AWARENESS AND PERCEPTIONS OF CLIMATE CHANGE IMPACT AMOUNG SMALL-SCALE MAIZE FARMERS IN ESWATINI: THE CASE STUDY OF HHOHHO, MANZINI AND SHISELWENI REGIONS

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DEDICATION

This thesis is dedicated to my family. Thank you for your prayers and patience.

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DECLARATION

I, MELUSI NOEL KUNENE, declare that, ANALYSING THE AWARENESS AND PERCEPTIONS OF CLIMATE CHANGE IMPACT AMOUNG SMALL-SCALE MAIZE FARMERS IN ESWATINI: THE CASE STUDY OF HHOHHO, MANZINI AND SHISELWENI REGIONS is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

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SIGNATURE **DATE**

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ACRONYMS

BCR	-	Benefit–Cost Ratio
DCF	-	Discounted Cash Flow
ECA-SA	-	Economic Commission for Africa Sub-regional Office for Southern Africa
FAO	-	Food and Agriculture Organization
FANRPAN	-	Food, Agriculture and Natural Resources Policy Analysis Network
GDP	-	Gross Domestic Product
IPCC	-	Intergovernmental Panel on Climate Change
IFPRI	-	International Food Policy Research Institute
IFAD	-	International Fund for Agricultural Development
KMO	-	Kaiser-Meyer Olkin
MoA	-	Ministry of Agriculture
MoTEA	-	Ministry of Tourism and Environmental Affairs
NMC	-	National Maize Corporation
NPV	-	Net Present Value
PACJA	-	Pan African Climate Justice Alliance
PCA	-	Principal Component Analysis

PC	-	Principal Component
SACCOS	-	Savings and Credit Cooperatives
SNAU	-	Swaziland National Agricultural Union
SNL	-	Swazi Nation Land
SPSS	-	Statistical Package for social sciences
TAR	-	IPCC Third Assessment Report
TDL	-	Title Deed Land
UNEP	-	United Nations Environment Programme
UNDP	-	United Nations Development Programme
USAID	-	States Agency for International Development
WFP	-	World Food Programme
WMO	-	World Meteorological Organization

ABSTRACT

Agricultural production is the major source of household food security and income for smallholder maize farmers in the rural households in the Kingdom of eSwatini. The sector also contributes approximately 6.5% to the national gross domestic product and 50% of raw material for industries and other sectors. However, the sector is faced with several challenges which hinder its development. The challenges are brought about by climate change. Farmers implement various strategies to adapt to the negative effects of climate change. Farmers awareness and perceptions of impacts of climate change influence the strategies and hence, farmers' level of adaptation. This study was undertaken to assess smallholder maize farmers' awareness and perceptions of the impacts of climate change in three maize producing regions of eSwatini. Descriptive statistics and a regression model were used for data analysis. The results from a descriptive analysis indicated that 71.3% of farmers were aware of climate change, while 28.7% were not aware. A regression test revealed that climate-related information was highly significant in determining farmers' awareness of the impacts of climate change. A Likert scale analysis showed that rural-urban migration, floods incidents and soil erosion were the most important variables that influenced small-scale maize farmers' perceptions of climate change. The study revealed that there should be more focus on improving extension services to promote access to financial services.

Key words: Climate change, Principle Component Factor Analysis, five-point Likert scale analyses, eSwatini

CHAPTER 1

INTRODUCTION

1.1 Background of the study

Climate change has affected climatic patterns around the globe, rising sea levels have been witnessed across the world and temperatures have been increasing gradually. The Food and Agriculture Organization (FAO) (2011), stated that there have been noticeable changes in environmental and land resources which are the main causes of climate change.

The United Nations Economic Commission for Africa Sub-regional Office for Southern Africa report (ECA-SA/TPUB/CLIMATE2012/2) noted that Southern African region has been left behind and is struggling with low agricultural productivity and fast-declining cereal production. The low agricultural productivity has a huge influence on household food security in Southern Africa. The continuous increase in population has resulted in an increase in the demand for agricultural products which the agricultural sector is unsustainable. This has led to a decrease in food production per capita. Climate change is expected to make the situation even worse in future. The report further states that climate change has brought about unknown risks and uncertainties, which is bound to worsen the already weak and low performing agricultural sector. The dependence on rain-fed agriculture by small holder farmers, post-harvest losses, rural-urban migration and the vulnerability of the sector to the impacts of climate change has the capacity to contribute to household food insecurity. Vulnerable countries are expected to deal decisively with effects of the changing climate. However, the impacts of climate change will differ from country to country across the world.

In eSwatini, smallholder maize farmers are already experiencing the unfavorable effects of climate change and the impact is already being felt across the socio-economic and agricultural sector. The level of vulnerability of the communities to the effects of climate change has increased sharply and that has negatively affected different sectors of the economy such as agriculture, water, energy, health and forestry. After briefly discussing the socio-economic impacts of climate change on smallholder maize producers in eSwatini, the study focused on exploring the level of awareness and perceptions of smallholder maize farmers on climate change and what farmers perceive to be the impacts of climate change on agricultural production.

The staple food of eSwatini is maize and it is the most consumed cereal crop compared to other cereal crops. Smallholder maize farmers are located in the rural areas of eSwatini and most of them are found on communal lands known as Swazi Nation Land (SNL) and others are found on privately owned land known as Title Deed Land (TDL). Magagula *et al*. (2007) reported that the land under the SNL is held in trust by the King or the Ingwenyama for the people (emaSwati); and 90% of maize crop is grown primarily under this system. Under SNL maize is grown by smallholder farmers with no access to irrigation systems, where maize production changes depending on prevailing climatic conditions. According to West (2000), the major drawback apart from the decline in maize production, which affects household food security in eSwatini, is that almost 10% of productive land is now offered for sale by smallholder farmers or they have ventured in other businesses like property development etc. Since smallholder farmers on SNL depend on rain-fed crops, the yield from the produce is low. The average yield on smallholdings on SNL is 4.42 tons of maize per hectare (Dlamini and Masuku, 2011). The productivity of maize is different in each of the geographical regions in eSwatini, with the Highveld having the highest yields and followed by the moist Middleveld (MoA, 2013). Land under agricultural production varies every planting season and so is the produce. Smallholder maize producers focus mainly on meeting household dietary requirements with little or nothing for commercial purposes.

The World Bank (2011) reported that, the total area under maize production was 67000 hectares in 2000 but dropped to 47,459 hectares in 2011. Magagula *et al.* (2007) found that 30% of farmers in eSwatini live on TDL on large farms with sophisticated irrigation equipment and modern technology. Farmers in TDL are the main producers of the agricultural produces that eSwatini exports. Of the total arable land in eSwatini, TDL covers an area of 40% (West, 2000). The average land per farmer in TDL is 4.9 hectares with an average maize yield of 9.75 tons per hectare (Dlamini and Masuku, 2011). The National Maize Corporation report (NMC, 2012) reported that for the past 40 years maize produced locally has decreased drastically to the extent that the local supply of maize is now below the national consumption requirements.

1.2 Significance of the study

Smallholder farmers in the rural areas of eSwatini practice mainly subsistence agriculture. The FAO World Food Programme Crop and Food Security Assessment

Mission to eSwatini (2015) reported that in 2015 agricultural production in eSwatini contributes 11% to the Gross Domestic Product (GDP). The report further stated that farmers on TDL are the major contributors (about 80%) to the agricultural sector, while about 10% comes from small-scale farmers on SNL. The smallholder farmers in eSwatini are the ones who are negatively affected by the impacts of climate change just like most smallholder farmers in other developing countries in Sub-Sahara Africa. This is made even worse because there are no social security safety nets or resources, which they could use to cope with drastic climate changes. However, the impact of climate change depends on the climatic zones of each area. It could be argued that different smallholder farmers in different geographical locations experience the impacts of climate change differently, therefore, they need different adaptation mechanisms to cope with the changes.

The Food, Agriculture and Natural Resources Policy Analysis Network (FANRPAN), Synthesis (2010) reported that climate change is evident in eSwatini and it has manifested itself in different forms, such as frequent droughts, changes in rainfall patterns and increase in temperature and harsh weather conditions. The FAO World Food Programme (2015) observed that the 2014/15 farming season (October-May) was associated with a dry period between January and March, which coincided with critical maize development stage when the demand for water is higher. Despite an overall expansion in maize acreage, the water deficit in early 2015 had a huge impact on maize yield, which was estimated at 81,623 tons; a reduction of 31% below the average yield for the previous year. Manyatsi *et al*. (2010), argued that low agricultural productivity in

SNL was due to several factors including climate change, drought and increase in temperature among other factors.

There is lack of information about farmers' awareness and perceptions of the impacts of climate change in the different regions, therefore, the purpose of this study was to determine the level of awareness and perceptions of impacts of climate change among the small-scale maize farmers in eSwatini, to address the knowledge gaps. Understanding the level of awareness and perceptions of the impacts of climate change among small-scale maize farmers in eSwatini was crucial for the establishment of long-term adaptation strategies that will reduce the negative impacts of climate change on the livelihoods of smallholder farmers and their communities.

1.3 Problem statement

World Vision Swaziland Agricultural Task Force (2011) reported that, the agricultural sector in eSwatini contributes 80% to the livelihoods of the population of eSwatini and is also the leading contributor of raw material to agricultural and non-agriculture-based industries. Although agriculture contributes 11% of GDP in eSwatini, it is the second employer after services; with 45% employed in the agricultural and related sectors such as sugar, textile and food processing. The production cost of agricultural products is higher due to the current climate variability, which is very devastating to the economy of eSwatini. Watkiss, (2011) found that the dry spells during the growing season have a negative effect on crop growth since it exposes the crops to water stress. The effects of climate change on crop production have given rise to the need for farmers to make informed decisions that will help them to adapt to the changing environment (Ajetomobi *et al*., 2010).

There are several studies on the impacts of climate change in agriculture and crop production (Mbilinyi *et al*., 2010; Herath *et al*., 2011; Nhemachena *et al*., 2010; Rowhan *et al*., 2011), but still little is known about socio-economics, the level of farmers' awareness and their perceptions of the impacts of climate change.

1.4 Research objectives

1.4.1 Overall objective

The main objective of the study was to determine the level of awareness and perceptions of climate change impacts among small-scale maize farmers in different smallholder maize production areas in Hhohho, Manzini and Shiselweni regions of eSwatini.

1.4.2 Specific objectives

The specific objectives of the study were:

I. To determine socio-economic characteristics of the small-scale maize farmers in Hhohho, Manzini and Shiselweni regions of eSwatini.

II. To analyze factors influencing the awareness of climate change among small-scale maize farmers in Hhohho, Manzini and Shiselweni regions of eSwatini.

III. To assess the perceptions of small-scale farmers of the impacts of climate change in Hhohho, Manzini and Shiselweni regions of eSwatini.

1.5 Hypothesis of the study

- The different socio-economic and demographic factors have an influence on small-scale maize farmers' level of awareness of climate change.
- small-scale maize farmers perceptive floods, soil erosion, water scarcity, drought patterns, shifts in rainfall, crop diseases, rural urban migration and structural destruction as factors affecting climate change.

1.6 Outline of the study

The chapters in the dissertation are organized as follows;

Chapter 1 provides the background of the study, the problem statement, the objectives of the study, the significance of the study and the outline of the study.

Chapter 2 focuses on the literature review of the awareness and perceptions of the impacts of climate change among small-scale maize farmers in Sub Sahara Africa, eSwatini and globally. The chapter also provides an overview of the effects of climate change in eSwatini.

Chapter 3 gives a brief description of the study area, research methodology, sampling and data collection methods which were used in the study. It also outlines econometric models that were used in the study.

Chapter 4 probes the socio-economic impacts of climate change on small-scale maize farmers in Hhohho, Manzini and Shiselweni regions of eSwatini. It also gives a summary of the results using descriptive statistics and discussions.

Chapter 5 presents the analyses of factors influencing the level of awareness of the impacts of climate change among maize small-scale farmers in Hhohho, Manzini and Shiselweni regions of eSwatini.

Chapter 6 assesses the perceptions of small-scale farmers of the impacts of climate change in Hhohho, Manzini and Shiselweni regions of eSwatini.

Chapter 7 provides the summary, conclusions and recommendations based on the findings of the study.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Climate change is a real phenomenon and its harsh realities have been experienced across the globe. Climate change can be understood and explained by observing some climate and weather phenomena like the increase in temperature, floods, typhoons, droughts, changing rainfall patterns, and the rise in sea level, all of which have huge impacts on agricultural production, that also affect smallholder farmers who are heavily dependent on rain-fed agriculture. The impacts of the changing climatic conditions negative consequences on agricultural production, health, water resources, ecosystems, shelter and vulnerable populations. This chapter reviewed different literature to understand the causes of climate change and how it influences weather patterns for a long period of time. It highlighted the level of awareness and perceptions of the impacts of climate change among small-scale maize farmers in eSwatini, and in the three maize producing regions.

2.2 Climate Change

According to the FAO report (2008), climate change is the ongoing change in the climatic system which comes as a result of environmental pollution and harmful human activities that bring about increased and continuing release of harmful gases into the atmosphere, that causes the loss of vegetation cover and other carbon sinks. Climate change is the degree of change in climate that is seen in temperature fluctuations and changes in the impact of climate and weather extremes (Krishna, 2011). It can also be described as the continuous change in the average and variability of climate variables such as temperature, rainfall, humidity and soil moisture. Kutua (2008) articulated that human activities which affect the environment can be easily associated with climate change. The signs of climate change are the increases and/or decreases in mean temperature or the change in the difference and rate of extreme climatic factors e.g. rainfall and temperature (Compass Resource Management, 2007).

2.3 The global perspective on climate change

The IPCC (2007) reported that climate change incidents in Asia region are closely related to drastic temperature increases during winter months. Cruz *et al*. (2007) stated that the Asia and Pacific regions have witnessed sudden increases in the degree and/or rate of the climatic incidents. Cruz *el al*. (2007), further noted that the region has been affected by the increase in the number of erratic weather conditions like the increase in temperature, floods, drought, tornadoes, snow avalanches and thunderstorms.

Climate change has raised a grave and additional danger to smallholder farmers in rural communities in the distant and marline villages, in the mountains, dry lands and deserts. Climate change models are showing that temperature will increase in the range of 0.5 to 2°C by 2030 and 1 to 7°C by 2070 in the Asia and Pacific region (IFAD, 2009).

Thornton *et al*. (2009) stated that the North America region is susceptible to the impacts of climate change and will have great effects and economic damage on the region soon. The ever-increasing poverty level among smallholder farmers and the highly unevenly distributed incomes have greatly contributed to the increases in the vulnerability of people living in the rural areas of that region. Liverman and O'Brien (1991) reported that Mexico has the potential to be affected by different types of climate change shocks such as droughts and hurricanes. Mexico as a developing country is fully dependent on the environment, and its economy is based on agriculture, like most developing countries. Any slight change in the climate and weather conditions has great influence on the agricultural sector.

2.4 Climate change based on African continent perspective

Africa is the leading continent in the world that is most susceptible to the effects of climate change (Boko *et al*., 2007). The interaction of many different events that take place at different levels have made climate change and climate variability worse. The low economic growth, slow development and the low level of adaptation has made the situation worse over the years. Most of the large economies in Africa are also experiencing the effects of the current climate changes. IPCC (2007) reported that the vulnerability to climate change is due to many different socio-economic and developmental challenges e.g. drastic change in climate and weather conditions, household poverty, poor governance and institutional challenges, less access to capital, poor markets, underdeveloped infrastructure and technology; environmental pollution as well as natural disasters and political conflicts.

Boko *et al*. (2007) explained that agricultural production and household food security in many African countries are greatly compromised by the constant change in climate. IPCC (2007) mentioned that several African countries are affected by semi-arid conditions because of constant degradation of the environment, which has made farming a big challenge. Planting seasons have been shortened and most countries whose economies are dependent on agriculture may be forced to abandon agricultural production. Estimated yield projections in some countries show that there could be a reduction of yield by almost 50% by the year 2020 and net revenue from agricultural produce is projected to fall by almost 90%. This will affect smallholder farmers more than commercial farmers. In turn these changes will negatively affect household food security more especially smallholder farmers in rural areas.

The IPCC (2007) stated that climate change will affect water availability in some countries more especially those that are already experiencing water shortages, and more countries that are currently not facing water deficiency problem will be exposed to the risks of water shortages in the future. Climate change is likely to exert increased stress on water availability and accessibility as well as increased demand for water in Africa. Boko *et al*. (2007) said that climate change will have greater impact on several countries in Africa especially those in northern Africa and this will decrease their arable land, agricultural productivity and water resources before 2025.

Climate change has altered the interdependent relations among living things and that the changes are taking place faster than expected especially in the southern Africa region (IPCC, 2001). Human activities such as cutting down of forests for development and wild fires are some of the major threats to the environment, which have given rise to land degradation and noticeable changes on grasslands and coastal ecosystems that have amplified the intensity of the impacts of climate change (Muriuki *et al*., 2005).

It is predicted that by the year 2080s, arid and semi-arid lands in Africa will have increased by 5 to 8% (Parry *et al*., 2004). That means climate change is already affecting the natural environment in a broader way. The African continent has unique climates which are determined by various seas and sublunary interactions that result in different climates across all the different regions (Christensen *et al*., 2007). Climate change poses a huge influence on day to day activities which are aimed at improving the economies in the Africa continent. The impacts of climate change are mostly evident on agricultural production and natural resources sectors, at regional, country and household levels (IPCC, 2007). The IPCC third assessment report on climate change in 2001 (TAR), reported that there has been a rise in temperature over the continent which are consistent sequences from 1960. Malhi and Wright (2004) reported that rain forests and tropical areas in Africa have witnessed increase in temperature of approximately 0.29°C in the past 10 years and the southern part of Africa including South Africa have experienced temperature increase between 0.1 and 0.3°C (Kruger and Shongwe, 2004). There has been a constant rise in temperature in summer and reduced cold winter days over southern and western Africa from 1961 to 2000 (New *et al*., 2006).

Nicholson *et al*. (2000) mentioned that annual rainfall has increased by almost 10% during the last 30 years in Guinea coast. The other regions have experienced short stints of rainfall patterns which have affected agricultural production. Richard *et al*. (2001) and Fauchereau *et al*. (2003) agree that post 1970s few longer annual rainfalls intervals have been observed during the summer seasons and strong and widespread droughts have also been reported.

The effects of climate change are seen when farmers receive long and erratic rainfalls or floods that cover the whole land. Floods are some of the major weather phenomenon which pose a grave danger to agricultural development in Africa region. Some countries have been affected by recurrent floods which are a result of the change in climate and weather patterns. Mirza (2003) and Obasi (2005) stated that Mozambique has experienced major floods which affected agricultural production, major economic and human losses as a result of the changing weather patterns. The change in weather patterns and the increase in floods has also affected countries that are known to be mainly arid. Countries such as Algeria, Tunisia, Egypt and Somalia have seen some changes from the normal dry weather to severe flooding (Kabat *et al*., 2002). In some part of Africa, climate change has been associated with long periods of abnormally below or/and above the mean rainfall patterns which are closely associated with drought. Pandey *et al*. (2003) reported that the major contributor to rural-urban migration and water shortages is drought. A third of the population in Africa lives in drought-susceptible communities that are prone to the effects of drought (The World Water Forum, 2000).

The African continent has seen millions of people who have regularly suffered from the consequences of droughts and floods due to climate change (Few *et al*., (2004). The effects of droughts and floods are evident and have been made worse by the increase in waterborne diseases such as diarrhea, cholera and malaria. Tarhule and Lamb (2003) stated that the economic losses suffered by the Sahel region, Horn of Africa and

Southern Africa in the 1980s due to droughts amounted to several hundred million US dollars. The impacts of droughts in many countries Africa have been experienced since the end of the 1960s (Richard *et al*., 2001; L'Hôte *et al*., 2002; Brooks, 2004; Christensen *et al*., 2007; Trenberth *et al*., 2007).

2.5 Climate change based on southern Africa region perspective

During the 1970s to 1990s, the whole world experienced major shifts in climatic and weather patterns, likewise the southern Africa region was largely affected by the increase in temperature, which have been consistent with the global trends. The IPCC (2001) report mentioned that for the past century southern Africa has experienced temperature change of 0.5°C. The Government of Namibia (2002) reported that the country has experienced an increase in temperature at the rate of 0.023°C per year between 1950 and 2000. The Indian Ocean has witnessed an increase in temperature of more than 1°C from 1950 and a decline in rainfall intensity (NCAR, 2005). The USAID (1992) reported that the southern Africa region has been experiencing below normal rainfall over the years, which has become more frequent. Usman and Reason (2004) stated that different countries in southern Africa region (Angola, Namibia, Mozambique, Malawi and Zambia) have experienced major shifts in rainfall patterns, an increase in floods and extreme weather (Tadross *et al*., 2005a; New *et al*., 2006).

2.6 Climate change in eSwatini

eSwatini is facing the unfavorable impacts of climate change like most African countries. The country has experienced above average temperature increase (Conway *et al*., 2004; Kruger and Shongwe, 2004). Between 1960 and 2003, eSwatini experienced temperature rise of 0.13°C, and annual rainfall decrease of 5 to 10% within 50 years (Kruger and Shongwe, 2004). The rainfall patterns are expected to change over the years and the impact on the agricultural sector would be significant.

The major threat to agricultural production in eSwatini is climate change. Mandleni (2011) reported that the main factor contributing to the devastating environmental, economic and social impacts in South Africa is climate change. The reduction in rainfall throughout the country poses a huge challenge to smallholder agricultural production which depends on rainfall. Mandleni (2011) further mentioned that smallholder farmers in the remote rural areas of South Africa are fully dependent on agricultural production, natural resources and animals rearing for their livelihoods. Gbetibouo (2006) reported that the previous three years have experienced very dry weather characterized by rainfall that had large inter-annual variability.

2.7 Socioeconomic and global climate change and its impacts on crop production

Climate change has significant impacts on the environment and socio-economics globally. Gbetibouo (2009) and Pant (2007) articulated that the global climatic conditions have been changing in alarming rates that have never experienced before. The reduction of greenhouse gases could easily decelerate the effects of climate change; therefore, it is necessary to develop effective and efficient adaptation mechanisms. Although climate change is a global catastrophe, the impacts differ from region to region and it affects the most vulnerable communities in developing countries.

Developing countries are the ones which were mostly exposed to the risks of climate change compared with developed countries because most developing countries are fully dependent on rain-fed agricultural production, which is influenced by weather patterns (Bruin, 2011; Gerald, 2009; Manyatsi *et al.,* 2010). Most of developing countries are also predominantly dry rural areas or semi-arid regions of sub-Sahara Africa, which have an increased level of vulnerability to climate change (Crosson, 1997). It had been reported that socio-economic issues, demographic and poor agricultural development policy implementation are the leading causes that affect, and limit smallholder farmers' capacity adapt to climate change (Morton, 2007). This has resulted in an increase in the number of people in developing countries who face challenges of food insecurity because of crop failure, change in land use and disasters such as drought and flood, water insufficient and famine.

According to Debela *et al* (2015) awareness of climate change among small-scale farmers and rural communities is driven by multiple forces, such as household demographics and farm factors, the age of a farmer is closely related to farming experience and their accumulated knowledge of the environment, including changes in climate conditions. Furthermore, Adebayo *et al,* (2012) stated that farmers with higher levels of education are generally considered as having slightly more knowledge and information on good agricultural principles, and those with university education are able to analyse and interpret information much better than farmers with no formal education. Debela *et al* (2015) have found that the level of formal education attained by farmers influences their ability, awareness and perceptions concerning climate change and its impact and that a high level of literacy has implications for agricultural production and for adaptation to climate change.

Households with large numbers of members are expected to have a positive impact on maize production if all household members are fully engaged in the agriculture activities (Mamba *et al,* 2015). According to Debela *et al* (2015), households with many members are more likely to engage in non-farm income generating activities because non-farm income buffers financial losses from farming.

2.8 Climate change and its impacts in eSwatini

Manyatsi *et al*. (2010) stated that climate change is a leading factor that has affected sustainable development targets of eSwatini. The adverse changes in weather patterns are the leading cause of the rising poor health, declining household food security, slow economic development initiatives and the destruction of physical infrastructure. Smallholder farmers have associated climate change with continuous reduction in rainfall amount and variability and temperature changes, which have made the country more susceptible and prone to droughts, floods, wildfires, windstorms and hailstorms. Brown (2010), Gamedze (2006) and Manyatsi *et al*. (2010) reported that the Lowveld region of eSwatini has experienced continuous increase in droughts patterns, and for the past 40 years the Lowveld and Shiselweni regions have been seriously affected by frequent droughts in 1983, 1992, 2001, 2007 and 2008, a cyclone (Domonia) in 1984 and flood in 2000.

The vulnerability baseline surveys conducted in 1998, 2002 and 2006 have showed that the Lowveld region experiences more severe impacts of droughts than Shiselweni and

Manzini regions in eSwatini (Gamedze, 2006). Smallholder farmers of maize and livestock who depend on rainfall have been hard hit by the decrease in rainfall. Households in these regions have experienced a major decrease in crop production which has affected household food security and the GDP. Furthermore, Gamedze (2006) explained that the impacts of climate change as well as variability of rainfall have contributed to the declining standards of living for people living in the lowveld. Several households have stopped farming, they are now fully dependent on social grants and other social interventions from the government.

The size of arable land ploughed in eSwatini during the 2004/ 2005 farming season was 10% of the total productive land available. Manyatsi *et al*. (2010) reported that for the past 10 years, 40% of productive land in the Lowveld has not been planted. Nxumalo (2012) explained that 30% of poor and vulnerable households come from the Lubombo region. Gamedze (2006) stated that the 1991/1992 drought period resulted in the worst productivity for smallholder farmers, while farmers in Lowveld and part of Shiselweni region were hardly hit by the drought. Smallholder farmers in Lowveld region lost as many as 91,000 cows due to drought. The Lowveld has been categorized as likely to be affected by drought and more susceptible to the negative impacts of climate change.

Manyatsi *et al*. (2010) found that the level of awareness of the impacts of climate change among smallholder farmers was higher than expected but they did not have the capacity to understand the scientific cause of climate change. As a result, smallholder farmers have developed agricultural and nonagricultural copping and adaptation strategies which they use against the impacts of climate change in their communities. Some of the coping and adaptation mechanisms include disposing their assets which include livestock, migration to urban areas in search of jobs, inter cropping, crop diversification, household backyard gardens and rain water harvesting. However, it has been found that some of the coping mechanisms are not as effective towards improving household food security because they do not last long enough and the households begin to develop dependency on food aid (Gamedze, 2006; Nxumalo, 2011).

2.9 Climate change and maize production in eSwatini

Maize is the major food crop produced in eSwatini and the major food crop grown by smallholder farmers in the country. Maize in eSwatini is mostly grown by smallholder farmers found in SNL in the rural areas. Although there are private farms in TDL that grow maize, it is at a small-scale and most of those farmers are involved in sugar cane production and other commercial crops. Although the land in rural areas is allocated to individual smallholder farmers, SNL is held in trust by traditional authorities for the Swazi people and most of the maize produced in eSwatini is grown under SNL (Magagula *et al*., 2007). Most smallholder maize farmers in rural areas lack the sophisticated irrigation systems, their production fluctuates with climatic conditions because they depend on rainfall.

The quantity of maize produced on communal land is heavily dependent on rainfall and that has affected the yield produced per hectare. The mean maize yield per hectare on SNL is 4.42 tons (Dlamini and Masuku, 2011). Maize produce differs among the four agro-climatic regions of eSwatini. According to the Ministry of Agriculture report (2013), the Highveld is one the regions that got the highest yield of maize produce followed by the moist Middleveld (MOA, 2013). The land under maize production in eSwatini has continued to decline from region to region and it fluctuates seasonally. The smallholder farmers grow maize primarily their household dietary needs with little or no desire to sell their produces.

Farmers in private farms produce most of the agricultural products that are sold in the market in chain stores or exported out of the country (Magagula *et al*., 2007). Private farm lands cover 40% of total agricultural productive land (West, 2000). The average ownership per farmer is 4.9 hectares on private land, while the average maize yield in private farm is 9.75 tons/ha and this is because farmers on private land do not depend on rainfall, they have irrigation systems (Dlamini and Masuku, 2011). In the past 40 years the country has experienced a major decline in locally produced maize. The production has declined below the national consumption requirement of 90,000 metric tons per year and this has forced the country to import more maize to meet national requirements (National Maize Corporation, 2012). The World Bank (2012) reported that eSwatini experienced a decline in maize production to 47,900 metric tons in 2011, while the national requirement was 90,000 metric tons.

The smallholder farmers in eSwatini are fully dependent on rain-fed agriculture, and farming is mostly done during the summer season. Maize production is characterized by a number of challenges emanating from the negative impacts of harsh weather as a results of long-term climate change. The last two decades have been the worst for eSwatini because of severe droughts and floods ever seen in the area, and rainfall has continued to decline especially during the time when maize development requires more water. The FAO World Food Programme Crop and Food Supply Assessment (2004; 2005) reported that maize production in eSwatini has been on a long-term decline. Maize production has dropped by 70% within a five-year period in most areas. This decline has forced most smallholder maize farmers to stop planting their fields due to late rainfall and the risk associated with drought. There was also a shortage of maize seeds for drought tolerant crops. The country has experienced rising unemployment and poverty.

2.10 Climate Variability and maize production

A research conducted by IPCC show that Africa is the most vulnerable continent that is mostly suffering from the devastating effects of climate change and climate variability because it often lacks adaptation strategies. Researchers (Olowatayo and Ojo, 2016; Raghuvanshi *et al,* 2017) argued that smallholder agriculture that is dependent on rainfall can be regarded as the most vulnerable sector and is prone to climate variability and the potential impacts of climate change.

A study by World Meteorological Organization (WMO) reported that world temperatures are expected to rise and are likely to cause challenges towards food production and household food security. The study further revealed that water shortage will be experienced as precipitation levels will drop and this will pose problems for agriculture and food production, especially in developing countries. IPCC (2006) reported that several variables like chronic poverty, poor government decisions, poor infrastructure, frequent social unrest and environmental degradation are the major contributors towards Africa's vulnerability to climate variability.

A study by Magagula *et al*., (2007) showed that 80% of the population in eSwatini live in the rural areas and are fully dependent on smallholder cropping systems and/or animal rearing. Factors such as land size, access to farming inputs, low job opportunities, lack of markets and high HIV/AIDS prevalence are the major contributors of household food insecurity, thus, weakening the livelihoods of smallholder farmers. The smallholder maize and cotton farmers in eSwatini practise monoculture and this type of farming system has increased household's vulnerability to the impacts of climate change. Any slight change in weather has a huge impact on agricultural production and poses a big challenge to rural household food security. The study also revealed that households with poor and chronically sick people are the ones who are hard hit by the climatic and weather shocks.

2.11 Economic impacts of climate change under different maize production areas

The rural economy of the southern Africa region is fully dependent on agriculture. Rural agriculture doesn't only provide food for the population in rural and urban areas, but it also provides incomes, employment and export earnings for the smallholder farmers and their immediate families. The impacts of climate change on the environment is expected to bring more negative effects on smallholder farmers in the rural areas. The smallholder farmer, the rural poor and indigenous people who are dependent on the ecosystems for their household food security, household energy, medicinal products, building material and protection from natural dangers are faced with grave and immediate risks (PACJA, 2009). The severity of the impacts of climate change are more evident in developing countries than in developed countries since it affects the environment which the rural people depend on.

Moreover, discussions by Krishna, (2011) revealed that the continued change in climate and over-dependence on rainfall, it could be assumed that maize farming in developing countries will decline by 11.9% by 2050 and this will impact more on the revenue of smallholder maize farmers compared with their counterparts in developed countries who have irrigation facilities, controlled humidity and temperature. Krishna, (2011) stated that if there would be no climate change by 2050 the world could an increase in maize yield of 455.2% and 434.9%, in developed and developing countries, respectively. Parallel Climatic Models speculate that there would be a 2^{o}C rise in temperature and 10% increase in rainfall by the year 2100. A study by Ajetomobi *et al*. (2010) reported a huge difference in the net-revenues between rain-fed and irrigated maize farms. The results showed that an increase of 2^{o}C to 6^{o}C would positively affect net revenue per hectare for farms under irrigation and would increase by an estimate of 3.9%; and alternatively, it would negatively affect net revenue for farms under rain-fed agriculture by 11.7%.

The eSwatini economy is fully dependent on the agricultural sector, which is highly susceptible to the impacts of climate change (Mabuza, 2010). In 2015, the agricultural sector experienced a difficult period because of a severe drought and GDP was reduced by about 1% (Watkiss *et al.,* 2011). Mngale (2009) commented that once the major climatic variables (temperature and rainfall) are altered in any way, the agricultural production is likely to be affected, because they have huge influence on agricultural production. And when household food security is affected, the livelihoods of people in rural areas is disoriented and household poverty and hunger level increases (FAO, 2008).

2.12 Farmers' perceptions on the impact of climate change

There are several researches which have assessed the level of awareness and the perceptions of smallholder farmers on the effects and impacts of climate change. Kuponiyi *et al*. (2010) applied descriptive statistics and multiple regressions to assess the perceptions of smallholder farmers on the impacts of climate change on crop production in Ogbomoso Agricultural zone in Oyo State, Nigeria; while Apata *et al*. (2009) applied logistic regression model to analyze the impacts of climate change, perceptions and adaptation by smallholder farmers crop farmers in South Western Nigeria. Results from these studies showed that smallholder farmers who relied on rain-fed agriculture have abandoned the monoculture system of agriculture and have opted for mixed cropping system, where they grow crops and are also rearing livestock in dry areas.

Daninga (2011) used descriptive statistics to assess smallholder farmers' perceptions and the variables that are affect agriculture in Tanzania. The results showed that the level of awareness among smallholder farmers towards the impacts of climate change was higher than anticipated. Hassan *et al*. (2007) and Dhaka *et al*. (2010) used descriptive analysis to assess perceptions of smallholder farmers on the effects of climate change, and the types of adaptation mechanisms employed by smallholder farmers in different countries like Ethiopia, South Africa and India. The results of the study indicated that, most farmers developed new adaptation and coping mechanisms against the effects of climate change.

2.13 Climate change awareness

Smallholder farmers and the general population are forced to make decisions daily on how to cope and adapt against the impacts of climate change both in agricultural production and their daily lives. Research in climate change awareness is supposed to be evidence-based to be able to equip smallholder farmers on how to deal with issues that affect agricultural productivity while empowering them with decision-making skills that are in line with the data shared and their values. Different studies aimed at understanding how to determine the level of awareness among smallholder farmers in agriculture and farming activities have been conducted in different places throughout the world.

A study by Oruonye (2001) showed that the level of awareness of climate change among tertiary students was lower than expected. A study conducted at Jalingo Metropolis found that tertiary students in Taraba State in Nigeria had lower level of awareness of the impacts of climate change than expected. Oruonye (2001) argued that there was strong need to empower university students about impacts of climate change to help students to set up clubs that will deal with raising awareness about climate change. Furthermore, Oruonye said that the clubs could be used as tools of research and development initiatives which could help to find solutions for the problems associated with climate change adaptation and mitigation in their communities. This could help spread and promote climate change awareness among smallholder farmers and their communities and it would further emphasize the health disorders associated with climate change (Indrani and Purba, 2010). Adebayo (2012) stated that smallholder maize farmers with poor resources have low level of awareness of climate change which in turn affects their food production. Therefore, the need for awareness creation is a major key step in addressing the impacts of climate change. In Nigeria, the most vulnerable region to the effects of climate change is the Niger Delta, because of its delicate environment and the disastrous gas exploration activities which are taking place in the area.

Several smallholder farmers in rural areas claimed to be aware of the impacts of climate change, but they were not aware. Aphunu *et al*. (2012) mentioned that some smallholder farmers were aware of the circumstances surrounding the impacts of climate change, but they had low knowledge about the factors that impact climate change. The study revealed that when discussing climate change awareness, smallholder farmers used their farming experience as the guide instead of using media or extension service agents because they either didn’t have access to media or didn’t know their extension service providers. Olayinka *et al*. (2013) reported that although smallholder farmers showed different stages of awareness, their understanding of the impacts of climate change and the consequences associated with that, they have very low knowledge and awareness of climate change.

Thaddeus *et al*. (2011) found that even though smallholder producers have high level of awareness of climate change in their region, their level of awareness of the effects of the change in climate was very low among them. Thaddeus *et al*. (2011) further mentioned that 60% of smallholder farmers have little or no understanding of the impacts of climate change. The findings by Francis *et al*. (2013) showed that smallholder cocoa farmers in Ghana have a high level of awareness to climate change, because the results showed that 100% of cocoa producing smallholder farmers from all the different regions.

Sujit and Padaria (2010) reported that the results from their study in India showed mixed type of information about the level of awareness of climate change by smallholder farmers. The results showed that although smallholder farmers were fully aware of climate change, they lacked some information about climate change, and therefore, there was a need for further analysis of farmers' awareness on climate change. Henry (2001) articulated that governments are supposed to conduct educational tours to target the marginalized, uneducated and poor female farmers; because social variables such as farmers gender, education level and income were found to be positively associated with the level of awareness of the impacts of climate change. Agricultural extension officers have the responsibility of disseminating information to the farmers about climate change, mitigation and adaptation.

2.14 Chapter summary

The literature reviewed showed that climate change is a worldwide occurrence that is affecting the whole world and especially agricultural production. The literature described climate change as an average pattern of weather conditions which happen over the long term. Based on various studies done at international, continental, regional and national level, climate change is viewed as a phenomenon which affects agricultural production. Several smallholder maize farmers have the perception that climate change is a period of extreme unfavorable weather conditions which include very intense heat wave, declining rainfall patterns, droughts, floods, hurricanes and typhoons, and constant rise in sea levels, all of which have great impacts on the environment. The negative impacts of climate change are evident and can easily be seen on agricultural production as well as on other economic sectors which are dependent on agriculture e.g. industries, health, water availability, environment, shelter, vulnerable populations and national security. Different studies showed that smallholder farmers have different levels of awareness and perceptions of climate change. The literature also showed that although smallholder farmers were fully aware of climate change, they lacked some information about climate change which made it hard for any interventions to take effect.

In conclusion, the chapter reviewed different literature related to climate change and its impacts on smallholder farmers globally, in African countries, in southern Africa region and in eSwatini. The literature revealed that social variables like farmer's gender, level of education and household status have great influence on the level of awareness and perception on the impacts of climate change.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

The chapter outlines the research methodology used in the study. There are different sections outlined in the chapter, namely; study area, research design, sampling procedure, data collection and analysis, and the econometric modelling used in the study.

3.2 Study area

The study was conducted in the Kingdom of eSwatini, previously known as the Kingdom of Swaziland. The Kingdom of eSwatini (Figure 3.1) is a small, landlocked, mountainous country in southern Africa, covering an area of 17 364 km^2 (Mamba *et al,* 2015). The covered only three regions of the Kingdom of eSwatin namely; Hhohho, Manzini and Shiselweni, since 96% of the maize produced in eSwatini resided in the three regions (FANRPAN, 2003). The National Maize Corporation has strategically placed silos within these regions which are closer to the farmers, the depots are in Matsapha, Ngwemphisi, Madulini and Ntfonjeni. **Table 3.1** shows the 4 regions of with the land size and the population per region. The average rainfall for all the three regions is shown in **Table 3.2.** Between 2010 and 2014, the average rainfall per season has declined with the lowest rainfall recorded in Manzini in 2014 being 33.9 mm/annum.

Table 3.1: The land size and population of the four regions in eSwatini

	Region	Area(km²)	Population
1.	Hhohho	3,569	270,000
2.	Manzini	5,068	319,530
3.	Shiselweni	3,79	217,000
4.	Lubombo	5,947	202,000

Source: Ministry of Natural Resources and Energy (2009)

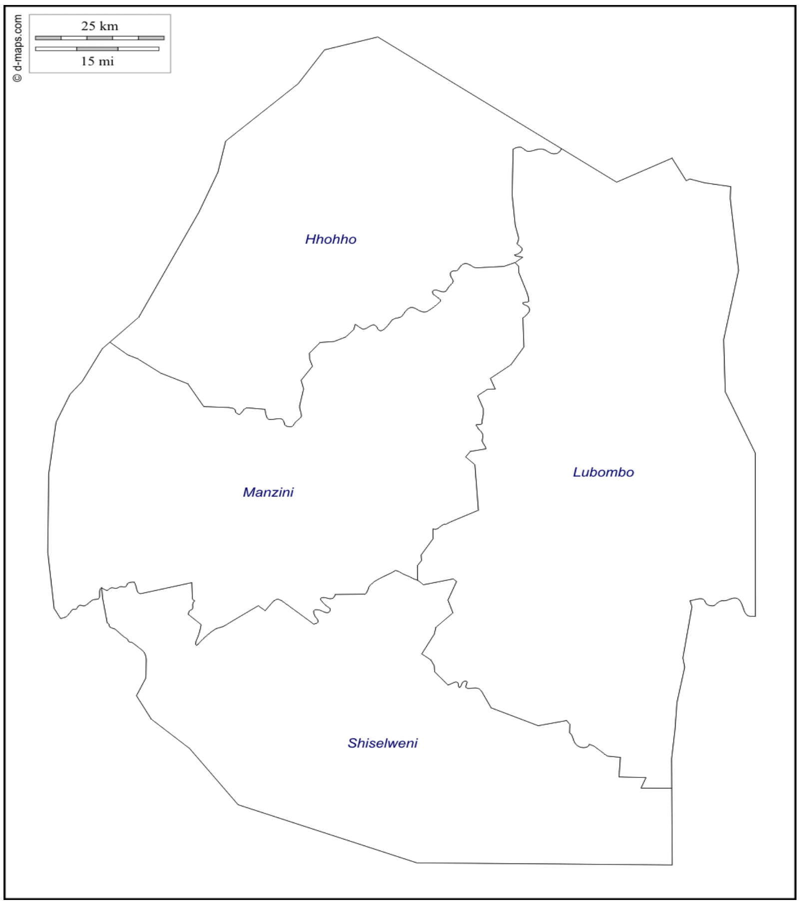

Figure 3.1: Map of the Kingdom of eSwatini showing all the four regions

Source: Ministry of Tinkhundla and Administration (2009)

Table 3.2: Average rainfall for of the 3 regions from 2010 - 2015

Year		2010	2011	2012	2013	2014	
Region	**Altitude(m)**	**Rainfall (mm)**	**Rainfall (mm)**	**Rainfall (mm)**	**Rainfall (mm)**	**Rainfall (mm)**	**Average temperature (ºC)**
Hhohho	900 – 1200	105.237	86.3041	113.170	95.6916	80.9125	16
Manzini	450 – 900	57.3833	58.475	74.0375	67.5125	33.94167	19
Shiselweni	150 – 450	61.129	58.3916	69.5375	72.0625	49.47917	22

Source: MoTEA 2016. Weather, Swaziland, 2015.

3.3 Research design

The study adopted quantitative approach and cross sectional approaches for population sampling, data collection and data analysis. Maize reports from NMC and the government were used as other sources of data. A structured questionnaire was used to collect information from smallholder farmers.

3.3.1 Study population

The study population included 539 smallholder maize farmers who have supplied maize to NMC in 2012/2013 farming season, as shown in **Table 3.3** below.

Table 3.3: Population of maize farmers who supplied maize to NMC depots

Region	Target population (N)
Hhohho	118
Manzini	250
Shiselweni	171
Total	**539**

Source: National Maize Corporation, (2013)

3.3.2 Sampling

The sample frame error was controlled by obtaining a list of the 539 maize farmers who supplied maize to National Maize Corporation (NMC) depots from 2010 to 2014. This list was obtained from the NMC in 2017, and data was collected during the period 2017 to 2018. The multi-stage sampling technique was used in the study; to involve maize farmers who produced for both consumption and for sale, purposive selection criteria were used. These criteria were very useful for identifying those farmers who supplied maize to NMC depots during the period 2012 to 2014; random sampling was then used to give each small-scale farmer a chance to be selected for questionnaire administration.

A sample of 188 farmers was selected following Roberts-Lombard (2006) formula of calculating sample size (**Table 3.4)**.

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

Where:

n= the sample size,

N= total population of farmers who supplied NMC in the three depots in 2012,

e= margin of error.

As per the calculations, the sample will be 35% per region

3.3.3 Sample size per region

Table 3.4 shows the population of the farmers targeted in the three regions and the sample size per region.

Table 3.4 Maize farmers per region who have sold their produce to NMC

Region	Target population (N)	Sample size (n)
Hhohho	118	54
Manzini	250	71
Shiselweni	171	63
Total	539	188

Source: National Maize Corporation, (2013)

3.4 Data collection

This study used a cross sectional approach to collect the data. Bailey (1998) found that the cross-sectional design was cost-effective, efficient and could be used to collect a lot of data in a relatively short time, and it allows data to be collected from different individuals or groups of respondents at the same time. The World Bank Policy Research Working Paper 3350 (2004) reported that the advantage of the cross-sectional method was that it captured smallholder farmer's adaptation strategies, as each farmer adapts to the climate that they have lived in. The technique measures the full socio-economic impacts of climate change, including how social-economic variables influence smallholder farmers' response to the impacts of climate change. The cross-sectional approach was used because it measures precisely what small-scale farmers decide to do to adjust to where they are. This approach was effective, and the study covered three different Agro-ecological regions. It was used to examine farm performance across a broad range of climates in the three regions. The approach was effective since it captured the level of farmers' awareness and perceptions towards climate change.

3.4.1 Primary data

Primary data was obtained using a structured questionnaire (**the Appendix**) to collect information from smallholder maize farmers. The questionnaire was administered during a face to face interview. The questionnaire was divided into four sections: **Section A:** Household head general background information; **Section B:** Awareness and perception level of smallholder maize farmers towards impact of climate change; **Section C:** Impact of climate change on agriculture and natural resources; **Section D:** Determinants of climate change. The questionnaire was pre-tested on 15 smallholder farmers to check the reliability and validity before the main survey (actual data collection). This helped to avoid ambiguity of some of the questionnaire items.

3.4.2 Secondary data

The major sources of secondary data were the meteorological rainfall data, Swaziland National Agricultural Union (SNAU), National Maize Corporation, and the ministry of agriculture. Various reports from publications including journal articles and reports were also used.

3.5 Data analysis

Primary data was organized, coded, processed and analyzed using the Statistical Package for Social Sciences (SPSS) version 24. The socio-economic characteristics of maize farmers were analyzed by using descriptive statistics. Factors influencing the level of awareness of climate change among small-scale maize farmers, were analyzed using logistic regression, (also called a logit model) in order to model dichotomous outcome variables. The perceptions of small-scale farmers of the impacts of climate change were analyzed using the Principal Component Analysis. Variables and the results of the study are further defined in detail in chapter 4.

3.6 Chapter summary

The chapter gave a brief description of methods used for collecting and analyzing the data for the study. This chapter also covers sample selection methods and the way data were collected and analyzed. The sample size of 188 farmers was determined by the Roberts-Lombard (2006) formula of calculating sample size. Descriptive statistics was used to analyze the socio-economic characteristics of maize farmers.

CHAPTER 4

THE SOCIO-ECONOMIC CHARACTERISTICS OF SMALL-SCALE MAIZE FARMERS IN THE HHOHHO, MANZINI AND SHISELWENI REGIONS

4.1 Introduction

In this chapter, descriptive statistics was used to describe socio-economic characteristics of the small-scale maize farmers in the Hhohho, Manzini and Shiselweni regions. Socio-economic variables such as age, gender and the level of education of smallholder maize farmers in the study area were analyzed, discussed and presented in a form of histograms.

4.4 Results and discussion

4.4.1 Demographic and socio-economic characteristics of respondents

The demographic and socio-economic profiles of the respondents studied included age of household head, level of education household head, household size, marital status and farming experience.

4.4.2 Age distribution among the respondents

Figure 4.1 presents age distribution of respondents. The age of the respondents was analysed as a reflection of the agricultural production experience of the respondents. Many of the respondents (33,3%) were above the age of 51 years, followed by 30.3% of respondents between the ages of 31 and 40 years and 25% of respondents between the ages of 41 to 50 years. A few of the respondents (3,9%) were between 25 and 30 years old. This indicates that maize farming in eSwatini is dominated by older smallholder maize farmers. The results also revealed that 30.3% of household heads (those who could take action and measures against climate change) were in the productive age groups of 31 to 40 and ≥ 51. A study conducted by Debela *et al* (2015) reveals that the age of a farmer is closely related to farming experience and their accumulated knowledge of the environment, including changes in climate conditions.

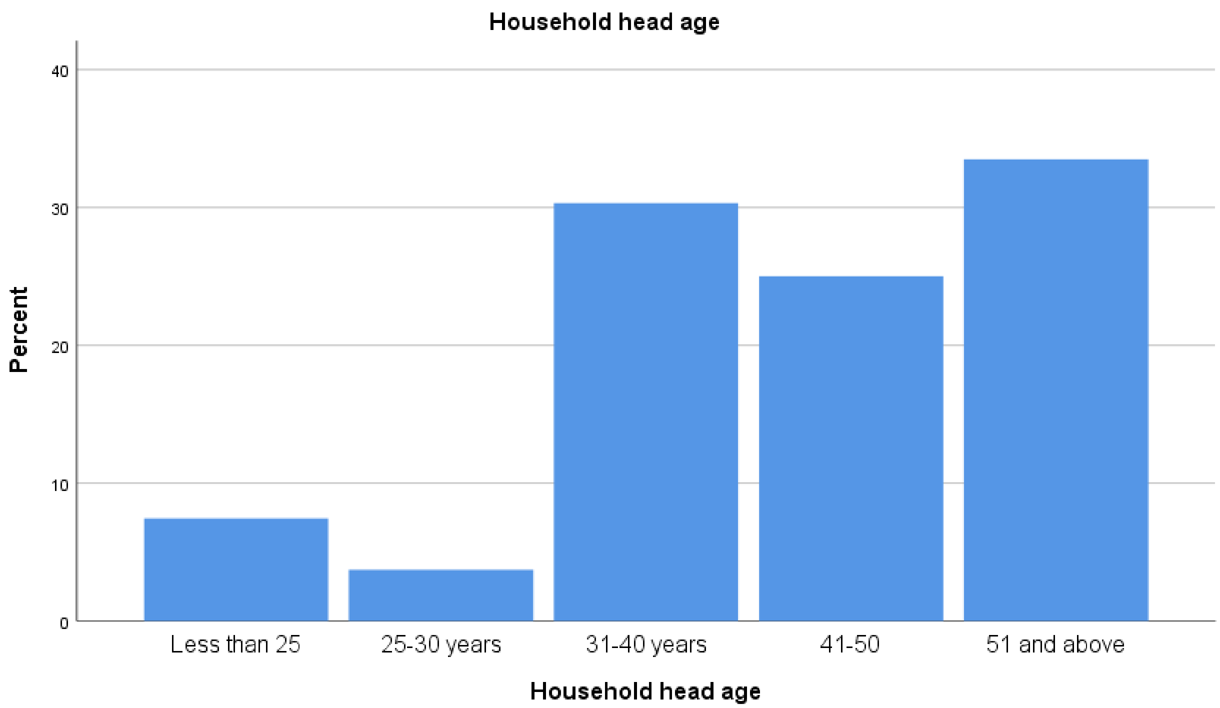

Figure 4.1. The age of the household head

4.4.3 Education level

The distribution of respondents by their education level is shown in **Figure 4.2** below. The results show that the highest number of respondents (39.9%) had primary education, followed by secondary education (27.1%), tertiary education (17.6%) and non-formal education (15.4%). Farmers with higher levels of education are generally considered as having slightly more knowledge and information on good agricultural principles, and those with university education are able to analyse and interpret information much better than farmers with no formal education (Adebayo *et al,* 2012). Adebayo *et al* (2012) state that a high level of literacy has implications for agricultural production and for adaptation to climate change. Debela *et al* (2015) have found that the level of formal education attained by farmers influences their ability, awareness and perceptions concerning climate change and its impact.

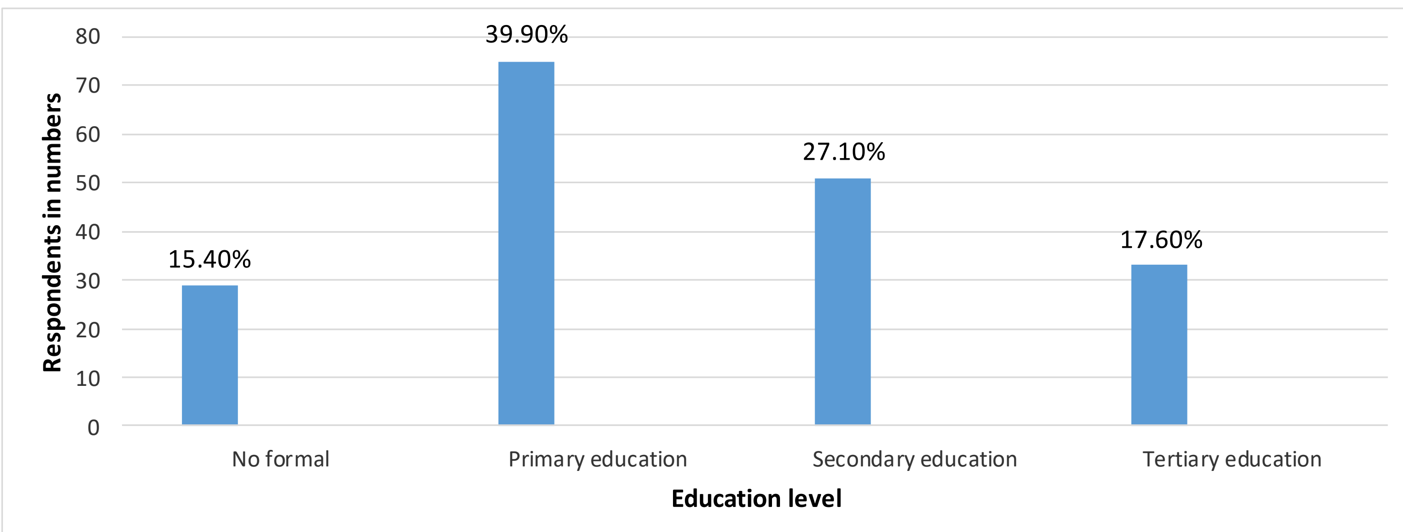

Figure 4.2. Education level of household head

4.4.4 Household size among respondents

Maize production areas in the three regions had 11.7% households with fewer than 2 members; 40.4% households had 3 to 6 members; 36.2% of the households had 7 to 10 members (**Figure 4.3**); while 11.7% of the households had more than 10 members.

Households with large numbers of members are expected to have a positive impact on maize production if all household members are fully engaged in the agriculture activities (Mamba *et al,* 2015). According to Debela *et al* (2015), households with many members are more likely to engage in non-farm income generating activities because non-farm income buffers financial losses from farming.

Figure 4.3. Household size

4.4.5 Number of years in farming of household head

The results showed that 31.4% maize farmers had farming experience for 1 to 5 years, 21.8% maize farmers had farming experience for 1 to 10 years, 30% maize farmers had farming experience for more than 21years (**Figure 4.4**). Farmers with years of experience between 11 to 20 years resulted in 16% and were the lowest among the respondents. Farmers with more farming experience were assumed to be more resilient to continue with maize production, because their experience in maize production could help them to adapt against the impacts of climate change.

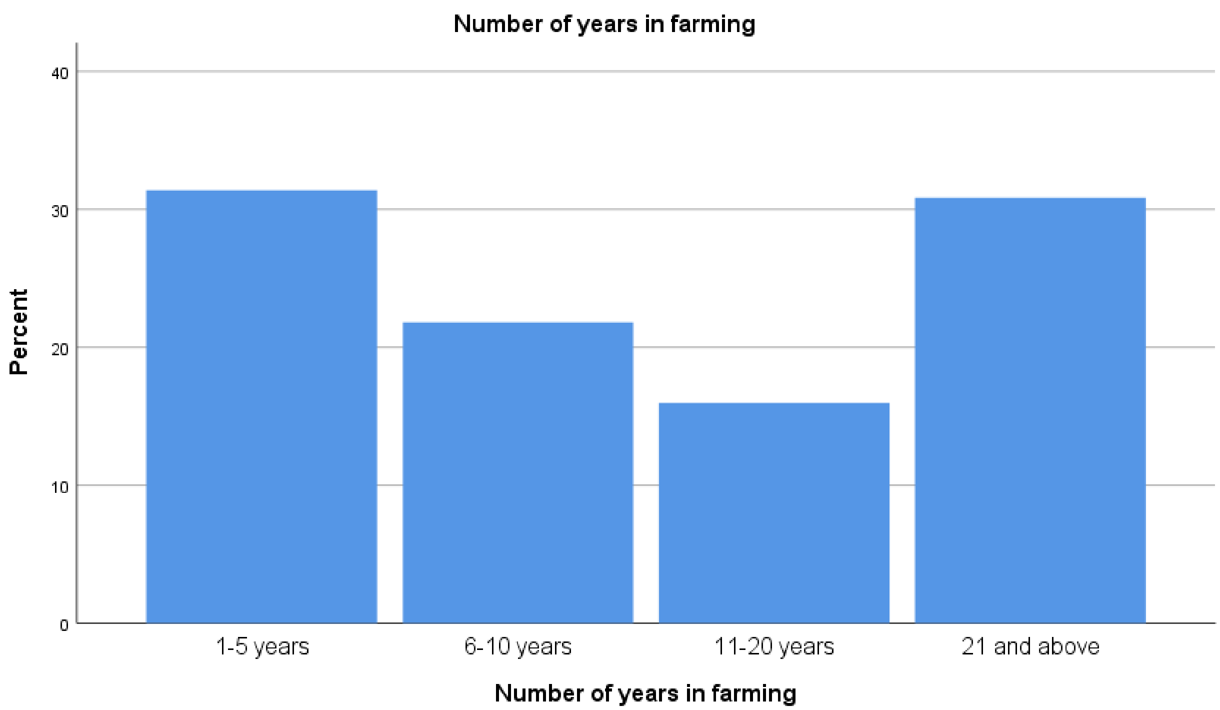

Figure 4.4. Number of years in farming of household heads

4.4.6 Gender of respondents

Figure 4.5 presents the gender of the respondents. The results showed that out of the 188 farmers that were interviewed during the survey, a total of 98 which is 52.1% of the whole population were women and 90 respondents which is 47.9% of the whole population were male. The results indicate that both men and women were active in the agricultural sector in eSwatini. The results did agree with Mucavele (2002) who found that women were the main drivers of the agriculture in developing countries, where 40% to 70% of farmers were women. Furthermore, about 80% of agricultural produce came from smallholder farmers, majority of whom were women. The findings indicated that women were the ones supporting the agricultural sector, while their partners worked somewhere else.

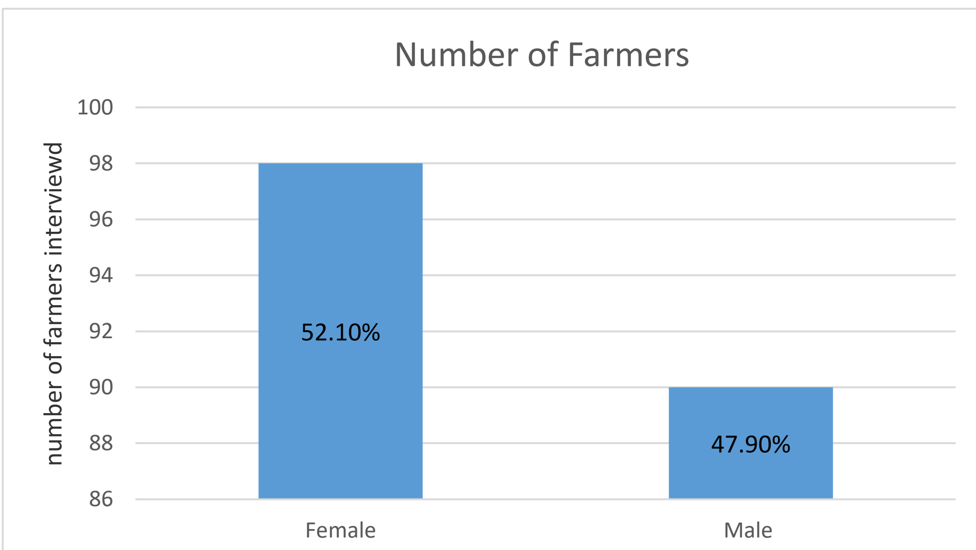

Figure 4.5. Gender of household head

4.5 Technical services

4.5.1 Extension services

Agricultural extension is a major factor in maize production, and it has more influence towards improving the yield. **Figure 4.6** shows farmers under Shiselweni and Hhohho have less access to extension services as compared to Manzini. A total of 33% under Shiselweni and 36% under Hhohho don't have access to extension services. Many farmers from Shiselweni and Manzini were among those who claimed that, although they were aware of the availability of the extension personnel, they had no access to extension services compared with farmers from Manzini who had access to extension services. This indicated that farmers who had extension services at their disposal were able to increase their production by using the best agricultural management practices and they gained the relevant knowledge and skills.

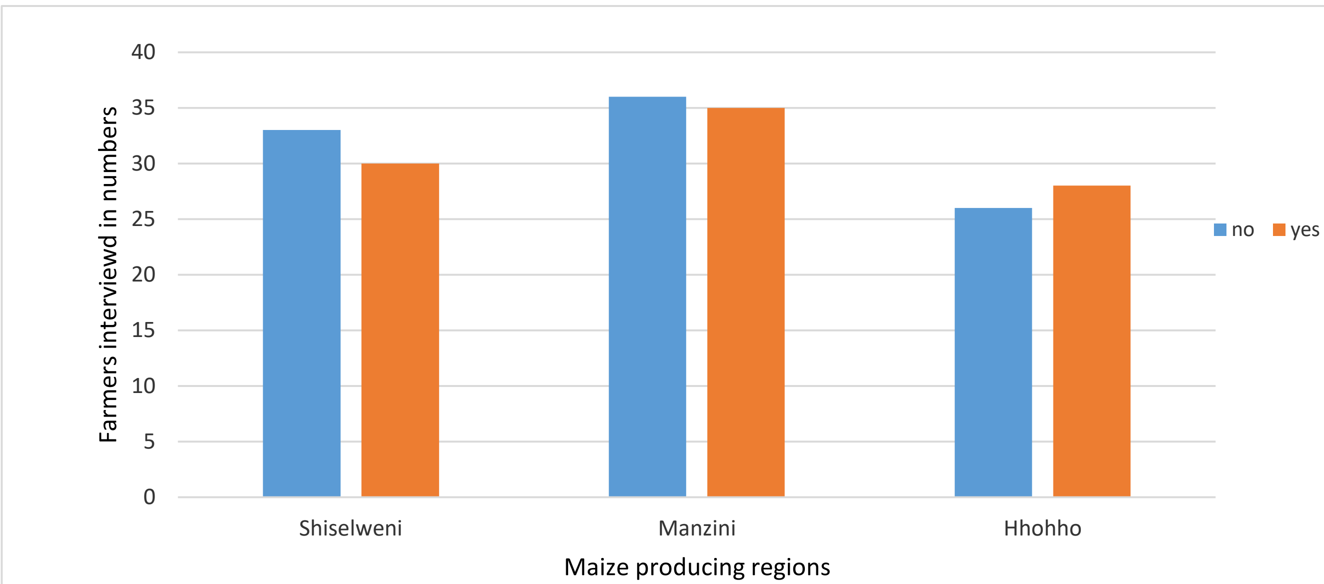

Figure 4.6. Extension services

4.5.2 Access to finance

Figure 4.7 below shows that most of the maize farmers in the three regions had access to finance or loans, while the rest did not have access to finance. The results indicate that the Manzini region is leading with farmers who had access to finance. 60 % of the population in Manzini had access to finance, followed by Shiselweni with 52% and lastly it was Lubombo region with 47%. Having access to finance made it easier for farmers to buy farm inputs and implements, and in addition, farmers who had access to financial services were in a better position to cope with the impacts of climate change, compared to those who had no access to any financial services. The findings indicated that it was easier for maize farmers who have access to financial services to adapt to climate change and that lack of financial services and agricultural inputs, hindered resource availability and farmers could not afford the costs related to adaptation.

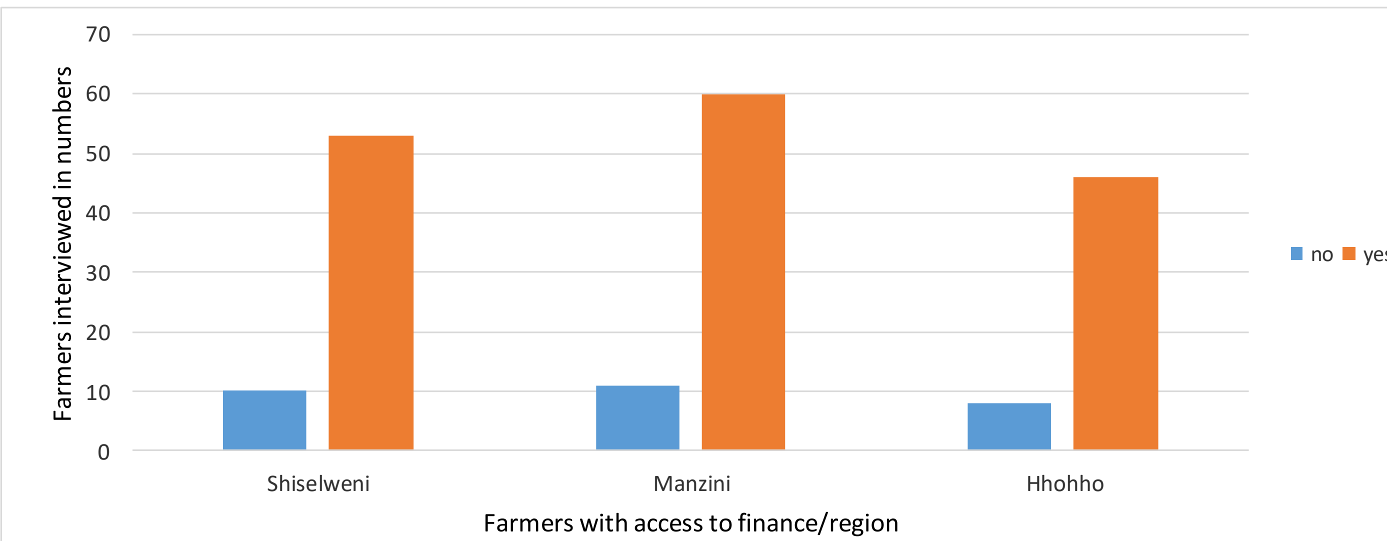

Figure 4.7. Access to finance

4.5.3 Gender and access to extension services

Gender participation in economic endeavours is crucial and a major factor in any economic activity. In agricultural production gender participation is very important as it outlines the responsibilities from both males and female's farmers in the sector. **Figure 4.8** below shows that both males (42%) and females (51%) had access to extension services at different percentages. Using simple mean comparison tests, female heads are more likely to be visited by and to receive advice from development or extension agents than male heads. The results show that female farmers had the highest percentages of farmers that have access to extension services. The reason that more female farmers had access to extension services was because more females participated in agricultural production than males, and more females were willing to access information on how to improve their production and how to adapt to climate change.

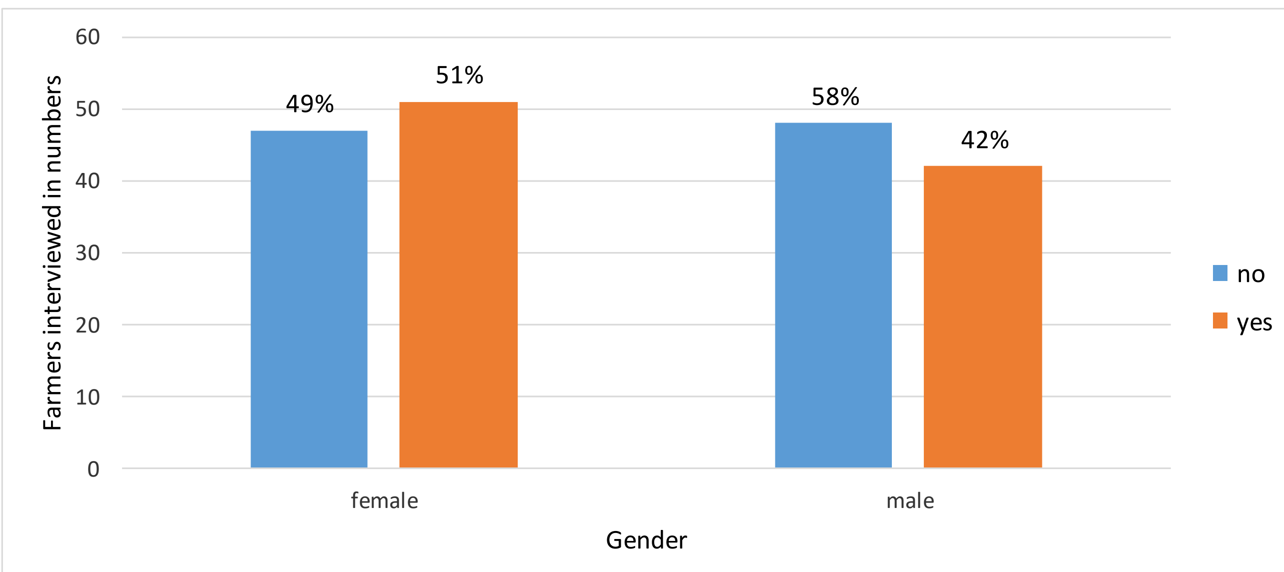

Figure 4.8. Gender and access to extension services

4.5.4 Gender and access to credit

The results showed that under the female farmer's a total of 81% of the interviewed female farmers had access to credit as compared to 78% of the male farmer's population interviewed as shown in **Figure 4.9** below. The main reason could be that most women were members of micro finance institutions such as savings, credit cooperatives (SACCOS) and Stokvel, where they get credit and other forms of financial assistance compared to men. Women had access to affordable loans because of their memberships, and they used their credit to boost their farming activities.

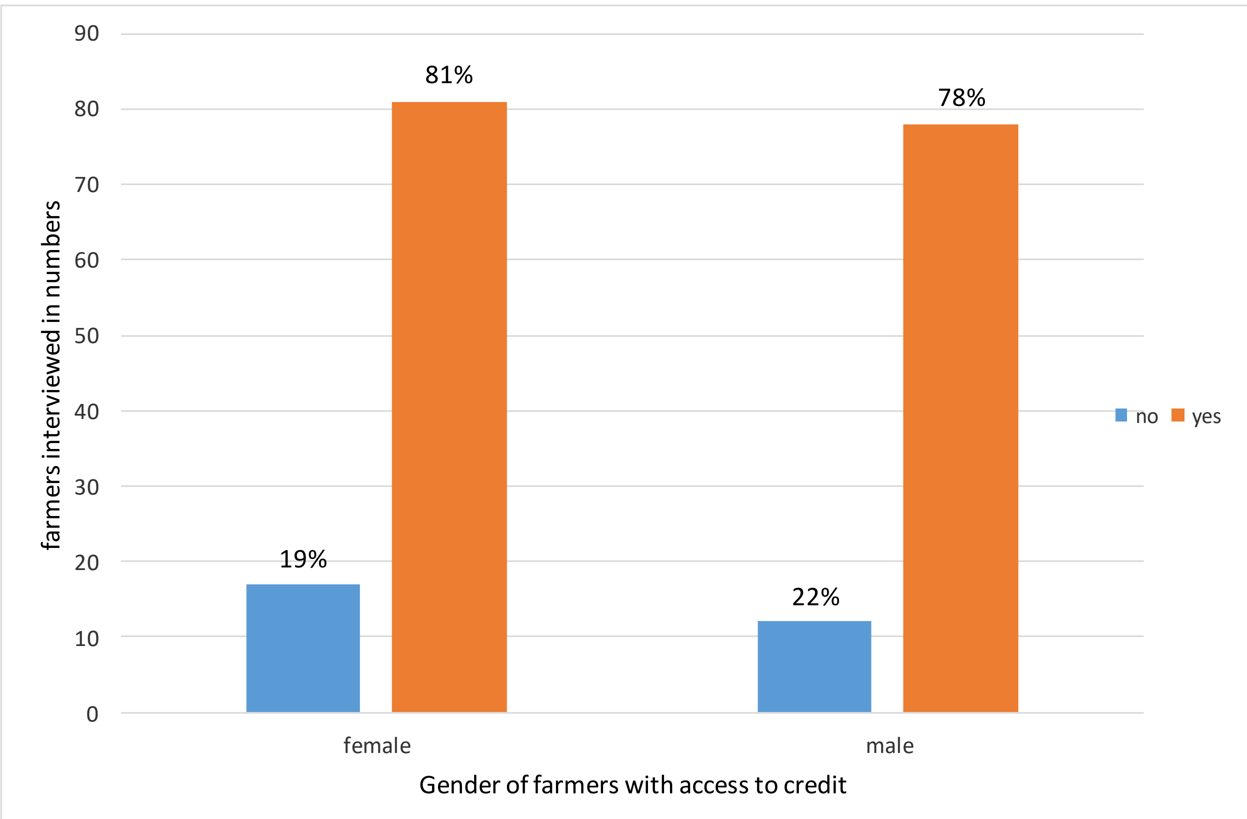

Figure 4.9. Gender and access to credit

4.6 Chapter summary

Descriptive statistics was used to analyse the socio-economic characteristics of smallholder maize farmers. Socio-economic variables such as age, gender, level of education was analyzed. The results showed that between 2012 and 2014 farming seasons, maize production decreased due to climate change. Further analysis revealed that maize farming in eSwatini was dominated by older farmers at the age of ≥ 51 years.

Based on the level of education, it could be concluded that farmers with higher primary education were more knowledgeable and they had more information on good agricultural practices. Farmers with tertiary education could interpret information more efficiently than farmers with low or no education at all. This indicated that the level of education and skills were the crucial for adaption to climate change.

Large households with many members were mostly involved in farming activities, since they had readily available labour and these households were most likely to adapt to climate change. It is a fact that experienced farmers are persistent and continue to engage in farming. The findings of this study showed that women were the backbone of agricultural sector, since their partners were engaged in other sectors of the economy. The study also revealed that access to extension services was very crucial to maize farming, since extension services provided information which improved farm productivity and livelihoods of smallholder farmers, that also enabled them to adapt to climate change. Access to financial services contributed positively towards farmers' adoption of new strategies for climate change adaptation for the reduction of the impacts of climate change. Farmers who lacked access to financial services and other agricultural related services could not cope with the new strategies for climate change adaptation.

CHAPTER 5

FACTORS INFLUENCING THE AWARENESS OF CLIMATE CHANGE AMONG SMALL-SCALE MAIZE FARMERS IN THE HHOHHO, MANZINI AND SHISELWENI REGIONS.

5.1 Introduction

This chapter identified the factors that influence the level of awareness of the impacts of climate change among smallholder maize farmers and assessed their level of awareness of the impacts of climate change. Descriptive statistics and logistic regression analysis model were used to achieve that. The chapter is organised in sections as follows: Section 5.2 the objective, Section 5.3 the hypotheses, Section 5.4 the empirical model that was used, Section 5.5 the results of descriptive statistics and the Logit Model, Section 5.6 discussions of the results, and section 5.7 the conclusion.

5.2 Objective

The objective was to identify the factors influencing the level of awareness of climate change among small-scale maize farmers in the Hhohho, Manzini and Shiselweni regions, and to determine the number of the smallholder maize farmers who were aware or not aware of climate change from a pool of 188 respondents.

5.3 Hypothesis

It was hypothesized that the different socio-economic and demographic factors have an influence on small-scale maize farmers' level of awareness of climate change. The hypothesis tested was that smallholder maize farmers' awareness of climate change is likely to be affected to some extent by size of household, age of household head, marital status, gender, farming experience, access to extension services, access to finance, production system, land tenure and land ownership.

5.4 Methodology

Logistic regression (Logit Model), was used to analyze dichotomous outcome variables. The dependent variable was dichotomous – small-scale maize farmers who were aware of climate change P_1, or the small-scale farmers who were not aware of climate change P_0. In the Logit Model, the log-odds of the outcome were modelled as a linear combination of the predictor variables.

The logit function is specified as the inverse of the sigmoidal "logistic" function or logistic transform used in mathematics, and particularly in statistics. When the function parameter represents a probability *p*, the logit function gives the log-odds, or the logarithm of the odds *p*/(1 − *p*).

The logit of a number *p* between 0 and 1 is given by the formula:

$$\operatorname{logit}(p) = \log\left(\frac{p}{1-p}\right) = \log(p) - \log(1-p) = -\log\left(\frac{1}{p} - 1\right). \qquad (1)$$

The "logistic" function of any number α is given by the inverse-logit:

$$\operatorname{logit}^{-1}(\alpha) = \frac{1}{1+\exp(-\alpha)} = \frac{\exp(\alpha)}{\exp(\alpha)+1} \qquad (2)$$

If p is a probability, then $p/(1-p)$ is the corresponding odds; the logit of the probability is the logarithm of the odds. Similarly, the difference between the logit of two probabilities is the logarithm of the odds ratio (R), thus providing shorthand for the correct combination of odds ratios simply by adding and subtracting:

$$\log(R) = \log\left(\frac{p_1/(1-p_1)}{p_2/(1-p_2)}\right) = \log\left(\frac{p_1}{1-p_1}\right) - \log\left(\frac{p_2}{1-p_2}\right) = \operatorname{logit}(p_1) - \operatorname{logit}(p_2). \quad (3)$$

So, putting all this together, the key equation usually termed the "multivariate logistic regression equation" or "multivariate logistic regression model" to which one fits the data is as follows:

$$\log\left(\frac{p_i}{1-p_i}\right) = \alpha + \beta_1 X_{i1} + \beta_2 X_{i2} + \cdots + \beta_p X_{ip} \quad (4)$$

where Pi is the probability that Y_i is 1.

$P_i/(1-P_i)$ is called the "odds". In the analysis, the function is estimated with the minimum likelihood method and Y=1 small-scale maize farmer were aware of climate change; and Y=0, the small-scale farmers were not aware climate change.

The independent variables considered in the study are presented in **Table 5.**

Table 5. Variable labels and their expected indicators

ID	Independent variables	Variable label	Expected effect
1	X_1	Household	+
2	X_2	Age	-
3	X_3	Marital	-
4	X_4	Gender	+
5	X_5	Education	+
6	X_6	Farming experience	+
7	X_7	Extension service	+
8	X_8	Finance	+
9	X_9	Production system	+
10	X_{10}	Land tenure system	+
11	X_{11}	Landownership	+
12	X_{12}	Constant	+

5.5 Results and discussion

5.5.1. Descriptive statistics (Aware/not aware of climate change)

Descriptive statistics on maize farmers' awareness of climate change

Table 5.1 presents the outcome of the descriptive statistics on small-scale maize farmers' awareness of climate change in the study area. The study considered the variables with the highest percentages. The results showed that 71.3% of the farmers were aware of climate change, while 28.7% were not aware of climate change. Similarly, Vani and Kumar (2016) report that 66.7%, which is most of the farmers in their study, were aware of climate change; and that 33.3% of the farmers were not aware of climate change. Findings from a study about climate change awareness conducted by (Raghuvanshi *et al* 2017) revealed that all the farmers (100%) were aware of climate change. Harmer and Rahman (2014) claim that high level of awareness may not necessarily translate into the take-up of adoption strategies. Farmers with household sizes of 3 to 6 constituted the majority (39.6%) of those who were aware of climate change; farmers with household size of more than 10 members accounted for 16.4% of farmers who were aware of climate change. Farmers with household sizes of ≤2 had very little awareness of climate change – they accounted for only 8.2% of farmers who were aware of climate change. The results also showed that 42.6% of farmers who were not aware of climate change had household sizes of 3 to 6. Knowledge of the factors influencing awareness of climate change may provide industry leaders and resources managers with the opportunity to enhance adaptive capacity at a farm scale (Marshall *et al,* 2013).

There was no gender difference between those who were aware of climate change (50% each). About 57.4% of farmers who were not aware of climate change were female. The majority (31.3%) of farmers who were aware of climate change were in the 31 to 40 years age group, while farmers in the ≥51 age group were the least (44.4%) aware of climate change. The results show that 59% of farmers who were aware of climate change were married people and 77.8% of farmers who were not aware of climate were also married. Farmers with primary school education accounted for the largest group (42.5%) of farmers who were aware of climate change. 38.9% of farmers who were not aware of climate change had a secondary school level of education. 52.2% of farmers who had access to extension services were aware of climate change. The results further show that 85.8% of farmers who were aware of climate change were on Swazi Nation Land tenure, while 66.7% of the farmers who were not aware of climate change were also on Swazi Nation Land tenure.

Table 5.1 also shows that 52.2% of farmers who were aware of climate change had access to extension services, while 57.4% of the farmers who were not aware of climate did not have access to extension services. In terms of access to finance, 85% of the farmers who were aware of climate change had access to finance, while 83.3% of the farmers who were not aware of climate change did not have access to finance. About 54.5% of the farmers who were aware of climate change were using family land, while 48.1% of the farmers who were not aware of climate change were also using family land. In terms of years of farming experience, 33.6% of the farmers who were aware of climate change were had 1 to 5 years of farming experience, while 37% of the farmers who were not aware of climate change had 11 to 20 years of farming experience.

Table 5.1: Descriptive statistics (Aware/not aware of climate change)

Dependent variable = Aware of climate change (1 if aware and 0 if not aware)

Description of variables	Aware N1 = 134 (71.3%)	Not aware N2 = 54 (28.7%)
	(%)	(%)
Household size		
1 = Fewer than 2	8.2	20.4
2 = 3–6	39.6	42.6
3 = 7–10	35.8	37.0
4 = More than 10	16.4	0.0
Gender (Gen)		
1 = Male	50.0	42.6
2 = Female	50.0	57.4
Age group (Age)		
Less than 25	6.7	9.3
26–30	5.2	0.0
31–40	31.3	27.8
41–50	27.6	18.5
≥51	29.1	44.4
Marital status		
1 = Single	15.6	9.2
2 = Married	59.0	77.8
3 = Divorced	19.4	13.0
4 = Widowed	6.0	0.0
Educational status		
1 = No education	16.4	13.0
2 = Primary	42.5	33.3
3 = Secondary	22.4	38.9
4 = Tertiary	18.7	14.8
Access to extension services		
1 = Yes	52.2	42.6
2 = No	47.8	57.4
Access to finance		
1 = Yes	85.0	16.7
2 = No	15.0	83.3
Experience		
1–5 years	33.6	26.0
6–10 years	27.6	7.0
11–20 years	7.5	37.0
21 years and above	31.3	30.0

Type of production system		
Rain-fed	87.0	63.0
Rainwater harvesting	6.0	0.0
Irrigation	7.5	37.0
Type of land tenure		
Swazi Nation Land	85.8	66.7
Title deed land	14.2	33.3
Land ownership		
Leased/rented	0.0	13.0
Family land	54.5	48.1
Communal land	5.2	16.7
Own land	40.3	22.2

Source: Own calculations based on the survey (2018); N = 188

5.5.3 Climate change awareness determinants among respondents

Table 5.2 presents the results of the logistic regression analyses of climate change awareness determinants among the small-scale maize farmers in the study area. The following factors had a statistically significant influence on farmers' awareness of climate change: household size, household head age, marital status, farming experience, access to extension services, access to finance, production system, land tenure and land ownership.

Household size normally has an impact on smallholder agricultural production, especially in developing countries. Deressa *et al* (2011) have found that the size of a household plays a major role in the labour force available to smallholder farmers. With all things being equal, the higher the number of people in a household, the more labour is available, which reduces production costs and increases net revenue. The results of the study show that household size has a positive and statistically significant (sig. 0.000) influence on farmers' awareness of climate change when other factors are held constant. This implies that an increase in the household size of farmers will increase their awareness of climate change. The results in Table 3 also indicate that the age of farmers was significantly and positively (sig. 0.001) related to climate change awareness. This implies that an increase in the age of farmers will increase their awareness of climate change. Thus, older farmers may be able to observe significant differences that might have been caused by climate effects, such as changes in rainfall patterns and durations.

The results show that gender had no influence on farmers' level of climate change awareness and the coefficient was not statistically significant (sig. 0.448). Harmer and Rahman (2014) comment that the effects of climate change have different impacts on different people. Lambrou and Nelson (2010) and Gandure (2013) report that men and women understand and experience climate change impacts in unique ways because of their different gender responsibilities, community status and identities, which result in different coping strategies and responses among them. The results of the logistic regression analyses also show that the formal education of the respondents had no significant influence on level of awareness of climate change.

A study conducted by Olowatayo and Ojo (2016) show that extension plays a pivotal role in providing information and promoting technologies or new ways of managing crops and farms but fails to provide information on changing climate conditions. Access to extension services is very important for climate change awareness and adaptation, and for improved agricultural production and management practices. The availability of extension services to smallholder farmers is important since they provide important information about climate change and farming practices. The results of the current study show that an increase in extension services received by farmers did not increase the level of farmers' awareness of climate change and the coefficient was statistically significant (sig. 0.000). However, a study by Deressa *et al* (2011) found that access to and the use of extension services have a strong positive influence on adapting to climate change. The results of this study imply that the extension services provided to the farmers in the study area did not touch on aspects of climate change. Farming experience was found to be statistically significant (sig. 0.000), with a negative relationship to the level of climate change awareness. This could be the result of providing extension services but no information about relevant aspects of climate change to farmers in the study area over many years.

Access to finance influenced the level of awareness of climate change positively and was statistically significant (sig. 0.034), implying that the more access farmers had to finance, the better they would be aware of climate change, which could reduce financial losses from poor harvests. The results in **Table 5.2** show that the land tenure system was negatively and significantly associated with the level of climate change awareness among farmers. This implies that the private tenure system among small-scale farmers negatively influenced their levels of climate change awareness. Land ownership was significant (sig. 0.000); it was positively associated with the level of awareness of climate change and statistically significant (sig. 0.000). Using one's own land will most likely motivate a farmer to provide fixed improvements and seek farming information (including information about climate change mitigation and adaptation strategies) from many reliable sources in anticipation of increased farm production and income.

Table 5.2: Factors influencing climate change awareness among respondents

Variables Xi	B	S.E.	Wald	Sig.	Exp (B)
Household size	6.3	1.391	20.527	0.000	544.571
Age	1.791	0.554	10.444	0.001	5.996
Marital	8.983	1.888	22.639	0.000	7966.395
Gender	0.454	0.599	0.575	0.448	1.575
Education	-0.398	0.329	1.467	0.226	0.672
Farming experience	-5.732	1.042	30.279	0.000	0.003
Extension service	-7.092	1.723	16.953	0.000	0.001
Finance	1.789	0.842	4.519	0.034	5.985
Production system	-8.916	2.058	18.762	0.000	0
Land tenure system	-4.281	1.31	10.686	0.001	0.014
Landownership	4.441	0.985	20.31	0.000	84.869
Constant	-10.443	3.488	8.961	0.003	0.000

p – values: * $p < 0.05$; ** $p < 0.01$ = Significant at 5% and 1% respectively

5.6 Chapter summary

This chapter investigated the level of awareness of climate change by small-scale maize farmers in eSwatini. The study was based on a cross-sectional household survey data collected from a pool of 188 respondents during the 2010-2015 farming seasons. The results from the selection model, which predicted factors that affected awareness to climate change, were household size, age of the household head, marital status, gender, farming experience, access to extension services, access to finance, production system, land tenure and land ownership.

CHAPTER 6

PERCEPTIONS OF SMALL-SCALE MAIZE FARMERS ON CLIMATE CHANGE IMPACTS IN HHOHHO, MANZINI AND SHISELWENI REGIONS.

6.1 Introduction

The objective of this chapter was to assess the perceptions of climate change among small-scale maize farmers in the Hhohho, Manzini and Shiselweni regions, by using the Principal Component Analysis (PCA).

6.2 Objective

The objective of this chapter was to assess factors influencing perceptions of climate change among small-scale maize farmers in the Hhohho, Manzini and Shiselweni regions, by using the PCA and to determine the proportion of the smallholder maize farmers that were aware of climate change.

6.3 Hypothesis

The hypothesis was that small-scale maize farmers perceptive floods, soil erosion, water scarcity, drought patterns, shifts in rainfall, crop diseases, rural urban migration and structural destruction as factors affecting climate change.

6.4 Methodology

A total of 188 questionnaires were administrated to small-scale maize farmers in the 3 maize producing regions of eSwatini, namely; Hhohho, Manzini and Shiselweni. The gender distribution was 47.9% males and 52.1% females. The respondents' perceptions were measured using a five-point Likert scale analyses. The scale ranked the respondents according to how they perceived climate change in the three maize producing regions ranging as follows; 1. strongly agree, 2. Agree, 3. Do not know 4. Disagree, and 5. Strongly disagree. A mean score of each variable was constructed based on questions measuring the perceptions. Other questions related to how the small-scale maize farmers perceived climate change were assessed according to the following domains; incidences of floods, shifts in rainfall seasonality, persistent droughts, increasing food crops costs, destruction of buildings, infrastructure and soil erosion. A "strongly agree" score on the scale indicated a positive perception of climate change and a "strongly disagree" indicated a negative perception of climate change.

Principal Component Analysis was used to rank a small number of variables that could account for the variability found in a relatively a large number of variables, not including all the original variables in the analysis. This method allows the researcher to find new variables that represent the underlying or latent variables of the data set of statement, which are referred to as the factors that best describe the ideas that depict farmers' perceptions of the impacts of climate change. Criteria, such as eigen values greater than one and cumulative variance were explained by increasing numbers of factors that were included in the factor model; and the interpretability of extracted factors were used to guide the choice of the appropriate number of factors to be included in the model of choice; or best fit model.

6.5 Results and discussion

Table 6.1 presents the descriptive statistics of the variables that showed perceptions of climate change. About 59% of the respondents perceived that climate change has a very huge influence on maize production, while 44.7% of the farmers strongly agreed that shifts in rainfall patterns have caused crop failures and low yield.

6.5.1 Percentage ratings of the perceptions on climate change impact

Table 6.1: Percentage ratings of the perceptions on climate change impact

Perceptions regarding climate change impact	Strongly agree	Agree	I do not know	Disagree	Strongly disagree
Climate change has a very big impact on maize production	59%	41%	00%	00%	00%
Variations in climate have caused an increase in incidences of floods	7.4%	12.2%	29.3%	16.5%	34.6%
Shifts in rainfall seasonality have caused crop failures and low yield	44.7%	34.0%	12.2%	4.8%	4.3%
Crop varieties have no longer been productive due to persistent droughts	25.5%	20.7%	29.3%	14.9%	9.6%
Climate change has led to crop infestation and diseases due to droughts	7.4%	31.9%	37.8%	22.9%	00%
Climate change has led to rural–urban migration.	00%	15.4%	46.3%	24.5%	13.8%
Excessive rainfall contributes to destruction of buildings and infrastructure	67.0%	17.6%	11.7%	3.7%	00%
Flood does not contribute to soil erosion	20.2%	5.9%	28.7%	24.5%	20.7%
Water becomes scarce due to droughts and low rainfall	72.3%	20.2%	00%	3.2%	4.3%
Dry spell of crops is the result of drought	30.9%	45.7%	12.2%	3.7%	7.4%
Climate variability has an impact on rain-fed production	42.0%	10.1%	31.9%	7.4%	8.5%
Decrease in rainfall reduces water stored in bands	27.7%	27.7%	3.1.9%	4.3%	8.5%
Climate change has led to deforestation	20.7%	31.4%	42.0%	3.7%	2.1%
The cost of food crops is increasing because of climate change	24.5%	36.2%	25.0%	4.3%	10.1%

Source: Own calculations based on the survey (2017–2018), N = 188

Table 6.1 presented 67% of the small-scale maize farmers strongly agreed that excessive rainfall contributes to destruction of buildings and infrastructure, 72.3% strongly agreed that water becomes scarce due to droughts and low rainfall. The results further reveal that 42% of smallholder maize farmers perceived climate variability to have a significant impact on rainfed maize production. Mamba *et al* (2015) reported different perceptions of climate change among farmers, further showing that these farmers tended to overestimate the negative impact of climate change, and that this misperception affected crop production.

6.5.2 Scree plot

In the scree plot in **figure 6.1**, eigenvalues were plotted against principal component (PC) numbers. The PC numbers were plotted on the X-axis, while the eigenvalues were plotted on the Y-axis. The PCs that were kept were those on the slope of the graph before the decrease in eigenvalues levels off to the right of the plot. Using this criterion, 4 PCs, namely: impact on maize production, climate change, flood incidences, shifts in rainfall and droughts were retained in the analysis of this study.

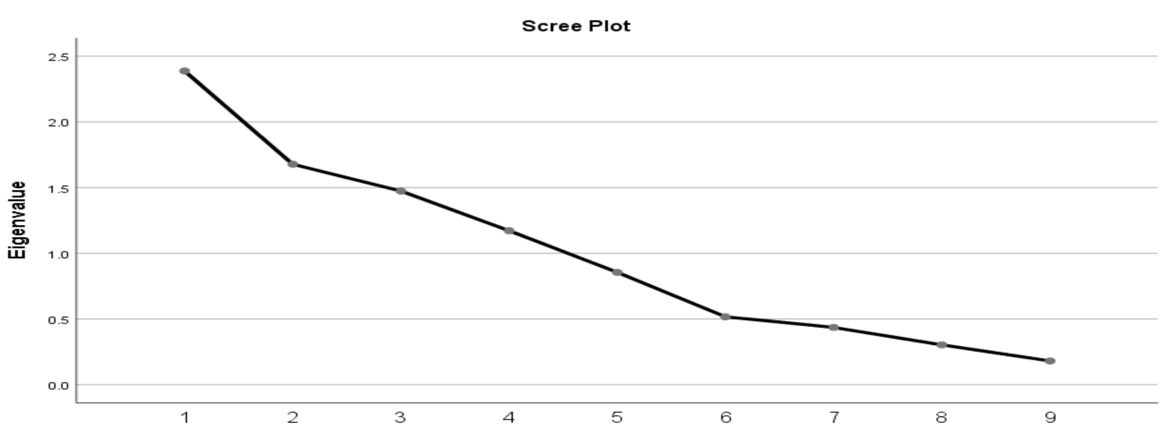

Figure 6.1. Scree plot **Source:** Own calculations based on the survey (2018)

In **figure 6.1**, the different variables represented different patterns of perceptions of small-scale maize farmers regarding climate change. The grouping of the original variables was done by observing the magnitude of the factor loadings. Each PC was considered a weighted linear combination of the variables and was written with the heavy loadings and given the most descriptive name.

6.5.3 Cumulative column

The eigenvalue table was divided into three sub-sections, namely Initial eigenvalues, Extracted sums of squared loadings and Rotation of sums of squared loadings. For analysis and interpretation purposes we were concerned only with the extracted sums of squared loadings. Note that the first factor accounts for 26.525% of the variance, the second 18.640%, the third 16.373% and the fourth 13.017%. All the remaining factors were not significant. **Table 6.2** presents the number of principals, from which 4 were selected. The cumulative column indicates that extracting the 4 factors made it possible to explain roughly 75% of the variation in the data.

Table 6.2: Cumulative percentages of variance

	Initial Eigenvalues			Extraction Sums of Squared Loading			Rotation Sums of Squared Loadings		
Variables	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
impact in on maize production	2.387	26.525	26.525	2.387	26.525	26.525	1.860	20.663	20.663
Floods incidences	1.678	18.640	45.165	1.678	18.640	45.165	1.762	19.577	40.240
Shifts in rainfall	1.474	16.373	61.537	1.474	16.373	61.537	1.671	18.562	58.802
Droughts	1.171	13.017	74.554	1.171	13.017	74.554	1.418	15.752	74.554
crop disease	0.855	9.499	84.053						
rural-urban migration	0.516	5.737	89.790						
structural destruction	0.436	4.840	94.630						
soil erosion	0.303	3.367	97.996						
Water scarcity	0.180	2.004	100.000						

Source: Own calculations based on the survey (2018). N = 188

6.5.4 Principal component factor analysis (Rotated factor pattern)

Principal component 1 (PC_1) contributed 26.525% of the variations, with an eigenvalue of 29.419, and represented small-scale farmers who were aware of the impact of climate change, such as floods, soil erosion and water scarcity between 2010 and 2014 (see the Component 1 column in **Table 6.3**). Of the four coefficients, three were positive, indicating a positive correlation among the significant variables, for instance, an increase in flood incidences will result in an increase in soil erosion; on the other hand, an increase in flood incidences decreases water scarcity. The PC_1 equation is presented as follows: $PC_1 = 0.465X^1 + 0.754X^2 + 0.400X^8 - 0.907X^9$.

Table 6.3: Rotated Factor Pattern

Variables	Component 1	Component 2	Component 3	Component 4
impact on maize production	**0.465**	**-0.349**	0.429	**0.477**
floods incidents	**0.754**	-0.051	0.184	-0.097
Shifts in rainfall	-0.057	**0.298**	**- 0.646**	**0.404**
Droughts	0.006	0.080	**0.860**	0.191
crop disease	0.159	**0.897**	0.016	-0.070
rural-urban migration	0.082	0.082	**0.519**	-0.366
structural destruction	-0.238	0.069	-0.029	**0.859**
soil erosion	**0.400**	**-0.729**	0.072	-0.286
Water scarcity	**-0.907**	-0.076	0.143	0.146

Source: Own calculations based on the survey (2018)

Principal component 2 (PC_2) contributed 18.640% of the variations, with an eigenvalue of 45.165. The variables included small-scale maize farmers who were aware of the impacts of climate change on maize production, and experienced shifts in rainfall, crop diseases and soil erosion between 2010 and 2014. The results in the Component 2 column in **Table 6.3** imply that shifts in rainfall to higher levels decreases the impact on maize production. However, an increase in shifts in rainfall increases crop diseases. The PC_2 equation is presented as follows: $PC_2 = -0.349X^1 + 0.298X^3 + 0.897X^5 - 0.729X^8$.

Principal component 3 (PC_3) contributed 16.373% of the variations, with an eigenvalue of 61.537. The variables included small-scale maize farmers who held perceptions on climate change and who had experienced a significant shift in rainfall, droughts patterns and rural–urban migration. The results in the Component 3 column in **Table 6.3** indicate that a decrease in rainfall increases drought patterns and rural urban migration. The PC equation between 2010 and 2014 is presented as follows: $PC_3 = -0.646X^3 + 0.860X^4 + 0.519X^6$.

Principal component 4 (PC_4) contributed to 13.017% of the variations, with an eigenvalue of 70.506. The variables included small-scale maize farmers who held perceptions on climate change and who had experienced impact on maize production, shifts in rainfall and structural destruction between 2010 and 2014. The results in the Component 4 column in **Table 6.3** show a positive correlation among the variables. The PC equation between 2010 and 2014 is presented as follows: $PC_4 = 0.477X^1 + 0.404X^3 + 0.859X^7$.

6.5.5 Correlation between the explanatory variable in the analysis of variance

To determine the degree and nature of the relationship and the direction of association among the independent and dependent variables, a correlation analysis was worked out and presented in the form of a correlation matrix. **Table 6.4** below shows a correlation or relationship between the perceptions of small-scale maize farmers regarding impacts of climate change and the independent variables: the impact on maize production, floods, shifts in rainfall, droughts, crop diseases, rural–urban migration, structural destruction, soil erosion and water scarcity. A positive relationship between perception and the independent variables was established. Of the nine independent variables, five, namely crop diseases, rural–urban migration, structural destruction, soil erosion and water scarcity, were positively and significantly correlated ($p < 0.05$) with the perceptions of farmers regarding climate change.

Table 6.4: Correlation between the explanatory variable in the analysis of variance

Variables	1	2	3	4	5	6	7	8	9
impact on maize production	1.000								
floods incidents	0.002	1.000							
Shifts in rainfall	0.016	0.000	1.000						
Droughts	0.000	0.003	0.000	1.000					
crop disease	0.008	**0.373**	0.033	**0.375**	1.000				
rural-urban migration	**0.305**	**0.307**	0.005	0.000	0.000	1.000			
structural destruction	0.010	0.000	0.000	**0.250**	**0.274**	0.001	1.000		
soil erosion	0.000	0.002	0.000	0.129	0.000	**0.417**	0.000	1.000	
Water scarcity	0.001	0.000	**0.255**	0.069	0.003	0.118	0.000	0.000	1.000

Source: Own calculations based on the survey (2018)

*$P < 0.05$, *$P < 0.01$., $N = 188$

Table 6.4 shows that crop diseases were positively and significantly correlated ($p < 0.373$) with floods and droughts (0.375). This meant that farmers who perceived that crop diseases were associated with climate change had high perceptions of floods and droughts as the effects of climate change. A study conducted in Swaziland by Mamba *et al* (2015) showed that the majority of farmers (88.1%) indicated that they had noted changes in the frequency, intensity and duration of drought over the preceding years.

Rural–urban migration was positively correlated (sig. 0.305) with impact on maize production and floods (0.307), and it affected the perceptions of farmers regarding climate change. The more aware the farmers were of rural–urban migration, the more they perceived maize production and floods to be effects of climate change.

The results in **Table 6.4** showed that structural destruction was positively associated with drought at (sig. 0.250) and crop diseases at (sig. 0.274). From the results, it could be inferred that farmers who perceived structural destruction to be caused by climate change also perceived that droughts and crop diseases were caused by climate change. Water scarcity was also positively correlated with shifts in rainfall. The likelihood of water scarcity as a result of shifts in rainfall was statistically significant (sig. 0.255).

6.5.6 Analysis of variance results and KMO Bartlett's test of sphericity

The Kaiser-Meyer Olkin (KMO) and Bartlett's Test measure of sampling adequacy was used to examine the appropriateness of Factor Analysis. The approximate of Chi-square was 480.330 with 36 degrees of freedom, which was significant at ($p < 0.05$) as shown on **Table 6.5,** this means that the Principal Component Factor Analysis model fitted very well to be used in this study. The Kaiser-Mever-Olkin measure of sampling adequacy = 0.471 was also less (less than 0.50). Hence, Factor Analysis was considered an appropriate technique for further analysis of the data.

Table 6.5: Analysis of variance results and KMO Bartlett's test of sphericity

Chi-square	df	Significance
480.330	36	0.000

Source: Own calculations based on the survey (2018) Kaiser-Mever-Olkin measure of sampling adequacy = 0.471

6.5.7 Interpretation of the independent variables

The results of descriptive statistics for all the variables under investigation is presented in **Table 6.6** below. The means and the standard deviation of respondents are given. The means showed rural–urban migration, floods, soil erosion, crop diseases and droughts to be the most important variables influencing small-scale maize farmers' perceptions of climate change. These variables had the highest means, namely 3.4734, 3.4043. 3.2340, 2.9894 and 2.6755 respectively.

Table 6.6: Descriptive statistics of the variables

Variables	Mean	Std. Deviation
Impact in climate	1.4096	0.49307
Flood incidents	3.4043	1.12644
Shifts in rainfall	1.9043	1.08040
Droughts	2.6755	1.35079
Crop disease	2.9894	1.24096
Rural-urban migration	3.4734	1.02604
Structural destruction	1.5585	0.96560
Soil erosion	3.2340	1.41743
Water scarcity	1.41743	0.94405

Source: Own calculations based on the survey (2018).

N = 188

6.4.8 Box plots

Box plots were used to show patterns of responses for each group, as shown in **Figure 6.2.** They provided a useful way of visualising the range and other characteristics of responses for large groups. As an indicator of centrality, the box plot was of a sample of 5 points from a population centred on 3. As an indicator of symmetry, the box plot was a sample of 5 points from a symmetrical population.

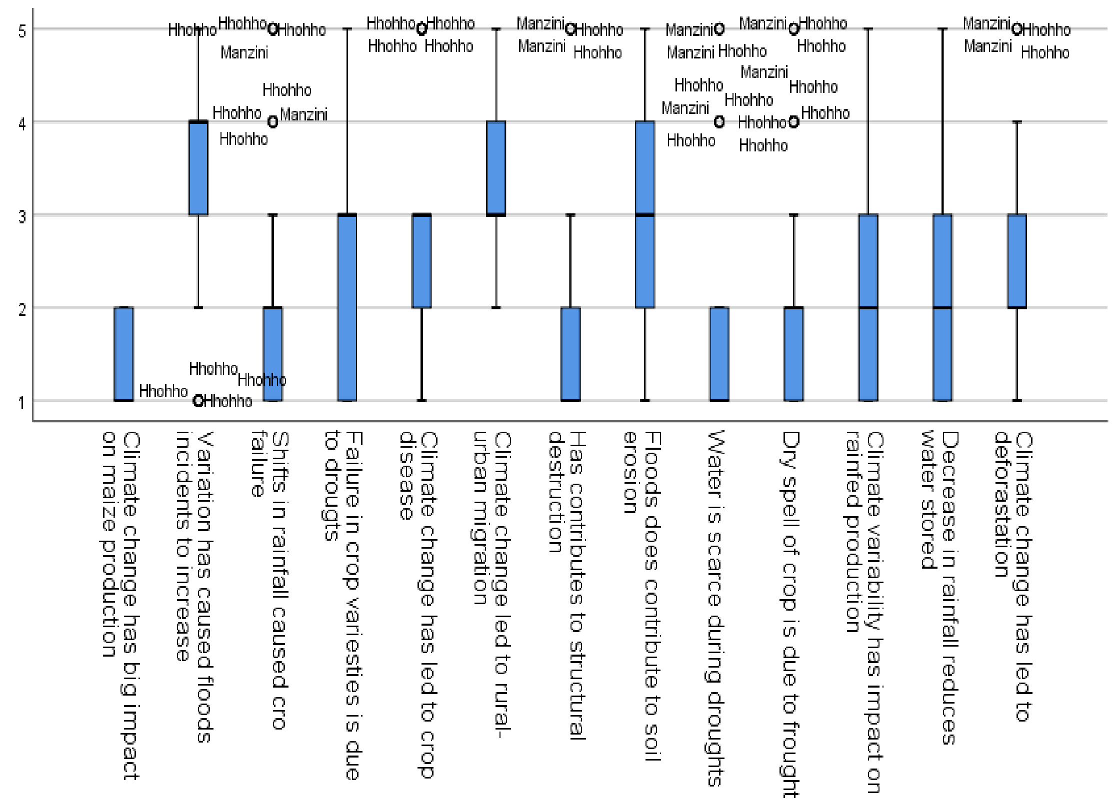

Figure 6.2. Box plots showing overall patterns of response for groups

The data sets for variables 1 and 9, namely impacts on maize production and water scarcity during drought, were skewed to the left with a median of 1. Variables 2 and 6, namely caused floods to increase and rural–urban migration, were skewed to the right and to the left, respectively. The data sets for variables 3 and 10, shift in rainfall caused crop failure and dry spells of crops due to drought, were skewed to the right. According to Debela *et al* (2015), farmers perceived the onset of rainfall to be much later over the past ten years than 20 years ago, and they also perceived rainfall to cease halfway through the growing season. Variable 8, floods which contributed to soil erosion, was symmetrical. This showed that small-scale maize farmers perceived soil erosion to be a significant result of climate change.

The line for 1 variable (Floods contributes to soil erosion) is in the centre of the box, and the whisker lengths are the same. In the case of 6 variables (shift in rainfall, structural destruction, dry spells, climate variability and reduced rainfall), the top whisker is much longer than the bottom whisker, and the line gravitates towards the bottom of the box. In the case of 1 variable (climate change has led to crop failure), the bottom whisker is much longer than the top whisker, and the line rises to the top of the box.

6.5 Chapter summary

In this chapter, perceptions of smallholder maize farmers on climate change was analysed using information from maize farmers on the farming season 2010 to 2014. Results showed that farmers had different levels of perceptions on climate change. They also showed that maize production declined in the 2012 to 2014 cropping seasons. The principal components analysis revealed that different perception factors affecting climate change could be grouped in different groups. In conclusion, smallholder maize farmers in the three regions had various perceptions on climate change. The results indicated that any adaptation strategies developed by smallholder maize farmers to fight against climate change were largely influenced by the farmers' perceptions towards climate changes. Farmers perceptions if well-articulated have a huge influence on how the government responds or intervenes in such situations.

CHAPTER 7

SUMMARY AND CONCLUSIONS

7.1 Introduction

The chapter is aimed at discussing the main findings of the study in summary form and ends with conclusions and recommendations.

7.2 Summary

The aim of the study was to contribute to the pool of knowledge on factors that affect the awareness and perceptions of small-scale maize farmers in eSwatini to the impacts of climate change. The study was conducted in Hhohho, Manzini and Shiselweni, the three maize producing regions of eSwatini. The specific objectives of the study were;

I. To determine socio-economic characteristics of small-scale maize farmers in the maize production regions of eSwatini.

II. To assess the perceptions of small-scale farmers in the three maize production regions on the impacts of climate change.

III. To analyze factors influencing the awareness of small-scale farmers in the three maize production regions on the impacts of climate change.

7.2.1 Summary of results

The results of the regression models showed that the independent variables that had significant impacts on farmers' awareness to climate change were: the size of household, age of the household head, marital status, farming experience, access to extension services, access to finance, production system, land tenure and land ownership.

7.2.2 Determination of socio-economic characteristics of small-scale maize farmers in the maize production regions

The socio-economic characteristics of small-scale maize farmers in Hhohho, Manzini and Shiselweni maize producing regions, were analyzed using descriptive statistics. Socio-economic variables such as age, gender and level of education were analyzed, discussed and presented in histograms.

The findings revealed that the age of household head had great influence on maize production. A large proportion of the respondents were ≥51 years old, followed by 31 to 40 years old and a few respondents who were 25 to 30 years old. That meant that maize production in eSwatini was predominantly done by old people. The results further showed that the respondents in maize producing areas had higher primary education (39.9%), secondary education (27.1%), tertiary education (17.6%) and non-formal education (15.4%). The findings showed that farmers' level of education marginally increased their uptake on knowledge and information on good maize production practices, although farmers with tertiary education were able to analyse and apply the information much better than those who had less or no formal education.

Most of the respondents in maize producing areas were females (52.1%) and 47.9% were males. The results showed that women are the ones engaged in the agriculture sector, while their partners were engaged in jobs in other sectors of the economy. Access to extension services was a major factor contributing towards smallholder maize production activities and it had a high impact in maize production. About 50.5% of the respondent claimed that they did not have access to extension services compared to 49.5% who had access to extension services. Shiselweni and Manzini had more farmers who claimed that, they had no access to extension services although they were aware of the extension personnel in their area, compared with Hhohho farmers who had access to extension services. This was evident from the amount of maize produced in Hhohho region which was leading with an average of 6.5 tons/ha, compared with 5.5 tons/ha and 5 tons/ha from Manzini and Shiselweni, respectively. It could be concluded that smallholder maize farmers who had access to extension services had higher maize production. The increase in maize production could be associated with the information on good agricultural management practices that they received. In addition, farmers acquired relevant climate change adaptation information which they could use to reduce the impacts of climate change. The results indicated that access to extension services provided knowledge that improved farmers' adaptation capabilities to climate change.

Most (84.6%) of the farmers in maize producing areas had access to financial services and only 15.4% who did not have any access to finance. It could be concluded that farmers who had access to financial services were able to procure the necessary farming inputs and farm implements in time. Also, farmers with access to financial services were in a better position to utilize the services and they were able to adapt to the impacts of climate change. The findings showed that smallholder maize farmers who had access to credit responded positively to the impacts of climate change and they could easily apply coping strategies. Farmers who lacked finance could not afford farming inputs and they could not afford the costs related to adaptation strategies.

The results also showed that 54.8% of female respondents had access to extension services compared with 45.2% of male respondents who did not have access to extension services. Female farmers had more access to extension services and they were able to apply the knowledge to improve maize production and through extension services they were able to improve their level of awareness and their coping strategies. It could be assumed that the negative effects of climate change in the maize producing regions was reduced. The study further revealed that 50.9% of female smallholder maize farmers had access to financial services compared with 49.1% male smallholder farmers. The main reason for the difference between female and male smallholder farmers could be that, women were members of community micro financing services like SACCO (Savings and Credit Cooperative) and stokvel that enabled them to borrow money for their businesses, unlike men who were not members.

7.2.3 Analysis of factors influencing the awareness of climate change among small-scale maize farmers in the different maize production regions.

The result revealed high correlation between dependent and independent variables in relation to farmers' awareness to climate change. The size of the household had a high impact in agricultural production on smallholder maize farming in rural areas. The results of the current study showed that size of household was positively associated with the level of awareness of climate change and it was statistically significant at 1% level. The age of the household head was statistically significant (sig. 0.001) and was positively associated with the level of awareness of climate change.

The marital status of the household head was positively associated with the awareness of climate change. The likelihood of marital status to influence climate change awareness was statistically significant (sig. 0.000). It could be argued that the likelihood of married smallholder farmers to be aware of the impacts of climate change was higher than those who are not married, widowed etc. The result also showed that gender in terms of being a male person increased the probability of being aware of climate change, although the coefficient was not statistically significant (sig. 0.448).

The logistic regression analyses indicated that formal education of the respondents did not have significant influence on the awareness to climate change among the farmers. Availability of extension services to smallholder farmers was important since it provided important knowledge about climate change as well as agricultural production and management practices. The results of the current study showed that a percentage increase in extension service received by farmer, resulted in a decrease in the level of farmers' awareness to climate change (sig. 0.000). This could have been due to lack of the relevant climate change aspects in the extension services given to farmers. Farming experience was statistically significant (sig. 0.000) and was negatively associated with the awareness to climate change the farmers. This could be that farmers' experience in farming did not mean that they had higher level of awareness towards climate change.

Access to finance was statically significantly (sig. 0.034) and positively associated awareness of the impacts of climate change among the farmers. It could be that the more farmers had access to finance, the more their level of awareness on climate change increased which reduced financial losses from poor harvest. The land tenure system was negatively associated with climate change awareness among the farmers. Private tenure system among the small-scale farmers negatively influenced their awareness of climate change. Land ownership was positively related to climate change awareness. The likelihood of land ownership the awareness of climate change was statistically significant (sig. 0.000).

7.2.4 Assessment of the perceptions of small-scale farmers on climate change impacts in the different maize production regions.

This section summarises small-scale maize farmers' perceptions on climate change. The descriptive statistical analysis showed that 59% of the respondents believed that climate change had a huge impact on smallholder maize production. About 44.7% of farmers strongly agreed that changes in rainfall patterns had a great influence on crop failures and low yield.

Furthermore, 67% of the small-scale maize farmers strongly agreed that floods contributed to the destruction of houses and infrastructures, while 73.2% strongly agreed that droughts and low rainfalls contributed to water scarcity. Climate variability was perceived by 42% of farmers to have a big impact on rain-fed maize production. The increase in dry spells was believed by 45.7% to result in drought.

The principal component analysis was further used to analyse the perceptions of small-scale maize farmers on impacts of climate change. The results showed that Principal Component 1 (PC_1) contributed 26.525% of the variations with an eigen value of 29.419 in the variables included and represented small-scale farmers who were aware of the impact of climate change, floods, soil erosion and water scarcity between 2010 and 2014. The PC_1 equation was presented as follows: PC1) = $0.465X^1 + 0.754X^2 + 0.400X^8 - 0.907X^9$.

Principal Component 2 (PC_2) contributed to 18.640% of the variations with an eigen value of 45.165.293 in the variables included small-scale maize farmers who were aware of the impacts of climate change, had experienced shifts in rainfall, crop diseases and soil erosion between 2010 and 2014. The PC_2 equation was presented as follows: (PC2) = $-0.349X^1 + 0.298X^3 + 0.897X^5 - 0.729X^8$.

Principal Component 3 (PC_3) contributed to 16.373% of the variations with an eigen value of 61.537 in the variables included and represented small-scale maize farmers who had perceptions of climate change and had experienced shifts in rainfalls, drought patterns and rural-urban migration. The information on the perceptions of small-scale maize farmers on the impacts of climate change between 2010 and 2014 was presented as follows: $(PC_3) = -0.646X^3 + 0.860X^4 + 0.519X^6$.

Principal Component 4 (PC_4) contributed to 13.017% of the variations with an eigen value of 70.506 in the variables included and represented perceptions of small-scale maize farmers of impacts of climate change. The impact of climate was, shifts in rainfall and structural destruction between 2010 and 2014. The information on the PC equation between 2010 and 2014 was presented as follows: $(PC_4) = 0.477X^1 + 0.404X^3 + 0.859X^7$.

The results showed a correlation between perceptions of small-scale maize farmers on impacts of climate change and independent variables such as floods, shifts in rainfall, droughts, crop diseases, rural urban migration, structural destruction, soil erosion and water scarcity. All the independent variables had a positive association with perceptions which also indicated positive correlation between dependent variable and independent variables. We see that practically all the correlations were significant ($p < 0.05$) and positive. This means that all indicators of perceptions of climate change among small-scale maize farmers were interrelated cohesively. The means showed that rural-urban migration, floods, soil erosion, crop diseases and droughts were the most important variables that influenced small-scale maize farmers’ perceptions on climate change. These variables had the highest means: rural-urban migration (3.4734), floods (3.4043), soil erosion (3.2340), crop diseases (2.6755) and droughts (2.9894).

7.3 Conclusions and recommendations

The regression models showed the degree of significance of different variables which had influence on the awareness and perceptions of the impacts of climate change among small scale maize farmers in eSwatini.

The results of the logistic regression analyses indicated that the level of education did not have a significant influence on the awareness to climate change among the farmers.

(i) There is a need for eSwatini government to make climate change issues as major components of long-term policy and planning, particularly in terms of education and awareness in order for the general public to appreciate fully.

(ii) The study recommends that extension services department should be redesigned again so that it can include more information on climate change and its impacts. Extension services is an important source of information on climate change as well as agricultural production and management practices.

Improving access to extension services which have climate change information for farmers has the potential to significantly increase farmers' awareness of the changing climatic conditions as well as adaptation measures in response to climate change.

(iii) Access to finance should be improved for small scale maize farmers, because access to finance was positively and significantly (sig. 0.034) associated with awareness to climate change among the farmers.

The more access the farmers had to finance, the more they were aware of climate change which reduced financial losses from poor harvest.

Both the government and NGOs should intervene and help small-scale maize farmers with credit for capital and business skills.

The majority small-scale maize farmers who had title deed land had less awareness on climate change than those on communal land. Likewise, farmers who owned land were more aware than those who were renting, leasing or using family land.

(iv) The study recommends that the government and other key stakeholders should promote access to land, especially to women who were more active in maize production areas.

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APPENDIX: THE QUESTIONNAIRE

QUESTIONNAIRE NUMBER _________ REGION______________HOUSEHOLD IDENTIFICATION NUMBER_______

Interviewer's code_____

Section A.

Hello, I am___________________________________. I am working with a research team from the University of South Africa as an enumerator interviewing.

- The goal of the research study is to establish agricultural management practices which are used by farmers in copping against climate change impact. I would request to ask question relevant to the type of agricultural practices that you use.
- Your information you will is confidential and will be treated so.
- If you chose not to answer, continue or feel discomfort as we continue with the interview, you can stop and pull out. All information collected will be used for any planning purpose.

All the information you provide will remain confidential. It is important that the answers to the questions are correct since the results of the study depend on the correctness of the responses.

- If you agree to participate the interview will take 30 minutes. We thank you in advance for your patience and co-operation. May we proceed?

Yes () [continue with the interview] No ( ) [terminate the interview and submit] [Tick]

PART 1: INTERVIEW (FARMER'S BACKGROUND)

Section A: Household head background

1. **Actual household size**

1) 2 and less member
2) 3-6 members
3) 7-10 members
4) more than 10 members

2. **Actual age group**

1) Less than 25
2) 25-30 years
3) 31-40 years
4) 40-50 years
5) Above 50 years

3. **Marital status**

1) Single
2) Widow/widower
3) Divorcee
4) Married

4. **Do you have relatives/friends within the community that you can go to for financial support in times of need? Please chose one**

   1) Yes
   0) No

If yes, which one of the following

1) Husband

2) Wife
3) Children
4) Family members
5) Neighbor
6) Any other, please explain

5. Are there people (relatives or friends) outside the village you can go to for financial support?

1) Yes
0) No

6. Do you have any government support?

1) Yes
2) No
3) Sometimes

If yes, what type of support did you get?

1) Subsidies for farm inputs
2) Tractor pool services for ploughing
3) Food aid if your crops fails

7. Do you have any NGO support?

1) Yes
2) No
3) Sometimes

If yes, what type of support do you get?

1) Subsidies of farm inputs
2) Tractor pool services

3) Food aid if your crop fails

8. Give any other support system

………………………………………………………………………………………………

………………………………………………………………………………………………

9. Do you have access to extension services or technical advice in your area?

1) Yes
0) No

10. Do you have access to financial services to fund your agricultural business?

1) Yes
0) No

If yes, what are the sources of credit?

1) Financial institutions
2) Shylocks
3) Farmers savings group
4) Credit cooperative
5) Family/friend

Section B: Awareness and perception level of smallholder maize farmers towards climate change Impact

11. Do you think climate has change?

1) Yes
0) No

If yes in which way

a) Later rainfall
b) Sun too hot

c) No rain

12. Do you think climate change is good or bad?

1) Yes, it's good
2) No it bad
3) I don't know

13. Give reasons

…………………………………………………………………………………………………
…………………………………………………………………………………………………
………………………………………………………………………………………………

14. What can farmers do in response to climate change?

……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………

15. Do you think there is climate variation in your area?

1) Yes
2) No
3) I don't know

16. The danger of climate change is extremely on

1) Health
2) Agricultural Production
3) Energy availability
4) Ecological Balance

Select an option below and answer the questions depending on how you understand them and if you agree or disagree. On the space provide, write the number you chose for each question

1. Strong Agree 2. Agree 3. Do not Know 4. Strong Disagree 5. Disagree.

17. Maize production is hugely affected by climate change……

18. Climate variations has resulted to increase in floods incidences during the ---------

19. Crop failure and low yield is caused by the change in rainfall patterns during the summer. --------------

20. The recurring drought has caused some crop varieties to fail ------------

21. Climate change has led to crop infestation and diseases ------------

22. Rural-Urban migration is caused by the change in climate rural-urban migration. ----------------

23. Too much rainfall has contributed to the destruction of buildings and infrastructures……

24. Flood do not contribute to soil erosion…………...

25. Water becomes scarce and dried due to droughts and low rainfall…………

26. Dry spell of crops is the results of drought…………………………….

27. Rainfed agriculture is affected by climate variability………………...

28. Decrease in rainfall reduce water stored in bands……………………….

29. Climate change has caused deforestation……………………...

30. The cost of food crops is increasing because of climate change. ----------------

Section C: Impact of climate change towards agriculture and natural resources

31. What type of production system are you using?

a= Rainfed ( ) b= Rainwater harvesting ( ) c= irrigation ( )

32. How many actual years do you on farm farming?

1) 1-5 years
2) 6-10
3) 11-20
4) 20 and above

33. Name the type of land tenure system

1) Title deed land
0) Swazi Nation Land

34. Type of land ownership

1) Leased/ rented
2) Family land
3) Communal land
4) Land owned by farmer

35. Actual tonnage produced during the past 3 farming seasons

1) 1-10 tons
2) 11-20 tons

3) 20-50 tons
4) 60 and above

36. Actual tonnage of maize sold

1) 1-10 tons
2) 11-20 tons
3) 20-50 tons
4) 60 and above

Section D: Climate change determinates

37. Have you made any adjustment to reduce the impact of climate variability?

1) Yes
0) No

38. What adjustment have you made in response to the changing in rainfall

1) Make earth dam for irrigation
2) Collect water into tanks for irrigation
3) Plant earlier or later
4) Plastics water tanks

39. What other adjustment have you made in response to changing in temperature

1) Plant under shade
2) Plant in greenhouse
3) Plough legumes

40. What measures do you practice to conserve the soil in your area?

1) Practice Conservation agriculture
2) Plant in ridges
3) Practice minimum tillage
4) Practice agroforestry

5) Practice intercropping

PART II: CLIMATE CHANGE COPPING STRATEGIES:

Have you ever used the following climate change copping strategies? Please tick the applicable response?

Agronomic strategies

1) Planting drought resistant varieties; yes ( ) no ( )

2) Early planting yes ( ) no ( )

3) Late planting yes ( ) no ( )

4) Minimum tillage yes ( ) no ( )

5) Crop rotation yes ( ) no ( )

6) Intercropping yes ( ) no ( )

7) Mulching yes ( ) no ( )

8) Irrigation yes ( ) no ( )

9) Any other method, specify

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………………………………………………………………………………………………………

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SECTION E

Fill the table about your farm performance in the last farming season

	2001/12	2012/13	2013/14	2014/15	2015/2016
Yield per farm					
Annual farm income					
Number of permanent workers					
Number of casual workers					
Production cost per hectare (cost of labour, chemicals, fertilizer, fuels and other costs)					
Price per ton					
Land under production					
Food security					
All seasonal rainfall					
All annual temperature					

THANK YOU FOR YOUR PARTICIPATION