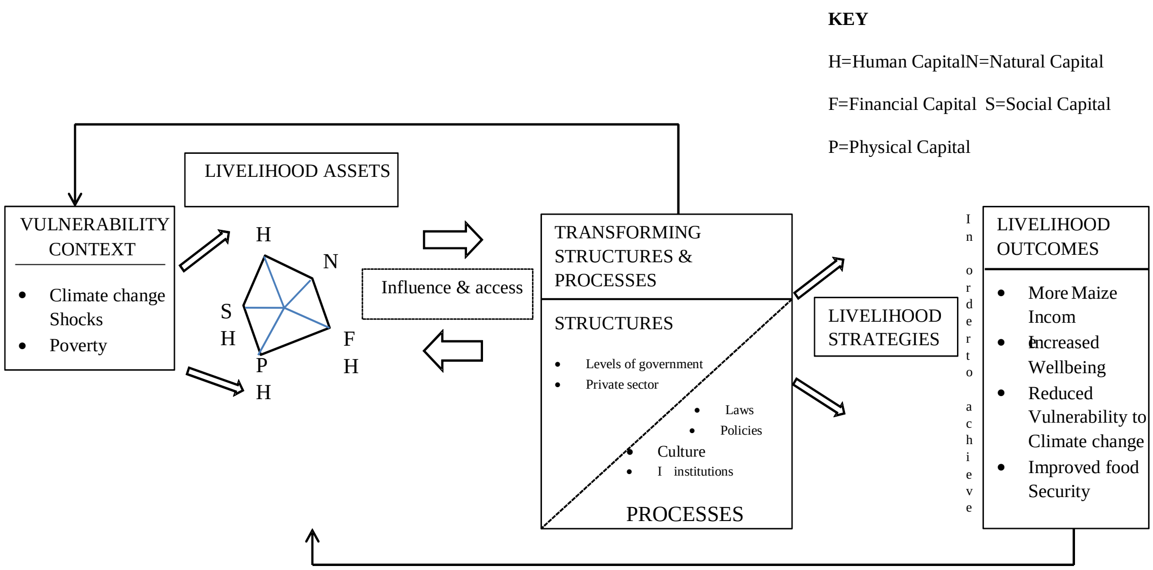

Figure 2. Sustainable livelihoods conceptual framework

Source: Adapted from DFID (1999) Sustainable livelihoods: Lessons from early experience

Households combine their livelihood resources (assets) within the limits of their context and utilize their institutional connections to pursue a number of different livelihood strategies (e.g. agriculture production, off-farm employment, informal sector employment). The Sustainable Livelihoods Approach tries to understand the factors that lie behind people's choice of livelihood strategy in order to reinforce the positive aspects (i.e. factors that promote choice) and mitigate the constraints. In the analysis of livelihood strategies, it is important to capture the types of (sustainable and non-sustainable) coping strategies different households use when normal livelihood options are not adequate to meet household needs.

Livelihood outcomes are the achievements of livelihood strategies. There are a number of measures that capture need or well-being satisfaction, such as nutritional status, sustained access to food, increased income, increased well-being, reduced vulnerability, more sustainable use of the natural resource base.

The rationale for using the Sustainable Livelihoods Approach in this research study was that it would enable analysis and quantification of the changes in the livelihood assets and food security of the households that have been engaged in the growing and non-growing of local maize varieties. Furthermore, an analysis of the type of climate change impact mitigation responses in the context of maize production was done for all the study households. For this study a positive change in the level of maize related food security possessed by households that have been growing landraces was synonymous with effectiveness of such varieties in climate change impact mitigation.

CHAPTER TWO

LITREATURE REVIEW

2.1 Introduction

"In the last decade, Zambia has experienced shocks both internally and externally driven by natural and economic factors, such as climatic shocks and fluctuating commodity prices. These factors have affected the country's economic growth and development path "(7NDP 2017). The goal of the 7NDP is to create a diversified and resilient economy for sustained growth and socio-economic transformation driven, among others, by agriculture.

The burning of fossil fuels, is already affecting the Earth's temperature, precipitation, and hydrological cycles. Continued changes in the frequency and intensity of precipitation, heat waves, and other extreme events are likely, all which will impact on agricultural production leading to considering local varieties that suit the environment. Furthermore, compounded climate factors can decrease plant productivity, resulting in price increases for many important agricultural crops**.** The hydrologic cycle now includes more frequent and intense droughts and floods in many agricultural regions. These events can damage and at times even destroy crops especially hybrids which are not suitable to local weather conditions.

2.1 Heat

Over the next 30-50 years, average temperatures will likely increase by at least 1.0 °C. Anticipated regionally-dependent changes include increased number of heat waves and warm nights, a decreasing number of frost days, and a longer growing season in temperate zones. The main study contents are: 1) climatic changes and impacts in 10 years (1998 to 2008), 2) local adaptation tools and practices (Traditional Knowledge (TK), biodiversity, Participatory Plant Breeding (PPB), community group's collective actions etc.), 3) results of adaptation, by comparing PPB project villages and non-ones, i.e. TK and local varieties with modern technologies and varieties, 4) taking gender as a cross cutting aspect integrated in the above 3 items given the popular phenomena of feminization of agriculture and aging agriculture in China.

The study looked at changes in climate and in the socio-economic situation of poor farmers, including male outmigration and increased rural poverty. It found that climatic and socio-economic changes are interlinked and mutually affected complex processes. Farmers' perspectives of climate change revealed that they have been severely affected and most farmers felt the effect of increasing temperature and drought and lower rainfall. It is noticeable that: 70% of the respondent villagers face the drought problem; 77% feel lack of rainfall; 87% realize that the temperature has increased; 62% feels stronger wind force; 56% of the villages feels stronger sunshine; 72% have more runoff, and in 64% of the villages, new pests and diseases have emerged.

2.3 Climate change impacts

The IPCC 5th Assessment indicates that, through its interaction with non-climate change drivers (e.g. urbanisation, population growth), climate change will increase the vulnerability of agricultural systems in Africa, especially in semi-arid areas. Climate change will also act as a compounder of existing health vulnerabilities, including access to safe water and adequate sanitation, and food insecurity. In particular, the IPCC suggests that climate change is a key hazard for small-scale farmers in Zambia, given their low adaptive capacity to cope with climate variability (Niang et al., 2014).The potential loss of agriculture due to climate variability has been estimated to be between US $2.2 to $3.1 billion of GDP (MoTENR, 2010). The Zambian Government through the MTENR has formulated the NAPA which has identified adaptation measures in all vulnerable sectors, including agriculture and food security, human health, water and energy sector, and natural resources (wildlife and forests). The predominant climatic hazards are droughts, high temperatures and floods. All the agro-ecological regions are vulnerable to the aforementioned hazards but the most vulnerable ones are regions I and II, mainly covering Eastern, Central, Western and Southern provinces.

The Tonga people today identify several varieties of maize on the basis of seed colour and size, and the length of the maturation period, this fall into two basic categories: early maturing flint maize Kafwamba and late maturing dent and flour maize Gankata (Scudder, 1974:82). In addition, traditional varieties or landraces are more genetically diverse than modern varieties and so are better able to withstand environmental stress such as lack of water or nutrients (CBD Secretariat, 2010).

The climatic hazards that have been experienced in the country include droughts, floods and high temperatures. In order to respond to priority needs for adaptation to Climate Change, the Zambian Government through MTENR formulated the NAPA, a national document that outlines the types of climatic hazards experienced in Zambia, their impacts and adaptation measures to respond to these impacts. The World Conservation Union (IUCN) in Zambia has also undertaken an assessment on climate change vulnerability in Zambia (IUCN, 2007). Journal of Agricultural Science vol.5 No. 4 : 2013, states that adaptation measures include: changing planting dates , using different crop varieties, planting tree crops, practicing irrigation, soil conservation and water harvesting.

According to Allan *et al*., (1945), the Tonga people were originally shifting cultivators who practiced subsistence agriculture combined with cattle raising, before the coming of colonial rule (Allan et al., 1945, p.2). The major crop that they cultivated was local maize like 'Kafwamba' and; Gankata'. This was done on the fertile plateau soils. It was also possible for the Tonga to keep cattle because the plateau was free from the tsetse fly. Other subsidiary gardens were prepared for sorghum and pulses (Allan *et al*., 1945, p.6 and p.81).

The agriculture sector is adversely affected by drought, floods and high temperatures. Droughts have led to crop failure, loss of income and increase in diseases (both human and livestock). High frequency of dry spells has also contributed to shortening of growing season and crop damage. Floods have led to water logging, soil erosion, and destruction to infrastructure and have hindered farming activities. All these factors have negatively impacted on food security, livelihoods and adaptive capacity of vulnerable communities.

Prior to the mid-1960's, active research collaboration between technical agricultural scientists (i.e. mainly working on experiment stations), agricultural economists (i.e., mostly in planning units) and anthropologists/rural sociologists (i.e., generally in academia), was limited. By the mid-1960s, the Green Revolution was beginning to have a major impact on crop production in parts of Asia and Latin America through the introduction of fertilizer-responsive, high-yielding varieties of rice, wheat, and maize in favorable and relatively homogeneous production environments where there was assured soil moisture, good soils, ready access to cheap fertilizer, and relatively efficient output markets.

The Farming Systems Research (FSR) approach thus became very popular with donor agencies, to the extent that, by the mid-1980s, about 250 medium- and long-term externally funded (i.e., in addition to those domestically funded) projects worldwide were implementing FSR-type activities. Between 1978 and 1988, USAID2 alone had funded 76 bilateral, regional, and centrally funded projects containing a farming systems orientation. Forty-five of these were in Africa. Most of these projects supported the establishment of separate FSR units, which often were poorly integrated into, or poorly linked to, mainstream technology development activities. Although it is probably true to conclude that few of these projects succeeded in producing new technologies that were widely adopted, the approach of looking at farmers' constraints and needs for technical change from within was eventually mainstreamed into most national and international agricultural research programs by the late 1980s. Therefore although donor support for supporting explicit FSR activities dwindled towards the end of the 1980s, most national agricultural research systems (NARS) had adopted major components of the FSR philosophy and approach, and the spirit of the FSR approach lived on (Norman 2002:3).

2.5 Climatic factors

The different climatic factors affecting maize production in Zambia include: droughts, dry spells and floods. For example, World Bank (2006) reported that due to repeated droughts maize production has shown a general decline from early 1990's onwards in Zambia. Also, flooding of lowland areas and death of animals (used as drought power) in many places affected the output (FAO, 1998).

2.6 Drought

Drought-induced crop failures have been the most common disasters experienced in Zambia in the recent past. Certain areas of the country, notably Western, Southern, Central, Eastern and Lusaka provinces have been particularly susceptible to periodic droughts. The impact of drought, which is usually multi-sectoral, leads to the disruption of productive activities that are depended on water and agricultural raw materials Disaster Management and Mitigation Unit Office Of the Vice President Lusaka August (2005: 21). Because of the likely impacts of climate change and variability, which include yield reduction, soil degradation, increased disease and pest incidences, it is important that adaptation and mitigation strategies are put in place to cushion farmers from the adverse effects of climate change, Summary Results of Focus Group Interviews in Zambia, (2012). The NAPA has also identified specific projects that would bring immediate local benefits to vulnerable sectors and community groups with respect to adaptation to climate change. These projects have been identified and prioritised and proposals shall be developed and submitted for funding to Global Environment Facility (GEF) and other cooperating partners. Government will also provide through its budget funds towards implementing adaptation and mitigations measures in the vulnerable sectors and regions. However, there have been no funding to implement these projects. Only one project has been earmarked for implementation in 2010 by the Ministry of Agriculture and Cooperatives. The project relates to the adaptation to the effects of drought in the context of Climate Change in Agro-Ecological Region I. This project supports climate resilient water management and agricultural practices, and includes pilot projects aimed at testing the feasibility and viability of the interventions in terms of financial sustainability and reduction in vulnerability to climate change.

2.7 Famine

This has been a common occurrence in semi-arid and drought prone areas of the country. The major causes of famine include drought, disease and pest attacks to domesticated animals and plants and these included Corridors and stalk borer being the common animal and plant diseases respectively. In addition to the human loss, there is also social cost to society as a result of diverting resources for development to meeting the cost of disaster relief Disaster Management and Mitigation Unit Office of the Vice President Lusaka August (2005:18).

For maize specifically, different studies have been done to investigate how the crop responds to different temperature levels during different stages of active growth. Studies done by Ramadoss (2004) on maize in Australia, found that maize crop that experienced extremely high air temperatures (41^{o}C) over several days at the time of anthesis (silking) had lower grain yield and numbers compared to those that experienced lower temperatures. Thus, from this study, it was concluded that under dry land environments, kernel set decreases at anthesis with temperature greater than 38^{o}C compounded by water stress (ibid). Another study done by Stewart *et al* (1997) indicated that during vegetative growth, maize has a maximum response to temperature of between 25 - 30°C and during reproductive growth, maize responds well to temperatures above 12°C.

Thus, though effect of temperature on photosynthesis seems to have much effect on the grain yield, temperature can also affect the crop at different stages of its growth starting from germination, to vegetative growth and then to reproductive growth.

2.8 Non-climatic factors affecting maize production

Non- climatic factors include: access to credit, market, transport, storage infrastructure, fertilizer and high yielding seeds to small scale farmers. For example, from the study done by FAO (1998) reduction in maize production was attributed to lack of credit facilities to farmers and those that were able to be offered credit facilities, the inputs were delivered late to them. Credit facility in terms of cash is also important as it can help farmers to pay for extension services and transportation of final products to the market. "The FISP input delivery dates ranged from the first week of December to February. It was too late to use inputs received in February for the season under study and farmers kept these for the following season. Late delivery of FISP inputs results in most recipients sowing late. A few of the farmers sowed recycled (F1 generation) seeds which they complained gave very low yields. Late sowing "brings its own problems", said one respondent. These problems include rodents eating the seeds before they germinate. This happens because when sowing is delayed, weeds grow and harbour rodents. Farmers also complained of receiving expired maize seed and inappropriate varieties. Late sown seeds also result in low yields" (African Journal of Agricultural Research Volume 11 Number 13 31 March 2016 ISSN 1991-637X).

2.9 Historical perspective of maize

Tonga custom allowed individuals to acquire land for cultivation in a number of ways. Firstly, an individual acquired land by clearing virgin or regenerated and unclaimed land. Secondly, land was obtained by transference of rights from one individual to another, temporarily or permanently. Thirdly, land was acquired by inheritance and by taking into cultivation his own vacated hut sites and their surroundings (Conroy, 1945:92).

The paper shows that pre-colonial ecologies of agricultural systems in some parts of rural Zambia were sustainable and resilient to prevailing environmental conditions, and were therefore able to ensure relative food security, under communal land tenure. However, colonial policies of land alienation and labour migration impacted negatively on food production systems of some ethnic groups like the citemene system of the Bemba and the flood plain cultivation system of the Lozi, making them extremely vulnerable due to the absence of large numbers of males. Paradoxically, the Tonga people in Southern Zambia responded positively to the introduction of modern methods of cultivation, exhibiting resilience by adapting and adopting the cultivation of hybrid maize and the ox-drawn plough Trapnell and clothier (1937).

The local farmers were very familiar with these two local maize varieties (Kafwamba and Gankata) and masterly of their performance up to growth and harvest. High yield is one of the most cited and important noted attributes of seed varieties as expected but farmers are also selecting varieties for myriad reasons. Numerous other studies have confirmed the importance of both production and consumption attributes to subsistence farmers in developing countries (Waldman et al., 2014; Ortega et al. 2016). Pest and drought resistance are important production attributes to farmers but are not often advertised effectively. According to SCCI records, few hybrid varieties are explicitly characterized as "drought tolerant" varieties in Zambia and in low rainfall areas like Choma district all maize varieties must be drought tolerant to some extent. Storing maize is a major challenge across Africa (Thamaga-Chitja, 2004) and hybrids tend to have greater than 40% loss in gross yields which is much higher than local landraces on average (Smale et al., 1991).

They also began to transform their land tenure system from being communal to become increasingly individualized. At independence in 1964, the UNIP government intervened strongly in promoting rural development (1964-1990), by subsidizing maize production and by implementing protectionist policies to maintain communal tenure. However, food security could not be guaranteed, and the policies led to over dependence of small-scale farmers on government and on maize at the expense of other food crops.

Climatic models suggest that the southern African region will be strongly affected by future climatic changes: they predict higher temperatures and an increased frequency and severity of drought, which will prejudice crop production if there is no adaptation or change of existing cropping systems. Using the results of 20 general circulation models, Lobell et al (2008) estimated that temperatures in southern Africa would increase by roughly 1.0◦C, and that precipitation would fall by 10%. They determined that maize SEED CO SC 621, ZM 421,ZM 521 ,ZM 621, ZMS402 ZAM SEED, and ZMS737ZAMSEED (*Zea mays* L.) and wheat (*Triticum aestivum* L.) would be the crops most negatively affected in the region, with estimated reductions in yield of close to 30% and 15%, respectively. A reduction in yield of this important crop would have negative effects on food security. The predicted lower rainfall increases the need for more water-efficient cropping systems to mitigate the effects of climate change. Adaptation strategies could include changes in varieties, planting dates, or changing from highly sensitive to less sensitive crops, i.e., sorghum (*Sorghum bicolor* L.) (Lobell et al. 2008). The study considered the period ranging from 2015 to 2018January because a relatively shorter period was ideal to give a comparison of activities under study than a long period of time.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Introduction

This chapter discusses the data collection process which was be used in this study. Specifically, it outlines key issues pertaining to the research strategy, description of study target population, study design and approach, data collection methods and analysis strategies that were be used.

3.2 Study area location and description

The study was conducted in Chief Mwanachingwala's chiefdom which is found in Mazabuka district of southern Zambia. The chiefdom stretches from Kafue river bordering with chief Shakumbila in Shibuyunji district of Central Province.

3.2.1 Location of study area

Figure 3 (three) below describes the extent and location of the study area as well as the agro-ecological zone in which the study area lies.

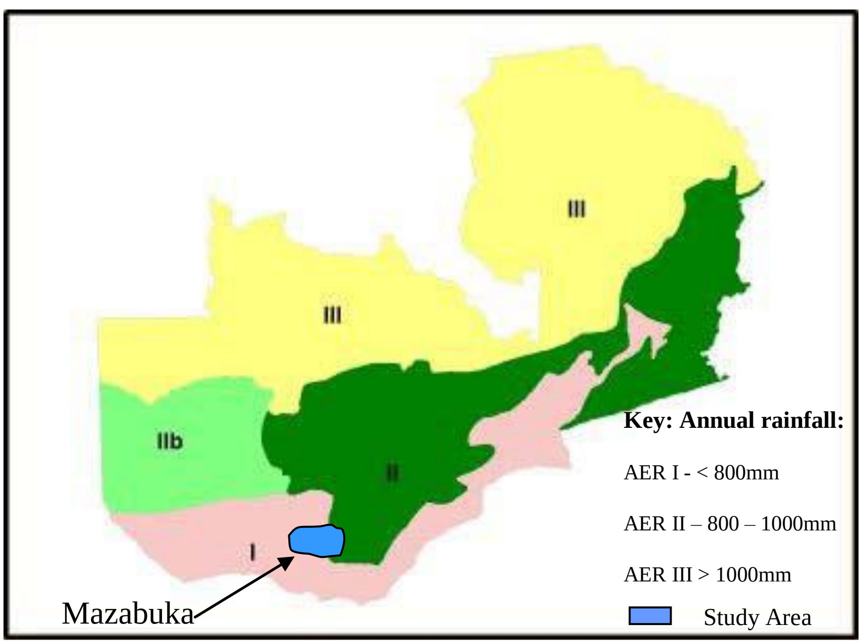

Figure 3 Location of study area

Source: MoLNREP (2014)

3.2.2 Area Description

This study was a case study of the local maize variety producers in Mwanachingwala chiefdom of Mazabuka district. The study used two types of data collection strategies; desk review of information pertaining to the research topic and a quantitative survey of one hundred (100) smallholder farm households. Literature review was conducted to have an overview of the different targeting processes and also learn about the use of landraces or local maize varieties in climate change mitigation as well as failures and successes of such practices. Surveys were done to collect household level information on maize production and climate change impact mitigation responses, household livelihood options and food security.

The targeted population are smallholder farmers who are growers and non-growers of maize landraces in Mazabuka district. A random sample of one hundred (100) farmers was selected for the study. The sampling frames are the Village Farm Registers which are in custody of the Agricultural Camp Extension officers (CEOs). At community level, two agricultural camps where a significant number of farmers are growing local maize varieties were purposively selected. In each camp, a random sample of fifty (50) households was drawn giving a total sample of one hundred (100) for the study out of five hundred and sixteen (516) farmers found the selected agricultural camps.

3.3 Data Collection

Two research assistants were recruited and trained by the researcher prior to questionnaire pretesting and data collection. Questionnaire pretesting was also done in a non-study area in order to assess the flow of the questions, ascertain questionnaire sections or questions that needed further attention. Data collection involved two research strategies; desk research of existing literature (secondary data collection) pertaining to the study, and a case study on growers and non-growers of local maize varieties (primary data collection method). A structured questionnaire was used to collect primary quantitative data from the respondents.

In addition, the survey also included key informant interviews with community leaders and Agricultural staffs who are actively involved in agricultural extension services in the chiefdom. For the household survey, the tool for data capturing was a quantitative questionnaire, whereas for key informant interviews, a qualitative checklist was used.

3.4 Data Analysis

Data was analysed using two statistical packages, Microsoft Excel and the Statistical Package for Social Sciences (SPSS) version 20.0. T-tests were computed to compare the significance in the differences between variables of interest between growers and non-growers of local maize varieties.

3.5 Ethical considerations

The research treated each and every response as confidential. All the respondents were informed about the confidentiality of the answers, had to give consent and no responses were attached to any name of a farmer or respondent.

3.6 Informed Consent

This research sought information from farmers as primary target population. As such, prior consent was sought from the respondents. To this effect, an informed consent was included as part of the data collection questionnaire at household level. The consent form was translated into local language by the interviewer and the purpose, benefits and possible risks for the research study was explained to enable the respondent make an informed decision to participate in the study or not.

3.7 Risks

The study had minimal if any risks to the study subjects. All data used in the study came from respondents' own experience and no reference to other households or organizations was made and recorded. All names of participating respondents were not be included as it is not a requirement and not necessary for the study. All data from the study is kept as strictly confidential despite not having identifiers.

CHAPTER FOUR
RESULTS

4.1 Introduction

In this section, findings of the study are presented focusing on the objectives of the study. These are based on the analysis of descriptive statistics which compared growers and non-growers of local maize varieties by components of the asset pentagon (human capital, natural capital, physical capital, and social capital). The study also compared livelihood outcomes between average growers and non-growers of Gankata and Kafwamba local maize varieties.

4.2 Socio-economic characteristics of Growers and Non-Growers of Local maize

4.2.1 Human Capital

About one third (31.6%) of the sampled farm households in the two research study areas of Munenga and Mwanachingwala Agricultural Camps of Mazabuka districts grow local maize. Majority (96.7%) of the local maize growers are male headed farm households. The household heads for the local maize growers are relatively older with a mean age of 52.71 years compared to non-local maize growing households whose head averaged 43.03 years. Despite the local maize growers having a longer experience (21.1 years) in farming, this was not statistically different from the years of farmers for the non-local maize growers (18.52 years) at 95% confidence interval. Literacy level, particularly one's ability to read and write is a key pre-requisite to responding to agricultural extension service especially if such advisory services are communicated through electronic print media. Findings indicate that most local maize growers have only gone up to primary school as opposed to the non-local maize growers who have on average achieved secondary education.

Mean household sizes were larger among local maize growers (9.63) than among non-growers of local maize seed, and the difference of means was statistically significant at 5% with a two-tailed t-test. In addition, local maize growers are clearly better endowed in terms of the number of economically active, male adults who can provide labour resources (Table 1).

Table 1 Human capital characteristics of households, by use of local maize

	Planted local maize		Did not plant local maize		T-test (p-value)
	Mean	Std. Error	Mean	Std. Error	
Age of household head (years)	52.71	2.468	43.03	1.404	0.000
Experience in farming (years)	21.10	2.181	18.52	1.272	0.282
Literacy (1=Illiterate 2=Primary 3=Secondary 4=Post-secondary)	2.38	0.167	2.61	0.102	0.228
Number of male adults (16-59 years)	2.74	0.318	1.76	0.177	0.005
Household size	9.63	0.736	7.56	0.470	0.015

Source: Author. P-values refer to Independent Samples two-tailed t-tests.

4.2.2 Natural Capital

Land resource is a critical asset in crop production including diversification into non-improved local maize varieties which are generally of low productivity. It is apparent from the statistics that the growers of local maize were more endowed in terms of land resource at 6.12ha compared to the non-local maize growers who on average owned 3.93ha. As presented in the human capital characteristics, the growers of local maize are elderly household heads who as expected may own more land than the young ones who are more into hybrids.

Both differences are statistically significant at less than 5%, despite the large variation in the sample in terms of land owned. Kolmogorov-Smirnov tests also confirm statistically significant differences, and that farm sizes are smaller for non-growers of local maize across the full range of values for the two groups. The kurtosis and skewness values based on the Kolmogorov-Smirnov tests are 1.019 and 1.097, respectively. These values are far above zero therefore confirmed that there was no normality in the distribution of land owned among the two groups. Figure 4 Shows that land ownership is skewed between 2-6ha.

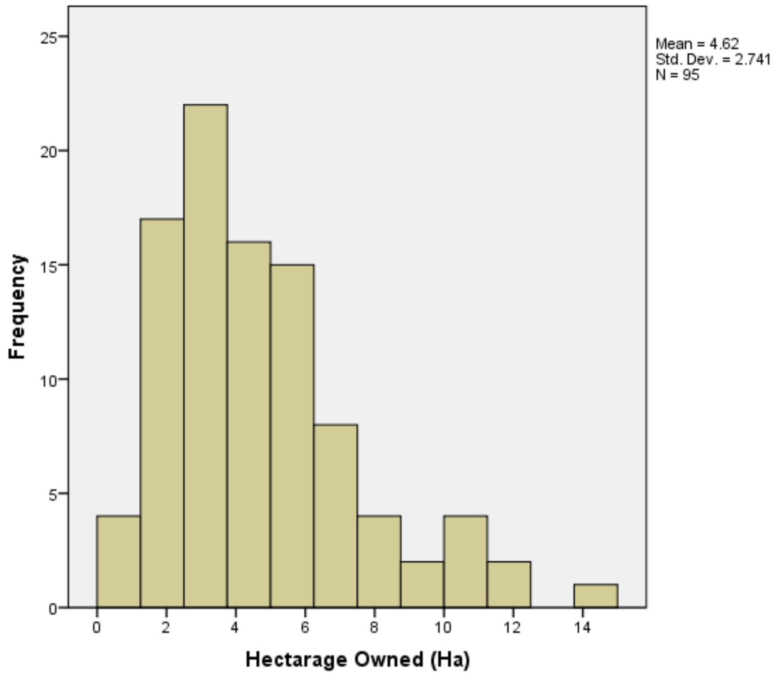

Figure 4. Sample distribution of average land size owned

Source: Author, based on survey data

4.2.3 Physical Capital

Physical assets facilitate crop production, and as noted long ago in the study by Kumar (1994), ownership of oxen, ploughs, and carts are strongly associated with use of inputs such as improved seed and fertilizer as opposed to dependency on land races such as local maize varieties. Overall, the comparison of asset endowments confirms that Non-Local Maize Growers tend to be significantly better-endowed in terms of most types of physical assets than are maize farmers who depend on local maize production (Table 2). They are more likely to own communication assets that are key in production which include; bicycles, televisions and radios, in addition to productive assets such as oxen, ploughs and harrows. Over half (56.5%) of the sampled non-local maize growers owned at least one pair of oxen compared to the local maize growers (43.5%). Statistically, significant differences were apparent for communication assets, particularly radio and cell phone ownership.

Table 2 Physical capital characteristics of households (numbers owned), by use of local maize

Number of units	Parameter	Local Maize Grower	Non-Local Maize Grower	T-test (P-Value)
Bicycle	Mean	1.450	1.580	0.505
	Std. Error Mean	0.121	0.129	
Television	Mean	1.100	1.25	0.245
	Std. Error Mean	0.095	0.090	
Radio	Mean	1.030	1.20	0.045
	Std. Error Mean	0.034	0.064	
Pairs of Oxen	Mean	1.810	2.110	0.453
	Std. Error Mean	0.316	.249	
Plough	Mean	1.43	1.58	0.509
	Std. Error Mean	.177	.145	
Harrow	Mean	1.43	1.67	0.238
	Std. Error Mean	.202	.553	
Ox-cart	Mean	1.11	1.00	0.180
	Std. Error Mean	.076	0.000	
Cell Phone	Mean	2.73	1.58	0.000
	Std. Error Mean	.275	.115	

Source: Author. P-values refer to two-tailed Independent samples t-test.

4.3 Advantages of growing local maize

In order to ascertain the advantages that are associated with the growing of traditional or local maize varieties, this research study assessed how these varieties have contributed to the different aspects of livelihood outcomes at farm household level. This section addresses the advantages of growing local maize as reported by the sampled farmers in the study area. The study also examined the differences in income sources between growers and non-growers of local maize.

In terms of livelihood outcomes, the major income sources at household level in the year preceding (2016/17) the survey period comprised of maize grain sales, petty trading, piecework, fruits and vegetable sales, livestock sales, remittances, self-employment and other sources. Out of the major income sources, maize remains the most important source of income for most of the farmers surveyed. It contributes about 27.5% of the total household income. Local maize constitutes about 15.1% share of the maize income which at smallholder farmer level is quite significant as its production costs are relatively lower compared to hybrid and OPV improved maize (Table 3). The mean total household income for the preceding year was almost the same among local and non-local maize growers. The independent samples t-test of the difference in average total annual income between local maize growers and the non-growers leads us to reject the null hypothesis that the means for annual income are not equal for the two farmer categories at less than 1%, with unequal variances. Maize grain sales income was significantly different, and higher, among farmers who planted local maize in addition to hybrids. This finding supports the hypothesis that local maize growers have not only diversified maize varieties, but these varieties also provide more resilience to agro-climatic shocks.

Table 3 Annual household income by source, 2016/17 season (K)

Income Sources	Local maize grower		Non-local maize		Significance	
	Mean	Std. Error Mean	Mean	Std. Error Mean	F (variance)	t test (difference of means)
Maize grain sales	12,107	1,385	3,668	605	0.004	0.000
Horticultural products	1,316	173	1,205	396	0.032	0.767
Livestock products	4,166	1,249	7,833	3,201	0.088	0.387
Paid employments/Piecework	1,957	463	7,269	3,420	0.034	0.061

Source: Authors. P-values refer to two-tailed t-tests.

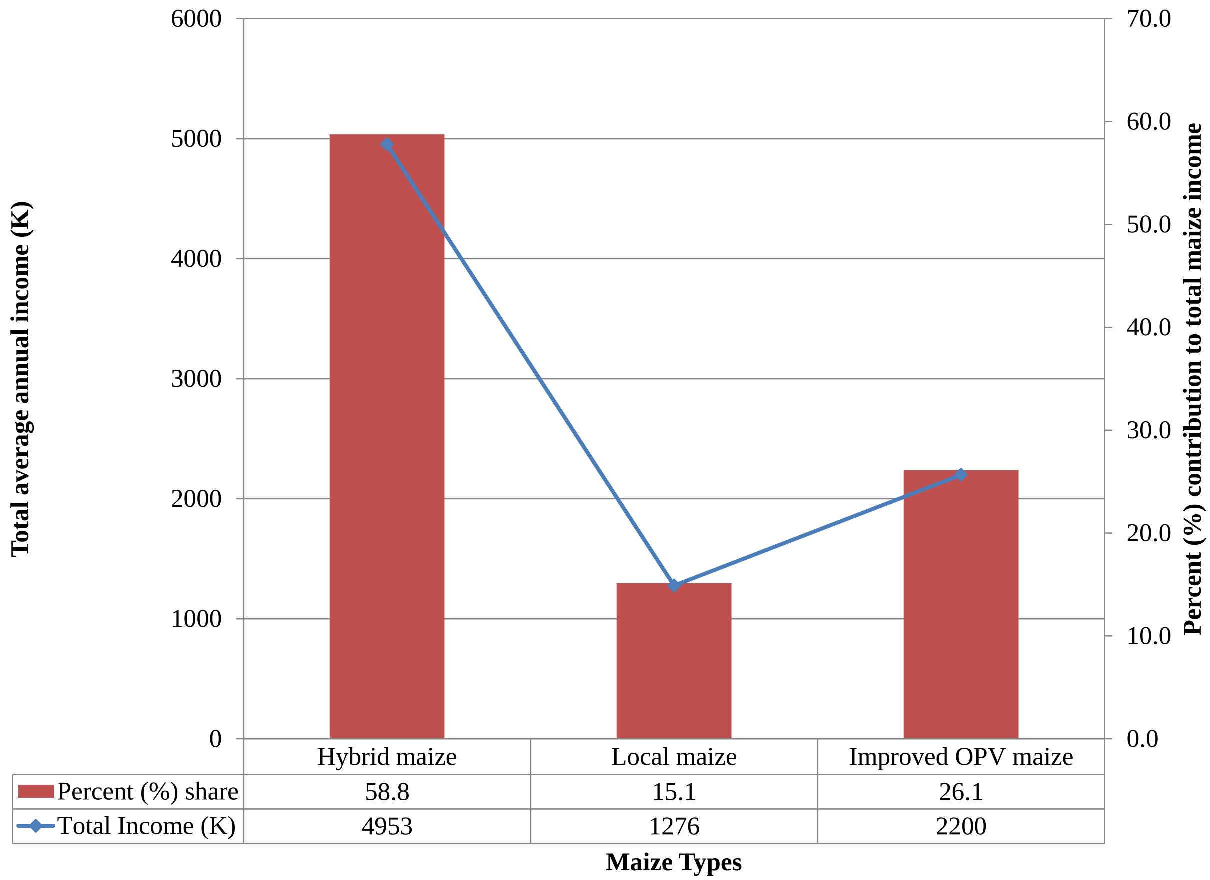

Figure 5 Local maize contribution to total maize income, 2016/17 season

Source: Author, based on survey data

It was apparent from the survey findings that local maize varieties are cheaper to grow and are less dependent on external inputs especially in terms of seed and fertilisers. Findings show that most of the hybrid maize growers however, depend so much on external support. Statistically, about 71.9% of the non-local maize growers who were interviewed in the study received inputs for hybrid maize production and mostly from the government supported Fertilizer Input Support Programme (FISP). The distribution of the total number of years the households surveyed have received input support for maize production shows a high density around three years of benefitting from FISP support (Figure 6). The histogram also displays a steady decline in number of years for households that have received support from FISP above 3 years. In terms of hybrid maize production and variety adoption, these findings support the assertion that most farm households have not consistently received FISP support over the past decade and to a greater extent still depended on other sources of maize seed. In view of the economic vulnerability of the smallholder farmers in Zambia, the low number of years of FISP support for the vast majority of farmers suggests that many households have not only benefited inconsistently but may have also grown hybrid seed irregularly and hence have resorted to other seed sources such as local maize.

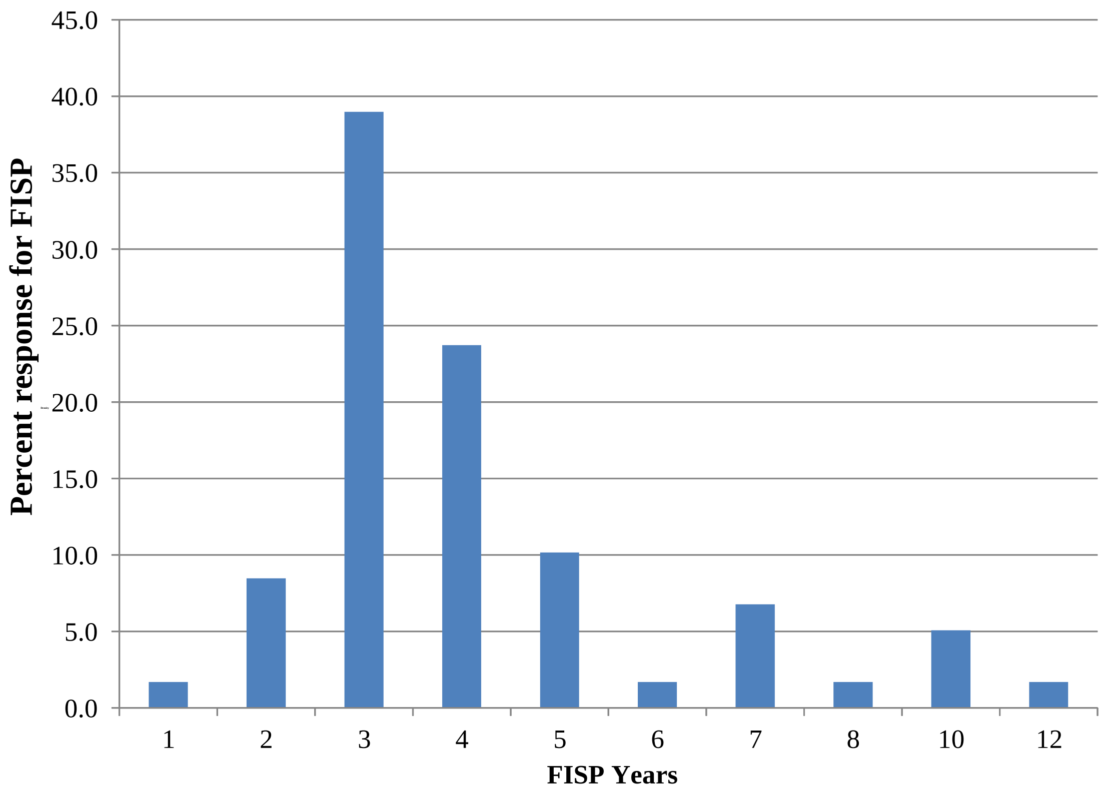

Figure 6. Sample distribution of number of years household has received FISP support

Source: Author, based on survey data

As shown in Table 4 below, it is evident that a total of 8.5% individuals among the sampled households were affiliated to the different institutions at community level that offer input support to crop production including maize. However, farmers who grow local maize varieties were also more likely to be affiliated with any agricultural organization, cooperative or club related to agricultural activities.

Table 4 summarizes the parameters that were used to measure the intensity of social capital. Based on the sample data, it is estimated that 8.5% of the population is affiliated to some form of agricultural cooperative society.

Table 4 Proportion of households affiliated to agricultural cooperatives in the sample

Parameters	**Total**
Total estimated sampled households in survey areas	100
Total sample population	697
Number of household members affiliated to farmer organizations in sample	59
Intensity measurement	0.085

Source: Author, based on survey data

4.4 Maize production practices

The dominant sources of hybrid maize seed reported in the SCCI variety release register are seed companies (Seedco, Zamseed, Pioneer, Dekalb, Maize Research Institute and Pannar) for the improved hybrids and OPVs. However, for local varieties, seed is sourced locally through on-farm recycling by the farmers themselves. Statistically, about one third (31.6%) of the sampled farm households grow local maize varieties in addition to improved hybrids and Open Pollinated Varieties (OPVs). Majority (80.7%) of the local maize growers reported that they have been growing current local maize varieties for over 10 years. However, on the contrary, there has been high inconsistency in terms of planting the same preferred improved hybrid varieties among the sampled farmers. Almost half (47.7%) of the surveyed farmers reported that they first planted the hybrid varieties which they grew in 2016/17 only two years ago. As such, the farmers have not been continuously planting the same preferred improved varieties over the years, and this situation has compromised their ability to withstand the impacts of weather shocks and climate change.

The major local varieties grown in the study area are Gankata and Kafwamba. In comparison to improved hybrids and OPVs, there are a number of agro-climatic and socio-economic factors that have motivated farmers to continuously grow local maize varieties despite their relatively low productivity potential compared to improved hybrids and OPVs. Among such factors are drought resistance, low soil fertility tolerance, availability and ease access to seed locally, adaptation to local environment, low cost of seed, and potential to be recycled without losing their genetic viability.

More than half (56.7%) of the farmers interviewed reported that they prefer growing local varieties because of their ability to resist drought stress. Only 17.6% of the sampled farmers indicated that the existing hybrids in Mazabuka district are drought tolerant (Table 5).

Table 5 Farmer perception on variety tolerance to drought

Parameter	**Percent (%) response by maize Type**	
	Hybrids	**Local Varieties**
High	17.6	56.7
Moderate	78.0	33.3
Low	4.4	6.7

Source: Author, based on survey data

In the context of climate change impact mitigation, the study sought information from farmers on the important issues they consider as they select a maize variety to grow. All the sampled farmers either local maize grower or non-local maize grower acknowledged that the important factors they consider are drought resistance, pest and disease resistance as well storage pest resistance.

The relative cost of seed for local maize is lower compared to hybrid maize. The average unit cost of seed in 2017/18 season was three times lower for local maize seed at K6.5/kg compared to hybrids which was being sold at K21.5/kg. As reported in table 6, farmers bought more of the cheaper local maize (49kg) than improved hybrids (41kg) on average.

Table 6 Seed purchase in 2017/18 season

Variety	Quantity Purchased (kg)	Cost of seed (K)	Unit cost (K/kg) of seed
Hybrid	41.29	888.65	21.5
Local Maize	49.22	320	6.5

Source: Author, based on survey data

Generally, farmers applied less fertilizer in local maize at an average of 100kg/ha compared to 150kg/ha in hybrid maize. However, as reported in table 7, equal quantities of manure at an average of 600kg/ha is applied to both hybrid and local maize crops.

Table 7 Quantity of fertilizer (kg) and manure (kg) applied in 2017/18 season

Variety	Basal Fertiliser	Top dressing Fertiliser	Cattle manure
Hybrid	150	150	600
Local Maize	100	100	600

Source: Author, based on survey data

On the basis of a synthesis of the above survey findings, it can be concluded that local maize varieties constitute a strategic crop in the livelihoods of farmers in the drought prone region of Mazabuka district as an assurance crop under erratic weather conditions. This maize (Gankata and Kafwamba) type has proved to be more adapted to the harsh environmental conditions associated with climate change than hybrids. Furthermore, seed for this crop type can be maintained through recycling without the varieties losing their genetic viability in terms of their productivity potential. Local varieties are also able to realize economic yield levels with minimal input support especially fertilisers, hence are cheaper to grow.

4.5 Challenges faced in adopting local maize for climate change adaptation

Despite the farmer experienced benefits of growing Gankata and Kafwamba as alternative local maize varieties in climate change adaptation and impact mitigation, a number of challenges were also identified as follows:

4.5.1 Lack of formal local maize seed banks

Farmers who have appreciated the benefits of growing local maize for climate change impact mitigation indicated that there is lack of a formal seed system to maintain the purity and supply of local maize seed. Farmers have not established seed banks which could be a key resource for the constant supply and replenishment of local maize seed into the maize seed sector.

4.5.2 Limited farmer knowledge in basic seed production and maintenance

The major players in the maize seed sector have not invested much effort in terms of time, expertise and financial resources to train farmers in basic seed production for local maize with the ultimate aim of helping them to maintain purity. This has adversely affected the adaptation of local maize as some seeds tend to be contaminated hence fail to express their full genetic potential in terms of tolerance to climate change shocks such as pests, diseases and dry spells.

4.5.3 Poor coverage on the importance of local maize in climate change by the media

Local maize is the only maize type that lacks an institutional structural arrangement in terms of its dissemination. Whereas local maize is well appreciated at smallholder farm level in terms of its potential to mitigate climate change impacts, there is no company or organization that has taken custody of the crop to deliberately promote it as the case is for most hybrids and improved open pollinated maize varieties. This has hampered the wide spread dissemination of local maize as alternative maize varieties to climate change adaptation.

CHAPTER FIVE

DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

A number of factors for that influence smallholder farmers' continued cultivation of local maize varieties despite their relatively low productivity when compared with the recently developed hybrids were identified in this research study. This chapter gives a synthesis of these factors based on the four research objectives and findings of the study. The synthesis addresses critical findings that may contribute to the body of knowledge on key policy interventions for the agricultural sector as it develops policy strategies for climate change impact mitigation. As presented in the discussion below, the major factors as presented in more detail in this section are centred around the following; household asset endowment levels and ability to diversify and adapt local maize for climate change impact mitigation, tolerance of local maize varieties to drought conditions, ease access and farmer ability to recycle local maize seed, low fertility tolerance of local maize varieties compared to hybrids.

5.2 DISCUSSION

5.2.1 Advantages of Local Maize adaptation to drought conditions

Local maize has been adapted to the drought conditions over a very long period of time. In the context of agro-climatic factors that influence smallholder farmers to continue growing local maize, a number of issues came up during the survey. Firstly, the local varieties which are primarily Gankata and Kafwamba have been adapted to the drought prone and harsh environmental conditions of Agro-Ecological Region I of Zambia which includes Mazabuka district over many decades. As reported by the majority of respondents in the main findings on farmer perceptions in table 5 of chapter 4.4, local maize varieties are looked upon as an assurance crop in the face of erratic weather conditions especially drought and frequent dry spells that adversely impact on improved hybrids. Other than being drought tolerant, these varieties are also resistant to most leafy diseases and tolerant to pests whose high prevalence in the recent years has been triggered by climate variability. The early maturity of Kafwamba enables the variety to offer food security in the lean period of the year around February and early

March. Statistically, local varieties remain determinants and significant in the maize production system for most smallholder farmers who are faced with agro-climatic and socio-economic challenges in AER I of Zambia.

It was apparent in the study as presented in the findings in figure 7 that quite a significant number of farmers (82.7%) growing hybrid maize depend so much on FISP inputs which in most seasons are distributed very late in the season around January and at times even February. This period coincides with dry spells. Furthermore, most farmers lack funds to buy hybrid or improved OPV seed which is almost three and half times more expensive than the local maize seed. As a result, the low resource endowment levels in terms of finances for most smallholder farmers has therefore in most seasons resulted in delayed planting of the hybrids thereby increasing the chances of crop failure or low productivity for hybrids as they tend to be planted late and fail to mature by the time the rains are ending around March as has been observed in the recent years.

Local maize has been adapted to the drought conditions over a very long period of time. In the context of agro-climatic factors that influence smallholder farmers to continue growing local maize, a number of issues came up during the survey. Firstly, the local varieties which are primarily Gankata and Kafwamba have been adapted to the drought prone and harsh environmental conditions of Agro-Ecological Region I of Zambia which includes Mazabuka district over many decades. As reported in the main findings, local maize varieties are looked upon as an assurance crop in the face of erratic weather conditions especially drought and frequent dry spells that adversely impact on improved hybrids. Other than being drought tolerant, these varieties are also resistant to most leafy diseases and tolerant to pests whose high prevalence in the recent years has been triggered by climate variability. The early maturity of Kafwamba enables the variety to offer food security in the lean period of the year around February and early March. Statistically, local varieties remain determinants and significant in the maize production system for most smallholder farmers who are faced with agro-climatic and socio-economic challenges in AER I of Zambia.

5.2.2 Challenges to adaptation of local maize to climate change

Despite the farmer experienced benefits of growing Gankata and Kafwamba as alternative local maize varieties in climate change adaptation and impact mitigation, a number of challenges were also identified. The major challenges include; lack of a formal seed system to maintain the purity and supply of local maize seed. As presented in chapter 4.4, seed for local maize varieties is either sourced from other farmers within the communities or through on-farm recycling of seed from the previous season's harvest. In this context, farmers have not established seed banks which could be a key resource for the constant supply and replenishment of local maize seed into the maize seed sector. The major players in the maize seed sector have not invested much effort in terms of time, expertise and financial resources to train farmers in basic seed production for local maize with the ultimate aim of helping them to maintain purity. Lastly, local maize is the only maize type that lacks an institutional structural arrangement in terms of its dissemination. This maize type has no formal company or organization that has taken custody of the crop to deliberately promote it as the case is for most hybrids and improved open pollinated maize varieties.

5.2.3 Farmer experiences in adopting local maize in climate change impact mitigation

Seed for Gankata and Kafwamba local maize varieties is readily available with farmers as opposed to the hybrids. This enables the majority of the farmers to plant local maize early and on time in the season. In view of the unpredictable onset of the rains in the past few decades, this has played to the advantage of the farmers who stock seeds of local maize as opposed to those who have to wait for subsidized hybrid seeds especially from FISP. Furthermore, farmers are able to recycle seed of local maize varieties without incurring significant economic yield loss. The local maize varieties are tolerant to low soil fertility conditions and hence tend to be less demanding in terms of fertilizer use compared to the hybrids as supported by the quantity of fertilizer applied to local maize and hybrids in table 7. It was evident from the field findings that on average, farmers applied far much less fertilizer about 100kg of either basal dressing and 100kg of top dressing fertilizer per hectare in local maize compared to 150kg of either basal or top dressing which was applied in hybrid maize. It was further observed that kraal manure which is a locally available source of nutrients is applied to local maize in addition to hybrid as well. The sampled farmers also never mentioned any challenges of serious disease incidences in local maize. Therefore, the cost of generally producing local maize varieties in terms of seed sourcing, disease management as well as fertilizer application is lower than that of hybrids.

The FISP input packs rarely maintain the same varieties across seasons. This situation has made it difficult for farmers to identify and consistently grow an improved hybrid variety or varieties of their choice as new and non-adapted varieties are ever being introduced on the market every season thereby confusing farmers on which hybrid to grow especially in the context of drought, pest and disease impact mitigation. Such characteristics of local maize have served as push and pull factors for most resource constrained farmers to continue growing local maize varieties for climate change related impact mitigation despite their being low yielding.

5.2.4 Asset endowment and local maize production in climate change impact mitigation

Study findings indicate that human, social, physical, financial as well as natural capital assets play a role in influencing the farmers' willingness to grow and adapt local maize as alternative crops for climate change impact mitigation. The growers of local maize as presented in table 1 and analysed in chapter 4.2.1 on human capital assets in this study are significantly older than those who only grow improved hybrid maize. Furthermore, the local maize producers are also less educated farmers who have only achieved primary school education compared to the hybrid maize growers who on average have achieved secondary education.

The local maize growers as reported in the results are mainly farmers who are not affiliated to farmer cooperatives or associations. In this case social capital played a positive role for the farmers who grow hybrids as subsidized input support especially for improved hybrids is only sourced through farmer cooperatives. Farmers who are more endowed in terms of land resource were found to be diversifying more in terms of maize varieties which they grew to include local maize. Agricultural land size was generally reported to be smaller among the hybrid maize growers as revealed in the analysis of natural capital assets in chapter 4.2.2 of the study findings.

5.3 Conclusion

Despite the importance of local maize in climate change impact mitigation, this maize type is not given adequate attention by the formal maize seed sector. Local maize is well adapted to local climatic conditions especially in terms of dry spells, pests and disease challenges. The seed system in Zambia has failed to adapt and maintain improved hybrid varieties which farmers are very familiar with and prefer for production. Every season farmers find new varieties on the market which in most cases fail to adapt to the environmental conditions hence yield poorly. As an assurance crop, a significant proportion of farmers, about one third still grow local varieties side by side with hybrids as a way of spreading the risk of maize crop failure in the face of agro-climatic and socio-economic challenges.

In terms of the economic importance of local maize for adaptation to climate change, this maize type has a comparative advantage over hybrids. It was revealed in the study that the cost of improved hybrid seed is high and unaffordable for most resource constrained farmers who are left with no option but to resort to local varieties which are low cost and easily accessible. The local varieties are also less demanding in terms of external inputs especially fertilizer and seed compared to hybrids. Farmers who grow local maize are still clinging onto these varieties as seed is easily recycled and accessible locally, is affordable and they are able to plant it on time in the context of the onset of the rain season as opposed to hybrids where farmers have to depend on external support. Seed maintenance and storage for local maize is done traditionally and cheaply either by treating it with ash or hang it in traditional kitchen where it is constantly exposed to smoke as a way of dispelling pests from the seed. In view of the high maize related income levels realized by the growers of local maize varieties, this study accepts the hypothesis that there is significant relationship between growing of local maize varieties and improved productivity as well as income from maize sales.

However, the adaptation of local maize for climate change also faces a number of challenges that include a lack of a formalized seed maintenance system and farmers are not trained in basic local maize seed production. Local maize has also not benefited in terms of media dissemination particularly in the context of its importance in terms drought, pests and disease tolerance which are the critical climate change related shocks.

5.4 Recommendations

In view of the important role which local maize varieties are contributing to food security and income among the resource constrained farm households in the drought prone and highly degraded soils of AER I of Mazabuka district and other similar environments, the following recommendations are made based on the major study findings;

i. There is need to refine the existing local maize varieties and improve on the local seed systems and seed banks.

ii. Farmers need to be trained in maize seed production methods so as to maintain the purity of local maize varieties and avoid contamination with hybrids.

iii. Farmers need to be sensitized on the importance of local maize as well as variety diversification in averting the devastating impacts of environmental shocks such as drought, diseases and land degradation

iv. The dissemination of maize production by the media needs to integrate messages of local maize production as alternative varieties to hybrids in the worst climate change impact affected regions

v. There is need to develop policy guidelines pertaining to plant genetic resource conservation in the context of poverty alleviation and climate change mitigation.

REFERENCES

African Journal of Agricultural Research Volume 11 Number 13 31 March 2016 ISSN 1991-637X

Climate Change Impact on Agricultural Production and Adaptation Strategies: Farmers' Perception and Experiences Summary Results of Focus Group Interviews in Zambia, (2012).

Disaster Management and Mitigation Unit Office of the Vice President: Lusaka August (2005).

Ellis, F. (2000) **Rural Livelihoods and Diversity in Developing countries**, Oxford University Press Inc., New York. http://doi.org/10.1016/j.foodpol.2014.03.015

http://www.aec.msu.edu/fs2/ag_transformation/scott.pdf

http://www.ssc.reading.ac.uk/bucs/Zambia%20Case%20Study.pdf Accessed date: 1st march, 2008 IPCC 4th Assessment, Working Group II. Cross Chapter Case studies. C4. Indigenous knowledge for adaptation to climate change

http://www.unccd.int/actionprogrammes/africa/national/2002/zambia-eng.pdf

Insight Review Article published online 21 August 2015 DOI: 10.1038/NCLIMATE2735 (Accessed date: 16th February, 2008)

IUCN (2007) Climate change and development project, pilot phase climate change vulnerability assessment in Zambia.

Kumar, S.K. (1994) **Adoption of Hybrid Maize in Zambia: Effects on Gender Roles, Food Consumption, and Nutrition**. Published by Int Food Policy Res Inst IFPRI, 1994

Kurji, P., Nanja, D., and Stern, R. (2003**) Exploring daily rainfall data to investigate evidence of climate change in Southern Zambia and its implication for farmers in the area**

Lobell, D.B., M.B., Burke, C. Tebaldi, M.D. Mastrandrea, W.P. Falcon, & R.L. Naylor. (2008) **Prioritizing climate change adaptation needs for food security in 2030**. *Science* 31:607–610.

Long, J., Cromwell, E. and Gold, K. 2000. **On-farm management of crop diversity: an introductory bibliography**. London: Overseas Development Institute for ITDG.

McSweeney, C., New, M., & Lizcano, G. (2010) **UNDP Climate Change Country Profiles: Zambia**. Retrieved from http://country-profiles.geog.ox.ac.uk/ (accessed 10 March 2015).

Ministry of Lands, Natural Resources and Environmental Protection (2014**) Second National Communication to the United Nations Framework Convention on Climate Change** (UNFCCC) 2000 - 2004.

Ministry of Tourism Environment and Natural Resources, Lusaka, Zambia (Date accessed 16th December 2006)

Ministry of Tourism, Environment and Natural Resources (MoTENR) (2010) **National Climate Change Response Strategy (NCCRS): Government of the Republic of Zambia MTENR, 2007**: Formulation of the National Adaptation Programme of Action on Climate

Mumba, L.A. (2002) **The National Action Program for Combating Desertification and mitigation serious effects of Drought in the context of the United Nations Convention to Combat Desertification**: Government of the Republic Of Zambia, Ministry of Tourism, Environment and Natural Resources.

Niang, Y.*et al* (2014) **Africa**. In V. Barros, C. Field, D. Dokken, M. Mastrandrea, K. Mach, T. Bilir … L. White (Eds.), **Climate Change 2014: Impacts, Adaptation and Vulnerability**. **Part B: Regional Aspects. Contribution of WG II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change:** Cambridge, UK and New York, US: Cambridge University Press.

O'Donnell, M. (2004) **Food security, Livelihoods and HIV and AIDS: A guide to the linkages, measurements and programming implications**, London: Save the children, UK.

Ramadoss, M.*et al* (2004) **Water and high temperature stress effects on maize production: The University of Queensland, Gatton Campus**, **Lawes, 4343**: Agricultural Production Systems Research Unit / CSIRO, Toowoomba, QLD 4350

SCCI (2014) **Variety release register, 2014**: Ministry of Agriculture, Zambia.

Scott, G. (1995) **Agricultural Transformation in Zambia**: **Past Experience and Future Prospects. Paper presented at the Workshop on Agricultural Transformation in Africa**: Abidjan, Côte d'Ivoire.

Scudder (1974) **The ecology of the Gwembe Tonga,** Butler and Tanner Ltd, London.

Seventh National Development Plan (2017-2021): Lusaka Zambia.

Smale M., and Heisey, P.W. (1997) **Maize technology and productivity in Malawi, in Africa's Emerging Maize Revolution**: Editors Byerlee, D., & Eicher, C. K. Lynne Rienner Publishers.

Stewart, D.W., Dwyer, L. M., and Carrigan, L.L. (1997) **Phenological Temperature Response of Maize. Agric. & Agri-Food Canada**, Eastern Cereal & Oilseed Res. Ctr., Ctr., Ottawa, ON K1A 0C6, Canada: Pioneer Hybrid Int., Plant Breeding Div., Willmar, MN 56201.

UNEP & UNFCCC (2002) **Climate Change Information Kit**: UNEP's Information Unit for Conventions, International Environment House, Geneva.

UNEP (2006) **Africa Environmental outlook 2**: Centre for Environment and Development for the Arab Region & Europe (CEDARE) http://www.cedare.org.eg

USAID Project, "Improved Modeling of Household Food Security Decision Making and Investments Given Climate Change Uncertainty" Associate Award AIDOAA-LA-11-00010 under Food Security III, CDG-A-00-02-00021-00.

Verschuren, P. and H. Doorewaard (1999) **Designing a Research Project**: Utrecht, Lemma.

Waldman, K. B., Kerr, J. M., & Isaacs, K. B. (2014) **Combining participatory crop trials and experimental auctions to estimate farmer preferences for improved common bean in Rwanda:** Food Policy.

Zambia fact sheet: **Zambia Fodder Pilot Project** (2012-2014).

Zeidler, J. (2013, July) **Adaptation to the effects of climate variability and change in agro-ecological regions I and II in Zambia (CCAP) - Mid-term evaluation**: Retrieved from erc.undp.org/evaluationadmin/downloaddocument.html?docid=7077 (accessed 10 March 2015).

APPENDIX I : QUANTITATIVE HOUSEHOLD QUESTIONNAIRE

Farmer experiences on the adaptation of local maize varieties in coping with climate change impacts in Mazabuka district of Zambia

Preliminary Information

1. Province: ____________________ __ 2. District: ___________________

3. Agricultural Camp : ____________________ 4. Distance to town (KM) : ___________

5. Village Name: _______________________

Section A. General Information

(As one of our contact farmers, we would like to know more about you)

A1. Name of current household (HH) head: ________________________________

A2. Sex of HH head: 1=Male 2=Female

A3. Age of HH head (in years): _____________

A4. Marital status of HH head: 1= Single 2=Married 3=Divorced 4=Widowed

A5. Educational level of HH head: 1=Illiterate 2=Primary 3=Secondary 4=Post secondary

A6. How long have you been farming? ___________ years

A7. Are you a native of the village? 1=Yes 0=No

A8. How many years have you been living in this village? …………years

Section B. Household Composition

We are interested in knowing more about the composition of your ***household*** *(all the people living in the same household, eating from the same "pot" and working on the family farm)*

B1. Household size: _______

B2. What is the composition of your household?

Grouping by sex	**Number living in the HH**	**Number currently attending school**
B2a. Male adults (**60 years and above**)		
B2b. Female adults(**60 years and above**)		
B2c. Male adults (**16-59 years old**)		
B2d. Female adults(**16-59 years old**)		
B2e. Male children (**15 years or less**)		
B2f. Female children (**15 years or less**)		

Section C. Household Resources

(We would like to know a little bit about the resources your household owns)

C1. What type of dwelling do you live in?

1=Mud hut with grass thatch roof 2=Mud hut with asbestos/iron roof

3=Brick house with grass thatch roof 4=Brick house with asbestos/iron roof

5=Block house with grass thatch roof 6=Block house with asbestos/iron roof

7=Pole and dagga with grass thatch 8=Other (specify) ___________________

C2. How many of the following assets do you own in the household?

Item	Units	Owner 1	Owner 2	Value (ZMK)
C2a. Commercial motor vehicle				
C2b. Private motor vehicle				
C2c. Motor cycle				
C2d. Bicycle				
C2e. Television				
C2f. Radio				
C2g. Private well				
C2h. Private borehole				
C2i. Water pump				
C2j. Cultivator				

Item	Units	Owner 1	Owner 2	Value (ZMK)
C2k. Tractor				
C2l. Tractor trailer				
C2m. Tractor plough				
C2n. Tractor harrow				
C2o. Pairs of oxen/donkeys				
C2p.Ox/donkey-drawn plough				
C2q. Ox/donkey drawn harrow				
C2r. Ox/donkey-drawn cart				
C2s. Wheel barrow				
C2t. Cell phone				

Owner codes: 1=HH head 2=Spouse 3=Parents 4=Siblings 5=Children 6=Other dependents

C3. What were the sources of income for your household in the 2016/17 season?

	Category	Amount (ZMK)
C3a	Hybrid Maize grain sales	
C3c	Local Maize grain sales	
C3e	OPV improved Maize grain sales	
C3g	Other Crop (specify)	

	Category	Amount (ZMK)
C3b	Fruits and vegetables sales	
C3d	Livestock/fish sales	
C3f	Remittances	
C3h	Self employed (i.e. through managing own	

	………………			enterprise)	
C3i	Petty trading		C3j	Other (specify)	
C3k	Paid employment (Piecework)				

Section D. Institutional Settings

(We want to know the different facilities at your disposal within the village)

D1. Did you receive any input support for hybrid maize production in the 2016/17 crop season?

1=Yes 0=N0

D2. What was the source of the support?

1=N/A 2=Financial institution 3=Money lender 4=Neighbor

5=Relative 6=NGO 7=Government program (FISP) 8=Other:__________

D3. How much financial support did you receive (ZMK)? ______________________

D4. What inputs were supplied?

1=Seed 2=Fertilizer 3=Chemicals 4=Seed and fertilizer 5=Seed and chemicals, 6=Seed, fertilizer and chemicals

D5. Have you benefited from any of the following governmental and/or non-governmental organization (NGO) programs in the last 10 years? ***(Please start by verifying the programmes/NGOs that have been supporting farmers with inputs in the area. Add the omitted programmes/NGOs in the additional roles indicated as others).***

NGO	Number of years you benefited	Benefit package (what was given to you?)
D5a. Farmer Input Support Programme (FISP)		
D5b. Food Security Pack		

<u>Benefit package:</u>

1) Food relief

2) Seed relief

3) Fertilizer relief

4) Chemicals

5) Seed and Fertiliser

			6)Seed and Chemicals *7) Seed, fertilizer and chemical*

D6. For the subsidized maize input support you have received last 2 seasons, please give us the following information for each season?

	Seasons	Inputs received		
		Maize seed quantity (kg)	Variety	Fertilizer quantity (Indicate number of 50 kg bags received)
D6a.	2017/18			
D6b.	2016/17			

D7. Give us a list of institutions/organizations that exist in this village for which any member of your household is affiliated to:

List of Institutions/organizations/Community Based Organization (i.e. cooperatives, womens' clubs, etc)	Give details of household members affiliated to respective farmer groups or CBOs or organizations in terms of the following factors in columns below					
	Position in household (1=Household head, 2=Spouse, 3=Son, 4=Daughter, 5=Other Specify)		Age (years)		Years member has been affiliated	
	Member 1	Member 2	Member 1	Member 2	Member 1	Member 2
a.						
b.						
c.						
d.						

D8. How far are you from inputs (seed, fertilizers, etc) retail store? _______________ (km)

D9. How far are you from outputs (grain, livestock products, etc) market? _________ (km)

D10. In the last two years, how many times did you attend field days/demonstrations organized by staff of the following organizations?

Organization	No. of field days attended	No. of field demonstrations attended
D10a. Agricultural Extension Service		
D10b. Agricultural Research		
D10c. Seed Company		
D10d. NGO (Specify ……………………….)		

D11. How frequently do your household members interact with agricultural extension workers in a year? (Enumerator, fill in table below)

Household members desegregation	Frequency of interaction with Extension Workers in a year (1=Once a year, 2= Twice a year, 3=Three times or more per year, 4=Not at all)
D11a. Household head	
D11b. Spouse	
D11c. Son	
D11d. Daughter	
D11e. Nephew	
D11f. Niece	

D11g. Other dependant	

Section E. Agricultural Production

(We need to discuss your agricultural production practices beginning with crop production and then livestock production)

E1. What is the total size of the farm land you have/own? _________________ha

E2. Distribution of farmland (Fill in table)

	Size (Ha)	Distance from homestead (km)
E2a. Plot under fallow		
E2b. Improved OPV maize field		
E2c. Hybrid maize field		
E2d. Local maize field		
E2e. Other crops		

E3. What are the most important factors that determine how large your cultivated **<u>HYBRID MAIZE</u>** field should be in any season? Rank them in order of importance

Determinants of size of cultivated land	Ranking (Start with 1 for most important and 10 for least important)
E3a. Expected family labor availability	
E3b. Cash availability to hire labor	
E3c. Cash availability to purchase other inputs	
E3d. Current grain prices	
E3e. Expected grain prices after harvest	

E3f. Household Food needs	
E3g. Availability of seed	
E3h. Availability of fertilisers	
E3i. Availability of seed and fertilisers	
E3j. Other (specify………………………..)	

E3. What are the most important factors that determine how large your cultivated **<u>LOCAL MAIZE VARIETY</u>** field should be in any season? Rank them in order of importance.

Determinants of size of cultivated land	Ranking (Start with 1 for most important and 10 for least important)
E3a. Expected family labor availability	
E3b. Cash availability to hire labor	
E3c. Cash availability to purchase other inputs	
E3d. Current grain prices	
E3e. Expected grain prices after harvest	
E3f. Household Food needs	
E3g. Availability of seed	
E3h. Availability of fertilisers	
E3i. Availability of seed and fertilisers	
E3j. Other (specify………………………..)	

E5. What quantities of the following inputs did you purchase this season, 2017/18 for the different maize field?

Input	Quantity purchased (kg)	Month of purchase	Amount paid (ZMK)	Name of supplier	Distance to homestead (km)
E5a. Maize seed (Hybrid)					
E5b. Maize seed (Local varieties)					
E5c. Maize seed (OPV Improved)					

E6. What quantities of the following inputs did you apply to the following plots this season?

Crop plot	Basal fertiliser (X 50kg bags)	Top dressing fertiliser (X 50kg bags)	Cattle manure (Ox-carts)
E6a. Maize (Hybrid)			
E6b. Maize (Local variety)			
E6c. Maize seed (OPV Improved)			

Section F. Maize Production

	Hybrids	Local variety	OPV improved
What maize varieties do you grow?			
When was your first time of planting the maize type? (Indicate year)			
source of seed?	1=Agrodealer, 2=Recycled, 3=Other farmer	1=Agrodealer, 2=Recycled, 3=Other farmer	1=Agrodealer, 2=Recycled, 3=Other farmer
Have you been planting maize varieties in last 5 years(continuously)?	1=yes, 0=no	1=yes, 0=no	1=yes, 0=no

Variety tolerance to drought	1=High, 2=Moderate, 3=Low	1=High, 2=Moderate, 3=Low	1=High, 2=Moderate, 3=Low
Main reason for not growing variety continuously: *1=Preferred seed no longer available, 2=No cash to purchase seed, 3=Not satisfied with performance of the varieties, 4=Poor storability of improved varieties, 5=Other: _______________*			

F8. What motivated you to continue growing local maize varieties (Responses could be multiple)? (Tick as appropriate)

Motivation factors	1=yes, 0=no
F8a. higher yields	
F8b. availability of seed locally	
F8c. attractive market price for maize	
F8d. availability of maize input support	
F8e. availability of varieties that are adapted to local environment	
F8f. availability of labour	
F8g. land availability	
F8h. improved household financial status	
F8i. Exposure to field days/demonstration plots	
F8j. other ……………..	

F10. List most important factors you consider when selecting the maize varieties to plant (Answers could be multiple):

Motivation factors	1=yes, 0=no
F10a. High yield potential	
F10b. Disease/pests resistance	
F10c. Drought resistance	
F10d. Resistance to storage pests	
F10e. Maturity period	
F10f. Cob coverage	
F10g. Good performance on poor soils	
F10h. Number of cobs per plant	
F10i. Cob size	
F10j. Ease of poundability	
F10k. Taste of meal	
F10l. Cost of seed	
F10m. Other (specify………………………………….)	

APPENDIX II PHYSICAL APPEARANCES OF THE LOCAL MAIZE VARIETIES

Kafwamba or Kampelya which is an early maturing local maize variety is shown below as captured in Mazabuka district in southern Zambia in April 2018.The variety is drought tolerant as well as disease and pest resistant at the same time it can be recycled years without losing its genetic viability.

Gankata a local maize variety as captured in chief Mwanachingwala's area in Mazabuka district of southern Zambia in April 2018. This local maize variety is tolerant to drought and resistant to diseases and pests. Additionally, this variety has been recycled for many years without losing its genetic viability. Gankata has bigger grains than any hybrid seed and is heavier as observed by most respondents when compared to hybrids.

Figure 7. Physical characteristics of local maize varieties

Kafwamba	Contaminated Gankata	Original Gankata
		

Source: Author, field pictures

Appendix III

The picture below shows the researcher with one of his assistants touring a local maize (Gankata) field during research.