SMALL-SCALE MAIZE FARMERS' WILLINGNESS TO PAY FOR CHANGING PLANTING DATES IN THE FACE OF CLIMATE CHANGE: A CASE STUDY OF MAKHUDUTHAMAGA LOCAL MUNICIPALITY, LIMPOPO PROVINCE

By

Lekobane Lebogang Tau

MINI-DISSERTATION

Submitted in partial fulfilment of the

Requirements for the degree of

MASTER OF SCIENCE

IN

AGRICULTURE

(AGRICULTURAL ECONOMICS)

In the

FACULTY OF SCIENCE AND AGRICULTURE

(School of Agricultural and Environmental Sciences)

at the

UNIVERSITY OF LIMPOPO

Supervisor: Dr MA Nkoana

Co-supervisor: Prof JJ Hlongwane

2023

DECLARATION 1

I, Lekobane Lebogang Tau, declare that "**Small-scale maize farmers' willingness to pay for changing planting dates in the face of climate change: a case study of Makhuduthaga Local Municipality, Limpopo Province**" is my original work and where I used other people's work I have acknowledged their work. This report is submitted in partial fulfilment of the degree of Master of Science in Agricultural Economics at the University of Limpopo and has not been submitted before for any degree or examination at any other University.

Signed:…………………… Date:…10/12/ 2022…..

Lekobane Lebogang Tau

DECLARATION 2

Lekobane L Tau, Mmaphuti A Nkoana, Jan J Hlongwane. Determinants of small-scale maize farmers' willingness to pay for changing planting dates in the face of climate change: A case study of Makhuduthaga Local Municipality, Limpopo Province. A journal of Economics and Sustainable Development has been identified for paper publication from this mini-dissertation.

DEDICATION

This mini-dissertation is dedicated to my family and beloved classmates for their support and encouragement extensively at larger.

ACKNOWLEDGEMENTS

First and foremost, I'd want to thank my wise and competent Supervisors, Dr. MA Nkoana and Prof. JJ Hlongwane. Their encouragement, patience, and vital support helped me to finish this study. I would also like to express my heartfelt gratitude to Magakwe P for supporting me with data collecting and to my classmates for their assistance. This study would not have been possible without their assistance. Thank you to the farmers in Makhuduthamaga Local Municipality for your patience and time spent participating in this study.

My heartfelt thanks also go to my mother, Tau Maurine Madiete, and my siblings.

Finally, I'd like to thank God Almighty for this research would not have been possible without His grace and blessings.

ABSTRACT

The agricultural sector plays an important role in South Africa regardless of the small contribution of 1.88% it has to the GDP of the Country. Small-scale maize farmers' decisions to adopt adaptation options in response to climate change and variability are influenced by socioeconomic, institutional, and environmental factors, indicating that decision patterns can be very specific to a given locality.

The study aimed to analyse the determinants of small-scale maize farmers' willingness to pay for changing planting dates in the face of climate change. This study had two main objectives, to identify and describe the socio-economic characteristics of small-scale maize farmers, and to determine factors influencing the small-scale maize farmer's willingness to pay for changing planting dates in the face of climate change in Makhuduthamaga Local Municipality. The study used primary data with a sample size of 150 small-scale maize farmers. Descriptive statistics and the Probit Regression Model were employed when analysing data. The study employed purposive sampling in the data collection process and three villages were selected. Probability was proportional to sample size and was used to select the number of small-scale maize farmers for the sample frame of each village. About 58% of the sampled small-scale maize farmers were willing to pay for changing planting dates in the face of climate change, as opposed to 42% of those not willing to pay for changing planting dates. Empirical results from the analysis reported that age (10%), educational level (1%), level of income (1%), years of farming (10%), total output (1%), exposure to climate information services (5%), and use of indigenous forecast (1%) out of twelve explanatory variables were found to be significant.

Based on the empirical findings of the study it is recommended that government officials together with other stakeholders such as NGOs and research institutions should invest in the education of small-scale maize farmers through knowledge systems such as (presentations, conferences, seminars, abet etc). Government policies and strategic investment plans that support improved small-scale maize farmers' accessibility to climate information are also recommended.

Keywords: Small-scale maize farmers, Climate change, Planting dates, and willingness to pay

TABLE OF CONTENTS

LIST OF TABLES **PAGES**

LIST OF FIGURES **PAGES**

LIST OF ABBREVIATIONS AND ACRONYMS

BFAP	Bureau for Food and Agricultural Policy
CO2	Carbon Dioxide
COVID-19	Coronavirus disease of 2019
DAFF	Department of Agriculture, Forestry, and Fisheries
DALRRD	Department of Agriculture, Land Reform, and Rural Development
DEA	Department of Environmental Affairs
DWAF	Department of Water Affairs and Forestry
GDP	Gross Domestic Product
GHG	Greenhouse gases
IBM	International Business Machines
IPCC	Intergovernmental Panel on Climate Change
IPPC AR5	Fifth Assessment Report of the Intergovernmental Panel on Climate Change
NAMC	National Agricultural Marketing Council
OECD	Organisation for Economic Co-operation and Development
RCP	Representative Concentration Pathway
SA	South Africa
SPSS	Statistical Package for Social Sciences
Stats SA	Statistical South Africa
UNFCCC	United Nations Framework Convention on Climate Change
WTP	Willingness to P

CHAPTER 1: INTRODUCTION

1.1 Background of the study

The agricultural sector plays an important role in South Africa regardless of the small contribution it has to the Gross Domestic Product (GDP) of the country. According to National Agricultural Marketing Council (NAMC, 2020), the agricultural sector contributes positively to the GDP of the country with an increase of 28.6%, which became the strongest performer (15.1%) in the second quarter of 2020 regardless of the unpleasant outbreak of Coronavirus Disease of 2021 (COVID-19) pandemic. According to the Department of Agriculture, Forestry and Fisheries (DAFF, 2016), Maize is an important crop in South Africa as it is the second most produced crop after sugar cane. It is one the most important crops in South Africa, and feeds moreover it plays a vital role as raw material in the industrial production of starch, oil, protein, alcoholic beverages pharmaceuticals, and cosmetics (Naveenkumar *et al.,* 2018). The crop forms an important staple for most South Africans, as it is a source of carbohydrates, however, climate change has caused a threat to past, current, and future maize production as a result of fluctuations in climatic variables (Porwollik *et al.,* 2017). Hence, changes in climatic conditions will influence the production of maize and result in serious socio-economic problems such as food insecurity and low economic growth (Mangani *et al*., 2018).

African countries depend more on natural resources and rain-fed agriculture. Hence, it is considered to be one of the most vulnerable regions to climate change, mainly due to poverty, lack of awareness and lack of access to knowledge (Wale *et al.,* 2022). An increase in greenhouse gas emissions as a result of human-induced activities has increased the impacts of climate change in the 20th century. Increased temperatures and frequencies of extreme weather conditions have a significant impact on natural and human systems (Intergovernmental Panel on Climate Change (IPCC), 2007). Climate change refers to a variation of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere, and that is in addition to natural climate variability observed over comparable periods (United Nations Framework Convention on Climate Change (UNFCCC), 2007).

Perception and adaptation are important in minimising the impacts of climate change. The ability of the farmers to perceive climate change is very crucial for their choice of adaptation. A study conducted by Acquah (2011) revealed that for farmers to adapt to climate change, they must first perceive that the climate has changed, and then identify and implement necessary adaptation strategies. However, adaptation strategies to climate change in rural communities of developing countries are constrained by a lack of awareness and campaigns (Deressa *et al.,* 2011). Farmers need to know about climate change and their perception of climate change, choice of adaptation, mitigation methods, and the factors affecting adaptation strategies as well as the adaptation methods to climate change. Furthermore, empirical studies which measured the economic impacts of climate change on agriculture in Africa have shown that such impacts can be reduced through adaptation strategies. Adapting agricultural production to climate change has the potential to reduce most of the climate change impacts by reducing vulnerabilities and promoting sustainable development by enhancing the welfare of poor people in rural societies. Hence, the empirical results of the study conducted by Acquah (2011) have revealed that lack of knowledge about adaptation strategies, insufficient access to inputs, and no access to water is the most barrier to adaptation methods. Other constraints include changes being expensive, insecure property rights, lack of credits, and lack of information about climate change.

It is therefore critical to identify the factors that influence small-scale maize farmers' willingness to pay for changing planting dates in the face of climate change in order to analyse the effects of climate change on maize yield and the maize industry in general, which will aid in the development of effective and efficient mitigation and adaptation practices. As a result, increasing maize productivity should be a top priority for the South African government.

1.2 Problem statement

Climate change introduces vulnerability to global agricultural systems. The uncertainties it brings forth make it difficult to determine future impacts on agricultural productivity (Wiebe *et al.,* 2019). According to IPCC (2007), agricultural production is carried out by selecting crops that are suitable for the climate of a specific region. According to a study conducted by Lobell et al. (2008), climate change may result in a 30% decrease in maize production in Southern Africa. The impacts of the climate change phenomenon are more likely to be on the countries that depend more on primary sector economic activities, primarily because of an increase in productivity uncertainties in the primary sector. These impacts include reduced water availability in already water-stressed areas, and changes in the incidence of extreme events such as droughts (Trenberth *et al*., 2007).

According to Stern *et al*. (2006), present exposure, economic and social sensitivity results in poor countries being more vulnerable to climate change. The effects of climate change are becoming noticeable through drought or floods which affect the yield of crops, especially the major food crops. Thus, changing planting dates is used as an adaptation strategy to climate change. In developing countries, studies regarding willingness to pay have been conducted mainly to examine consumers' willingness to pay for renewable concentrating on the environment (Bain *et al*., 2012; Park *et al*., 2013). Most of the studies analysed determinants influencing farmers' willingness to pay for changing planting dates but did not necessarily examine the determinants of small-scale maize farmers' willingness to pay for changing planting dates. As a result, the study intends to analyse the determinants of small-scale maize farmers' willingness to pay for changing planting dates in the face of climate change.

1.3 Rationale of the study

Despite its tiny contribution to the country's GDP, the agriculture industry plays an essential role in South Africa. Agriculture is predicted to contribute roughly 1.88% of the country's GDP, according to Statista (2019). The sector is critical to constructing a healthy economy and, as a result, eliminating disparities through improving income and employment possibilities for the poor (Dethier and Effenberger, 2012).

Maize is classified as a warm weather crop that forms part of the daily diet as a staple food for human consumption and livestock feed in rural communities. It is an important grain crop in South Africa and can be grown under diverse environmental conditions Department of Agriculture, Land Reform and Rural Development (DALRRD) (2017). Agricultural activities are highly dependent upon weather and climate to produce the food and fibre necessary to sustain human life. However, agriculture is extremely vulnerable to climate change wherein, high temperatures reduce yields of maize crops while encouraging pests and weeds to spread (Rao *et al*., 2016). Thus, the development of adaptation strategies for maize is important to agricultural production and ultimately food security, considering maize is the third most cultivated crop globally (Ahmad, 2020).

As a result, the purpose of this study is to examine the determinants of small-scale maize farmers' willingness to pay for changing planting dates in the face of climate change, as well as the economic valuation for changing planting dates in the face of climate change, as the findings could potentially contribute to the reduction of climate risk and uncertainties among small-scale maize farmers, ensuring the sector's sustainability.

1.4 Aim of the study

The study aims to analyse the determinants of small-scale maize farmers’ willingness to pay for changing planting dates in the face of climate change in Sekhukhune District, Limpopo Province.

1.5 Objectives of the study

i. To identify and describe the socio-economic characteristics of small-scale maize farmers in Makhuduthamaga Local Municipality;
ii. To determine factors influencing the small-scale maize farmer’s willingness to pay for changing planting dates in the face of climate change in Makhuduthamaga Local Municipality, Limpopo Province.

1.6 Research Hypothesis

The determinant factors do not influence the small-scale maize farmer’s willingness to pay for changing planting dates in the face of climate change.

1.7 Organisation of the dissertation

The remainder of this dissertation is divided into five chapters. Chapter one entails the general introduction of the study, which consists of the background of the study, problem statement, rationale of the study, and the scope of the study. The following chapter constitutes the literature review for the study and deals mainly with small-scale maize farmers' willingness to pay for changing planting dates in the face of climate change. Chapter 3 presents the research methodology approaches followed in this study and explains the method of data collection and data analysis methods. This includes study area choice, data collection instruments, sampling methods, and empirical model analysis. The study area is briefly described before discussing data collection methods and procedures. The conceptual framework and the empirical models that were used in this study are presented subsequently. Lastly, it describes both the dependent and independent variables used in the models. Chapter 4 reports and discusses the descriptive results of the study and provides the empirical results and discussions on the small-scale maize farmers' willingness to pay for changing planting dates in the face of climate change. Finally, chapter 5 presents the main conclusions and policy recommendations based on the empirical results of the study and makes recommendations for further research and future research directions.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter provides a literature review. The main purpose of this chapter is to introduce the reader to the concepts of climate change and willingness to pay. The literature review is the process of acknowledging the accredited published studies relevant to the research title in question and summary related to the context of the study, which is the small-scale maize farmers' willingness to pay for changing planting dates in the face of climate change. This introduction is followed by the definition of key concepts, a review of previous studies, and lastly the summary of the literature review. The

2.2 Definition of key concepts within the context of the study

2.2.1 Climate change

The phrase climate change is defined differently by different stakeholders, and different writers have proposed distinct definitions of climate change even though the contents are comparable in context. Climate change refers to the "change in weather patterns such as temperature, precipitation, and wind over some time, ranging from months to millions of years" (IPCC, 2007b). The UNFCCC (2011) has defined climate change as "a change of climate that is attributed directly or indirectly to human activity that alters 10 the composition of the global atmosphere; this is, in addition to natural climate variability observed over comparable periods".

2.2.2 Small-scale farmers

Different terms have been used in literature to refer to smallholder farmers. These include small-scale farmers, peasant farmers, resource-poor farmers, subsistence farmers, food-deficit farmers, household food security farmers, and emerging farmers. Smallholder farmers are a heterogeneous group whose resources, livelihood patterns, and income sources are quite diverse (Van Averbeke, 2013). Smallholder farmer means different things to different people depending on the country one is looking at. Within the South African context, smallholder farmers are black farmers most of whom reside in former homelands (Van Averbeke, 2013). Pienaar *et al.* (2018) conclude that there is no universally accepted definition of smallholder farmers. However, in South Africa, smallholder farmers are often referred to as black farmers that are characterised by non-commercial and subsistence producers (Pienaar *et al.,* 2018).

2.2.3. Willingness to pay (WTP)

WTP is defined as the maximum monetary amount that an individual would pay to obtain a good. WTP, therefore, provides a purchase price, relevant to valuing the proposed gain of a good. WTP measures are widely used to provide information to policy makers regarding the economic value of nonmarket, or non-pecuniary, environmental assets, for example as inputs to cost-benefit analyses or as part of resource damage studies (Brown *et al*., 1999). In this study willingness to pay is defined as the extent to which the small-scale maize farmers are willing to sacrifice in changing planting dates as a result of climate change. In this case, the willingness to pay does not necessarily mean monetary payment.

2.2.4 Maize

The maize plant scientifically known as *Zea mays*, is characterised by an erect green stalk. Maize is one of the three most important staple crops in the world, it provides almost half of the daily carbohydrates to both developed and developing countries (Nuss and Tanumihardjo, 2010; Shiferaw *et al.*, 2011). According to Zhang *et al*. (2015), increasing demand for maize as a result of increasing populations will require tremendous increases in production, sustainability, as well as the resilience of maize-based farming systems. The demand shifts for maize have occurred due to climatic factors, as the crop became more important in Ethiopia during the period of drought leading to continuous expansion as a result of improved varieties, enhanced farmer access, and growing market demand (Tanumihardjo *et al*., 2020).

2.3 Review of literature

2.3.1 Overview of climate change: A global, African, and South African review

2.3.1.1 Global overview

Climate change is a global threat to the world. Greenhouse gas (GHG) emission is one of the causes behind this global threat. A study conducted by Nema *et al*. (2012) identified exclusive causes of climate change, greenhouse gas emissions being the major cause of climate change. Policies advocating for climate change have been implemented and have influenced GHG emissions as well as energy consumption and agricultural activities. The cause-effect relationship between agriculture and climate change is very complex, as the agricultural sector generates GHG emissions to the atmosphere and the sector is also vulnerable to the effects of climate change (Wreford *et al*., 2017). Hence, climate change constitutes a dual challenge for the agricultural sector. Agricultural production generates gas emissions that affect the climate, greenhouse gases emitted to the atmosphere increase the temperatures, and the precipitation regime has repercussions on the volume (Agovino *et al*., 2019). Global climate change has entailed rising temperatures in the past century, as a result droughts and heat waves; increasing precipitation levels, storms, and floods risks, and high levels of Carbon Dioxide (CO2) were generated in the atmosphere (Nema *et al*., 2012; OECD, 2016a).

2.3.1.2 African overview

The increased usage of fossil fuels and land use has increased the amount of greenhouse gases in the atmosphere (UNFCCC, 2007). A rise in greenhouse gases has resulted in an increase in the amount of heat from the sun. Hence, an increased amount of heat led to greenhouse effects that resulted in climate change. Climate change has various wide-ranging effects on the environment, socio-economic and related sectors including the agricultural sector water resources and food security as well as human health (UNFCCC, 2007). Africa is one of the continents that are under pressure from climate change stresses and is more vulnerable to climate change impacts. Many factors contribute to the impacts of current climate variability in Africa which have negative effects on the ability of the continent to cope with climate change. These effects include poverty, weak institutions, lack of technology and information, and low levels of primary education. According to Guernier *et al*. (2004), Africa is vulnerable to several climate-sensitive diseases including malaria, tuberculosis, and diarrhea.

A study was conducted aiming at assessing “farmers’ perception and adaptation to climate change to enhance policy towards tackling the challenges climate change possess to the farmers in Ghana” (Acquah *et al.,* 2011). A logistic regression model was employed to assess farmers’ perception and adaptation to climate change. The model revealed that age, years of farming experience, farmland owner, farm size, and other income-generating activities as significant predictors of the probability to pay for climate change policy (Acquah *et al.,* 2011). Studies conducted by Dai *et al.* (2004); Trenberth *et al*. (2007), revealed that most developing countries have experienced floods, drought heat waves, and tropical cyclones that are more intense as compared to the previous experiences that affect the environment, production systems, and livelihoods from future climate variability and change negatively.

2.3.1.3 South African overview

Climate change is a major concern in South Africa. The climatic regions of South Africa ranges from semi-desert to Mediterranean and subtropical conditions. There is an uneven distribution of rainfall in South Africa and the country is characterized by average annual rainfall of 450 mm per year. The western part of South Africa exhibits desert conditions with less than 100 mm of rainfall per year whereas the eastern part of the country exhibits humid subtropical conditions with about 1 000 mm of rainfall per year (Department of Water Affairs and Forestry (DWAF), 1999). According to Ziervogel *et al.* (2014), the average annual temperature has increased at least 1.5 times the observed global average of 0.65∘C over the past five decades and extreme rainfall events have increased in frequency. These changes are likely to continue. The long-term report in South Africa 2013 Adaptation Scenarios and Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC AR5) for Representative Concentration Pathway (RCP) 8.5 suggest warming relative to 1986–2005 of 3–6∘C by 2081–2100 in the interior, yet less certain precipitation changes in terms of both direction and magnitude (Department of Environmental Affairs (DEA, 2013).

Climate change poses a great challenge to agricultural production in several ways (IPCC, 2007). Few studies have highlighted that climate change is accepted as an occurring reality in most cases (Stocker *et al*., 2013; Zhang *et al*., 2015). Hence it was found that variation in annual rainfall will increase, resulting in an increase in the severity and frequency of both drought and floods (IPCC, 2013). Climate change is associated with water scarcity, and they are limiting factor to crop production. In regions that are rainfall reliant for agricultural productivity, water availability is necessary for the physiological development of maize (Moeletsi and Walker, 2012).

Various sectors of economic development in South Africa are threatened by climate change. These sectors include natural resources, agriculture and food security, forestry, tourism, manufacturing, and health (Ubisi *et al*., 2017). With high poverty levels and inequality in South Africa, climate change impacts pose critical difficulties for national development. The results of the study conducted by Gbetibouo *et al*.

(2010) showed that regions that are heavily affected by climate change, and variability do not always overlap with areas of high sensitivity or low adaptability. Furthermore, climate change vulnerability and variability are intrinsically related to social and economic development. The study further highlighted that Western Cape and Gauteng provinces are characterised by improved levels of infrastructure development, high literate levels and low shares of agriculture in total GDP which makes these provinces relatively low on the vulnerability index. On contrary, Limpopo, KwaZulu-Natal, and the Eastern Cape are highly vulnerable regions. These provinces are characterised by remote sense populated areas, large numbers of small-scale farmers, rain-dependent agriculture, and high land degradation (Gbetibouo *et al*., 2010).

2.3.2 Agricultural production in South Africa

Agriculture plays an important role in supporting the nation, through improved food security, economic growth, employment creation, and providing social welfare and wellbeing for the most vulnerable members of the rural communities in South Africa. The Bureau for Food and Agricultural Policy (BFAP, 2016:5) has estimated that the number of black households that engage in crop production in the former homelands is 1.9 million in 2015. According to DAFF (2016a:3), the contribution of the sector to the GDP of the country was R66, 7 billion (1.9%) in 2015. Regardless of the small contribution of agriculture to the GDP of the country, the sector has played an important role in job creation and employment in rural areas. Hence, according to the Quarterly Labour Force Survey for Quarter 3 of 2015 (Statistics South Africa (Stats SA), 2015b) "agricultural sector has employed 897 000 people during the period July to September 2015. This is equal to 5.7% of the employable population of South Africa".

Agriculture and food security are significantly impacted by climate change, the impact of climate change varies by region and the type of crop (Anderson *et al*., 2020). It is predicted that climate change will alter pest and disease outbreaks due to an increase in the frequency and severity of droughts and floods. It results in poor yields, crop failure, and livestock mortality (Jamshidi *et al*., 2019). The negative impacts of climate change on crops increase the vulnerability of smallholder farmers. Hence, climate change does not only affect agricultural productivity but also affects the household income of the smallholder farmers as well as food security (Alam *et al*., 2017).

Small-scale agriculture is characterised as a dual purpose, it provides a buffer against poverty for poor people, and is known as a wealth creation strategy by households of higher income class. Policy makers identify small-scale agriculture as a buffer against food insecurity. Small-scale and subsistent farming is important for poverty alleviation among black women in rural communities, as more than 50% of the people engaging in rural agriculture in the African population are women (Statistics South Africa (Stats SA), 2015b:181). Women in rural areas are also more likely to engage in agricultural activity as an extra source of food. The agricultural sector is very complex in nature as it faces the challenges such as fluctuating weather patterns, increasing climate change, a free market system with fluctuating input costs, and high commodity prices hence, it is important to educate the small-scale farmers about the adaptation strategies.

A study conducted by Simiyu (2014) showed that the socio-economic conditions of small-scale farmers are the most cited influential factors in the adoption of technologies. The variables most commonly included in this category are age, education, household size, and land size. Evidence from numerous studies confirming that the role of education in technology adoption has been extensively discussed in the literature. Education enhances the allocative ability of decision-makers by enabling them to think critically and use information sources efficiently.

2.3.3. Climate change and maize production in South Africa

Agricultural production is highly dependent on climate and thus bears the effect of climate change. With evidence from numerous studies confirming the impact of climate change on crop yields (Challinor *et al*., 2014; Knox *et al*., 2012). Lobell *et al.* (2014) revealed that each degree day above 30°C reduced maize yield by 1.7% under drought, compared with a decrease of 1% under favourable rain-fed conditions in Africa. Thus, small-scale farmers face a high risk of declining crop yields. Rurinda *et al*. (2015) further demonstrated that improving the time of planting and adjusting soil nutrient inputs can improve and stabilize maize yields in smallholder farming systems.

According to DAFF (2016); Mensah *et al.* (2009) Maize is among the most important grain crop in South Africa. The crop is ranked as the third most important grain crop after rice and wheat in the world and it also serves as the staple food of most of the South African population and is considered to be a major feed grain. A study conducted by Baloyi (2012), revealed that maize is produced throughout South Africa. Free State, Mpumalanga, and North West Provinces are the largest producers of maize in the country, accounting for more than four-fifths of the total production. Maize production is mostly on dry land and less than 10% is produced under irrigation. This crop not only plays an important role in the agricultural economy, but it also serves as food for human beings, feeds for animals and it provides raw materials to the industries. Maize is produced mostly on dry land with less than 10% being produced under irrigation systems (Baloyi, 2012)

Table 2. 1: Maize production in South Africa

Season	Total area planted (ha)	Commercial area planted (ha)	Non-commercial area planted (ha)
2006/07	2,897,066	2,551,800	345,266
2007/08	3,296,980	2,799,000	497,980
2008/09	2,896,183	2,427,500	468,683
2009/10	3,263,340	2,742,400	520,940
2010/11	2,859,060	2,372,300	486,760
2011/12	3,141,314	2,699,200	442,114
2012/13	3,238,100	2,781,200	456,900
2013/14	3,096,200	2,688,200	408,000
2014/15	3,048,050	2,652,850	395,200
2015/16	2,212,880	1,946,750	266,130

(Source: Crop Estimate Committee (CEC) -Department of Agriculture, Forestry and Fisheries, 2016).

From the data above, the Eastern Cape, Limpopo, Mpumalanga, Northern Cape, and KwaZulu-Natal provinces are dominated by non-commercial production (Department of Agriculture, Forestry and Fisheries, 2016b:9)

The table above shows the total area planted as non-commercial maize and the total area planted in the 2015/16 season is estimated at 266 130 ha (191 225 ha white and 74 905 ha yellow). The non-commercial portion produces white maize which is used for human consumption. South Africa is a highly populated country where most land is used for settlements rather than agriculture (Nkoana *et al.,* 2019). Therefore, a decline in maize yields is magnified by the fact that the population continues to increase annually at a rate of about 4.3% leading to decreasing per capita consumption with a population density of 570 people per km2.

2.3.4 Small-scale maize farmers' perception about climate change

The perception of small-scale maize farmers on climate change is very crucial in reducing the impacts of climate change on maize production. A study was conducted aiming at analysing farmers' preference for seasonal climate forecasts and their willingness to pay for seasonal climate forecast information. The empirical results of the study found that the majority of the small-scale maize farmers (85.33%) perceived that the climate is changing while the rest of the farmers (14.67) perceived that there was no change in climatic conditions (Ibrahim *et al*., 2019). Farmers that perceived that the climate is changing adopted various adaptation strategies which include early planting (10%), changing planting dates (40%), short-term crop planting (15%), fire belts around farms (5%), improved seed varieties (20%) and fertilize application (10%) (Ibrahim *et al*., 2019). The findings of the study conducted by Baudoin *et al*. (2014) revealed that none of the respondents was aware of the term 'climate change' regardless of their educational level, however, all the respondents were aware of the changes in seasonal rainfalls. Hence, it is important for farmers to perceive climate change for them to adopt climate change adaptation strategies.

2.3.5 Socio-economic characteristics

1. Age

Age is one of the factors that influence small-scale farmers' willingness to pay for climate change adaptation strategies. The influence of age on farmers' willingness to adopt climate change adaptation is unclear however, in this study age is expected to have a positive effect on the small-scale maize farmers' willingness to pay for changing planting dates in the face of climate change. Ndambiri *et al.* (2013) revealed that age may affect the farmers' willingness to adopt new farming technologies as older may be reluctant to take risks as compared to younger farmers. On the other hand, Ebi *et al.* (2011), argued that the age of the farmer does not show significant effects on the adoption of climate change adaptation strategies. Older farmers are likely to adopt climate change adaptation strategies as compared to younger farmers because they are more experienced hence, they can perceive climatic changes (Amare and Simane, 2017). On contrary, older farmers may be less willing to bear in changing planting dates. This study hypothesizes that the age of the small-scale maize farmers has both positive and negative impacts on willingness to pay for changing planting dates in the face of climate change.

2. Gender

The gender of the small-scale farmers is important in determining the access to climate change adaptive strategies. Various climate scholars Djoudi *et al*. (2016); Carr and Thompson (2014) have found that in climate change literature, gender is often characterised as a dichotomy with little attention paid to power dynamics and socio-political contexts in which climate change issues are situated. A gender perspective is essential for understanding global environmental dynamics. Hence, gender is important in determining to a larger extent the climate change resilience of the farmers (Harris, 2010). Kaijser and Kronsell (2014) argue, that women are often viewed as weak and marginalised victims, which can lead to a reduction of the gender aspect. Intersectionality has gained more traction in studies relating to climate change and gender. However, various studies found that gender did not significantly influence farmers' decisions in adapting to climate change. Households headed by women and men are significantly different in how they adapt to climate change (Nhemachena and Hassan, 2008).

3. Marital status.

The marital status of an individual has a bearing on their level of vulnerability and ability to adapt to climate change. Marital status plays a crucial role in determining the farmers' willingness to pay for climate change adaptation measures. Marital status was found to be an important factor in determining how various socio-economic and gendered entitlements such as accessing resources and receiving material support from family members were likely to play out (Van Aelst and Holvoet, 2016). For example, farmers of different marital statuses tackle different barriers and opportunities differently in their attempts to adapt to climate change. The study conducted by Denkyirah *et al.* (2017) revealed most of the farmers who participate in agricultural activities are married. The study is in line with the findings of Van Aelst and Holvoet (2016) who found that the marital status of a farmer was statistically significant at 10% however, marital status influenced a farmer's adaptation to climate change negatively. The study further concluded that married farmers are less likely to adapt to climate change since they invest most of their resources in household activities as compared to climate change adaptation strategies.

2.3.6 Factors affecting climate change adaptation strategies

Climate change has become an obvious threat to human society in developing countries. Small-scale farmers have a very limited understanding of climate change on climate change perception and adaptive measures (Guo *et al.,* 2021). Even though small-scale farmers are both grassroots actors in adaptive agriculture, however, they are still one of the most vulnerable groups to climate change. Climate change is complex and affects different regions differently therefore, there is no one-size-fits-all solution for agricultural adaptation. Arbuckle *et al.* (2013) argued that how scall-scale farmers perceive climate change may be different from reality and small-scale farmers may have the wrong perception about climate change. This could result in hindering the effectiveness of climate change adaptation. The number of studies on farmers' attitudes and behaviour is increasing to an extent whereby some scholars develop a psychological model in trying to tackle climate change adaptation measures based on protection motivation theory (Esham and Gartforth, 2013; Truelove *et al*.,2015). Frank *et al.* (2011) argued that for the small-scale farmer to adapt to climate change, they first have to perceive that the climate is changing, secondly, they have to decide whether to adopt certain actions. Gosnell *et al.* (2019) proposed the concept of regions of friction and traction to explain how transformation adapting to change can be achieved, which integrates goals and subjective attributes of adaptation to climate change. There are several determinant factors considered when discussing the factors influencing small-scale farmers' attitudes and behaviours in the face of climate change, namely the characteristics of the small-scale farmer (e.g., gender, age, education, farming experience), psychological (e.g., cognitive changes in temperature or precipitation) and socioeconomic factors (e.g., network, market access) (Guo *et al.,* 2021).

Climate change adaptation is defined as the adjustments in natural or human systems in response to actual or expected climate stimuli or their effects, to minimize damage or exploit favourable opportunities (IPCC, 2001). Adaptation and mitigation are crucial in reducing the negative impacts of climate change. Adaptation strategies are important in directly reducing the vulnerability of the small-scale farmers whereas mitigation strategies slow down the scale as well as the speed of climate change

(Ntanos *et al.,* 2018a; Abid *et al.,* 2019). Various adaptation strategies in agriculture are used by farmers. These strategies include the adoption of mixed crop farming systems, new crop varieties, irrigation systems, and changing planting dates (Nhemachena and Hassan, 2008). A study conducted by Dharmarathna *et al.* (2014) was aimed at "understanding the effect of different planting dates on rice yield under changing climate conditions and to establish it as a better adaptation strategy for improving rice production while providing a firm background for policy makers to change their cropping calendars" revealed that most of the scholars have shown that changing planting dates of rice from current practices can be a good adaptation strategy to improve rice yield impacts of climate change.

2.4. Chapter summary

This chapter offered an overview of climate change as well as the factors that influence small-scale farmers' willingness to implement climate change adaptation techniques. Several studies have been undertaken in South Africa and around the world to determine the factors that influence small-scale farmers' willingness to pay for climate change adaptation techniques. Changing planting dates was discovered to be one of the most popular climate change adaptation tactics used by small-scale farmers. It was discovered, however, that in order for small-scale farmers to adapt to climate change, they must first recognize that the climate is changing. Farmers' willingness to pay for climate change adaptation measures is influenced by socioeconomic factors, psychological factors, and farmer characteristics such as gender, age, marital status, and so on.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

This chapter gives a background on the study area and the methodology used to accomplish the objectives of the study. It elaborates on the sources of data for the research, the sampling procedures employed to collect primary data, and the data analysis methods.

3.2 Study area

This study was conducted in Greater Sekhukhune District, Makhuduthamaga Local Municipality. The municipality is among five local municipalities that are found in the Sekhukhune District (Figure 3.1). It shares borders with Fetakgomo on the northeast, Ephraim Mogale to the west, Elias Motsoaledi on the south, and Lepelle-Nkumpi Local Municipality in the north. Makhuduthamaga Local Municipality is characterised by poor infrastructure and major service delivery. According to the 2011 Census, Makhuduthamaga Local Municipality has a total population of 274 358 people, Makhuduthamaga is the second leading municipality in Sekhukhune District in terms of population size with 25% of the district population (Stats SA, 2011). Jane Furse, the headquarters of Makhuduthamaga Local Municipality, is located 347 km north-east of Johannesburg, 247 km north-east of Pretoria, and 189 km southeast of Polokwane, and 70 km south-west of Burgersfort.

Makhuduthamaga Local Municipality is credulous to major climate conditions, which can oscillate between drought and floods. The municipality is situated in a summer-rainfall region, it receives most of its rainfall between September and March, extending to April. The average annual rainfall in Makhuduthamaga Local Municipality range from 500-800mm with the annual average mean temperature of 20°c. The thunderstorms, low soil penetration, and high levels of soil erosion are common in this area as well as a high risk of evaporation resulting in low moisture supply capacity, hence irrigation systems are essential for cultivated farming practices (EnviroGIS, 2009)

A study conducted by Mpandleli *et al*. (2015), found that smallholder farming dominates with 70% of farming activities in the district whereas commercial agriculture accounts for 30%. Makhuduthamaga Local Municipality is characterised by subsistence farming. According to the census (2011), the agricultural sector employs

6% of the population. The most planted crops in the area are wheat, maize, sunflower, sorghum, and vegetables. The communities depend more on rainfall for agricultural activities.

Figure 3.1: Map of Greater Sekhukhune District, Limpopo Province

Source: Department of rural development and land reform, (2017)

3.3 Research methods/ Analytical procedures

3.3.1. Descriptive analysis

Descriptive statistics was used to address the first objective which was to identify and describe the socio-economic characteristics of small-scale maize farmers in Makhuduthamaga Local Municipality, Limpopo Province which include data related to age, gender, level of education, marital and employment statuses, and the household size. In descriptive data analysis socio-economic characteristics of the small-scale maize farmers were summarised in the form of means, standard deviations, percentages and frequencies. The descriptive statistics results were displayed in the form of graphs and tables.

3.3.2 Econometric model

Probit Model is a type of regression where the dependent variable takes two values which are denoted as 1 and 0 (Fernando, 2011). The Probit regression model was used to identify the determinants of small-scale maize farmers' willingness to pay for changing planting dates in the face of climate change. In this study, small-scale maize farmers who are willing to pay for changing planting dates prone to climate change are denoted as 1, and small-scale maize farmers who are not willing to pay for changing planting dates prone to climate change are denoted as 0. The probit model is generally specified as below:

3.3.2.1. General Probit Model:

$Y = Pr(Y=1 | X) = \Phi(X'\beta)$ ………………………………………………………..…………..1

Where Pr denotes probability, Φ is the Cumulative Distribution Function (CDF) and β is/are parameter(s). The Probit Model, as a latent variable model with an auxiliary random variable, is expressed as $Y^* = \beta' X + \varepsilon$,

Where $\varepsilon \sim N(0, 1)$. Then Y can be viewed as an indicator of whether this latent variable is positive: $Y = 1_{\{Y^*>0\}} = \begin{cases} 1 \; if \; y* > 0 \; i.e \; \epsilon < X'\beta \\ 0, otherwise \end{cases}$

3.3.2.2. Specific Model

$Yi = \beta_0 + \beta_1 A + \beta_2 G + \beta_3 EdcL + \beta_4 MS + \beta_5 SI + \beta_6 HS + \beta_7 MO + \beta_8 ECIS + \beta_9 SF + \beta_{10} UIF + \beta_{11} LFS + \beta 12 LI + ui$……..……………………………………….……………………………..2

Twelve explanatory variables were used to determine their level of influence on the small-scale maize farmer's willingness to pay for changing planting dates in the of climate change. These include age, gender, household income, level of education, etc. Therefore, the table below provides a summary of the variables that were used in the probit regression model.

Table 3.1: Description of variables for the regression model

Variables	Description	Units	Expected outcome
Dependent variable			
Farmers' willingness to pay for changing planting dates in the face of climate change	1, if the small-scale maize farmer is willing to pay for changing planting dates in the face of climate change, 0 otherwise	Dummy	
Independent variables			
Age (A)	Age of the farmer	Years	+/-
Gender (G)	1 if the farmer is male, 0 otherwise	Dummy	+/-
Educational level (EL)	Number of years of schooling	Years	+
Marital status (MS)	1 if the farmer is married, 0 otherwise	Dummy	+/-
Household size (HS)	Number of the household members	Numbers	+
Market-oriented (MO)	1 if the farmer is market-oriented, 0 otherwise	Dummy	+
Years of farming (YF)	Number of years of farming	Numbers	+
Level of income (LI)	Level of income of the farmer	rands	+
Total Output (TO)	Number of Kilograms produces per year	Kgs	+
Exposure to climate information services (ECIS)	1 if the farmer is exposed to climate information services from any source, 0 otherwise	Dummy	+
Use of indigenous forecasts (UIF)	1 if the farmer is using the indigenous indicator for climate forecasts, 0 otherwise	Dummy	+
Farm size	Size of the farm utilised for maize production	Hectares	+

Y= 1 if, the small-scale maize farmer is willing to pay for changing planting dates prone to climate change, 0 if the small-scale maize farmer is not willing to pay for changing planting dates prone to climate change.

3.3 Sampling procedures

Purposive sampling is a type of non-probability sampling that is based on the researcher's practical knowledge or judgments of the study area and representative sample. It is very useful in a situation where the researcher does not know the population of study and it helps to reach the target sample quickly (Palinkas *et al*., 2015). The study employed purposive sampling in the data-collection process. Three villages were selected from the Makhuduthamaga Local Municipality. Small-scale farmers were sampled from each selected village. Probability proportional to sample size was used to select the number of small-scale maize farmers in relation to the sample frame of each village which served as units of analysis for the study. Hence, the estimated sample size of 150 small-scale maize farmers was selected from the three villages which were based on the feasibility study.

The formula that was employed to determine the sample size per village.

$$sample\ size = \frac{sample\ frame\ per\ village}{total\ sample\ frame} \times 150$$

A list of small-scale maize farmers from the three selected villages was obtained from the traditional leaders. From the three selected villages.

Table 3.2: Sample sizes per village within Makhuduthamaga Local Municipality

Village	Sample frame	Sample size determined	Percentage (%)
Tikathone village	94	41	27%
Setebong Village	53	23	15%
Kutupu village	201	86	58%
Total	348	150	100

Source: Author’s calculations (2021)

3.4. Data collection methods

The study used quantitative data which was collected specifically for this study. Primary data was used to know the opinions of the small-scale maize farmers through questionnaires. The questionnaires had structured closed-ended and open-ended questions in which the small-scale farmers had to fill in.

4. Scientific contribution

This study will benefit small-scale maize producers by ensuring maize production sustainability is prioritized through policies addressing climate change challenges and ensuring expected growth targets are met by providing small-scale farmers with information about farmers' climate change awareness levels and their WTP for changing planting dates in the face of climate change. Additionally, the empirical findings of the proposed study will allow for the determination of factors of critical influence on most of the small-scale maize farmers' willingness to pay for changing planting dates, thus guiding policy interventions through addressing the key factors, hence reducing the costs associated with policy implementation processes. To this end, the study of the WTP of farmers is necessary, especially given the fact that, to date, no such research has been conducted in the Makhuduthamaga Local Municipality context.

CHAPTER 4: RESEARCH FINDINGS AND DISCUSSIONS

4.1. Introduction

This chapter presents the results of the descriptive statistics which were explained in chapter three and the empirical results from the Probit regression model. Data on the socio-economic characteristics were collected from the sampled small-scale maize farmers in Makhuduthamaga Local Municipality.

4.2. Descriptive statistics

To achieve objective one, descriptive statistics such as means, minimum and maximum values, frequencies, percentages and standard deviations were used. The descriptive statistics assisted to describe the socio-economic characteristics of the sampled small-scale maize farmers. The socio-economic characteristics of the small-scale maize farmers were analysed using IBM SPSS version 26.0.

4.1 Gender of the small-scale farmers

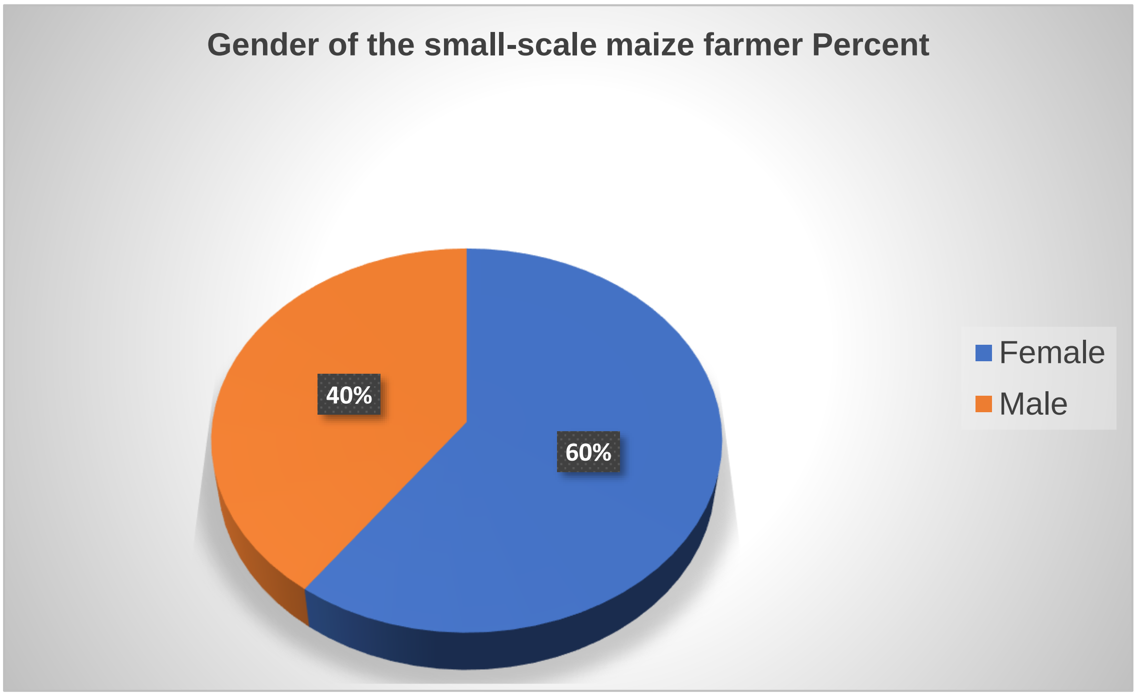

Figure 4.1: Gender of the sampled small-scale maize farmer in Makhuduthamaga Local Municipality, Limpopo Province (n=150)

Source: Field survey (2021)

Figure 4.1 depicts that from the 150 sampled small-scale maize farmers, 60% of the small-scale maize farmers in Makhuduthamaga Local Municipality were female and 40% were male. There is a 10% difference between the males and females, this means that more females were actively involved in maize production as opposed to males. The results are consistent with the findings of (Kom *et al*., 2020). According to the study conducted by Kom *et al*. (2020), females were predominantly involved in agricultural activities, and “females comprised most of the small-scale farmers”. The study further highlighted that female farmer were mostly likely to employ crop rotation as a strategy to adapt to climate change, in line with the findings of Nhemachena and Hassan (2007). Crop rotation could play a crucial role in the reduction of negative impacts of climate variation. The results disagree with the findings of Ade´gnandjou and Barjolle (2018) who found that men are the majority of small-scale farmers and women are involved more in processing activities. The authors further concluded that females are more likely to adapt to climate change as they have more responsibilities in the agricultural space, hence they are more experienced and have access to information on several management and farming practices.

4.2. Marital status of the small-scale maize farmers

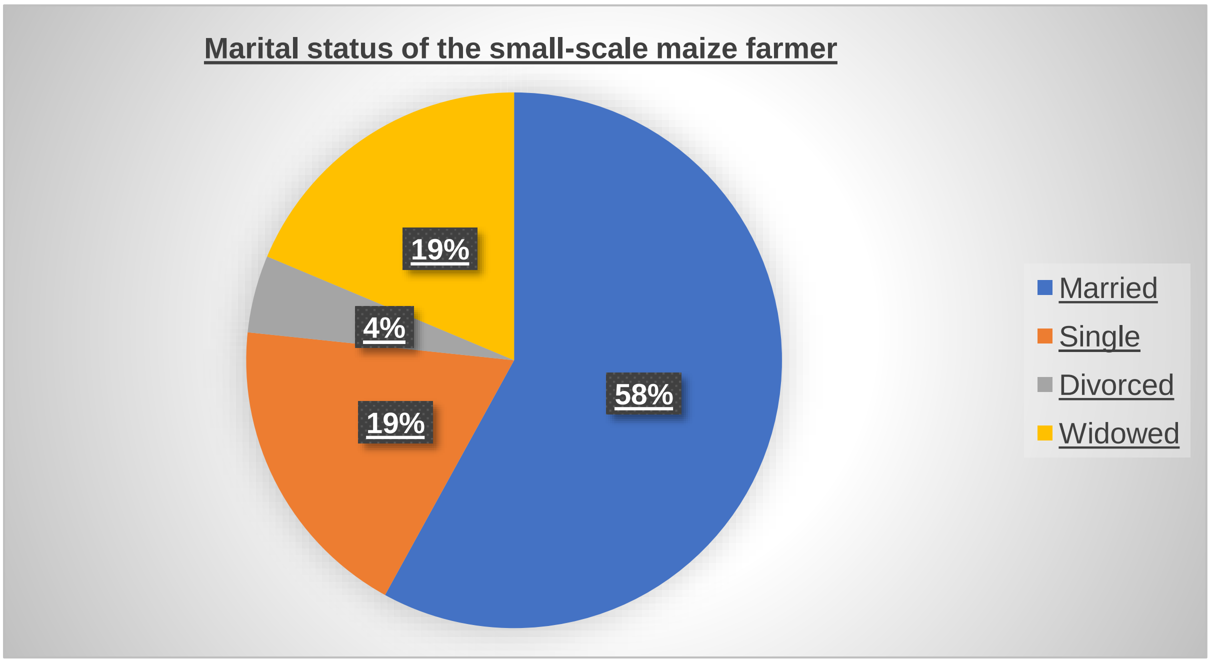

Figure 4.2: Marital status of the sampled small-scale maize farmer in Makhuduthamaga Local Municipality, Limpopo Province (n=150)

Source: Field survey (2021).

The above figure reports on the marital status of the small-scale maize farmers in Makhuduthamaga Local Municipality. The results show that from the 150 sampled small-scale maize farmers, 4% of the small-scale maize farmers were divorced, 19% of the small-scale maize farmers were single, another 19% of the small-scale maize farmers were widowed and 58% of the small-scale maize farmers were married. Married farmers were found to be more active and productive as compared to single farmers as they tend to have large household sizes which provide the needed labour (Kom *et al*., 2020).

4.3. Educational level of the small-scale maize farmers

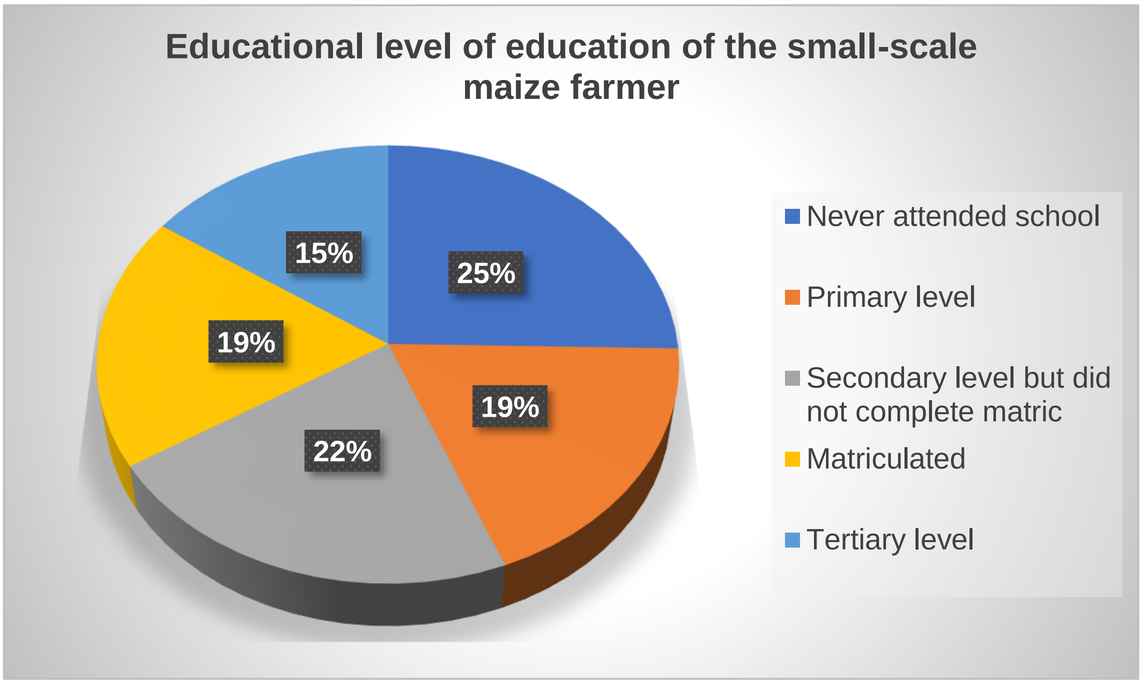

Figure 4.2: Educational level of the sampled small-scale maize farmer in Makhuduthamaga Local Municipality, Limpopo Province (n=150)

Source: Field survey (2021)

Figure 4.3. above shows the educational level of the small-scale maize farmers in Makhuduthamaga Local Municipality. The results show that from the 150 samples of small-scale farmers, 25% of the small-scale maize farmers never attended school, 19% of the small-scale maize farmers have primary education, 22% of the small-scale maize farmers have secondary education but did not complete matric, 19% of the small-scale maize farmers matriculated and 15% of the small-scale maize farmers have tertiary education.

4.4. Employment status of the small-scale maize farmers

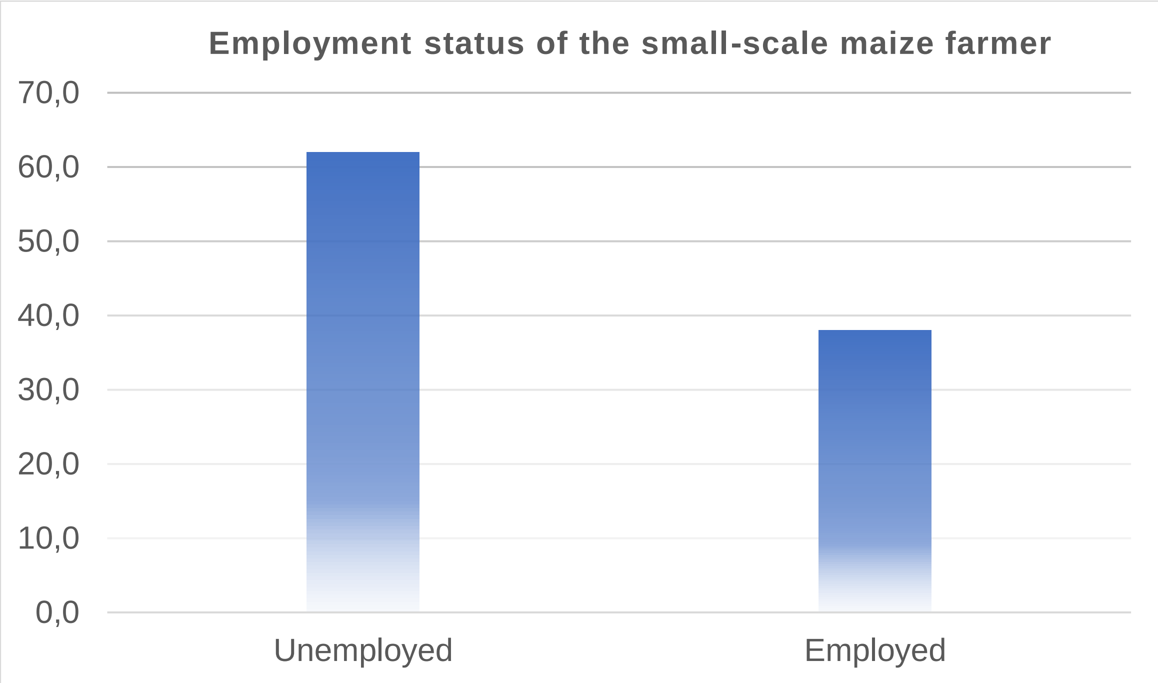

Figure 4.3: Employment status of the sampled small-scale maize farmer in Makhuduthamaga Local Municipality, Limpopo Province (n=150)

Source: Field survey (2021)

The above figure shows the employment status of the small-scale maize farmers in Makhuduthamaga Local Municipality. The results show that from the 150 sampled small-scale maize farmers, 68% of the small-scale maize farmers were unemployed and 38% of the small-scale maize farmers were employed. There is a difference of 24% between the unemployed small-scale maize farmers and the employed small-scale maize farmers.

4.5. Source of income of the small-scale maize farmers

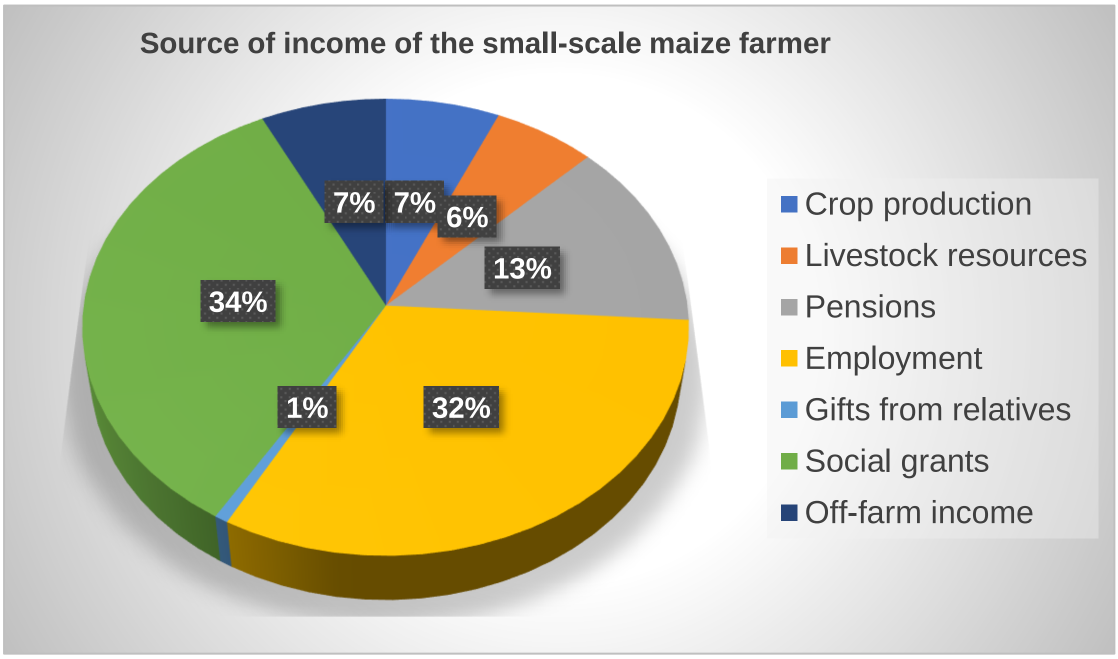

Figure 4.4: Source of income of the sampled small-scale maize farmer in Makhuduthamaga Local Municipality, Limpopo Province (n=150)

Source: Field survey (2021)

The above figure shows the sources of income of the small-scale maize farmers in Makhuduthamaga Local Municipality. 1% of the respondents receive gifts from their relatives as their major source of income, 7% of the respondents' major source of income is from crop production as well as off-farm income, 6% of the respondents generate their major income from livestock resources, 13% of the respondents receive pensions as their major source of income, 32% of the respondents generate their major of income from employment and 34% of the respondents receive social grants as their major source of income. The study shows that the majority of the small-scale maize farmers receive a social grant as their major source of income. According to Mokone (2016) households with stable and unstable incomes often engaged in agriculture compared to those that depend on remittances, investments, and other sources of income.

4.6. Use of indigenous forecast

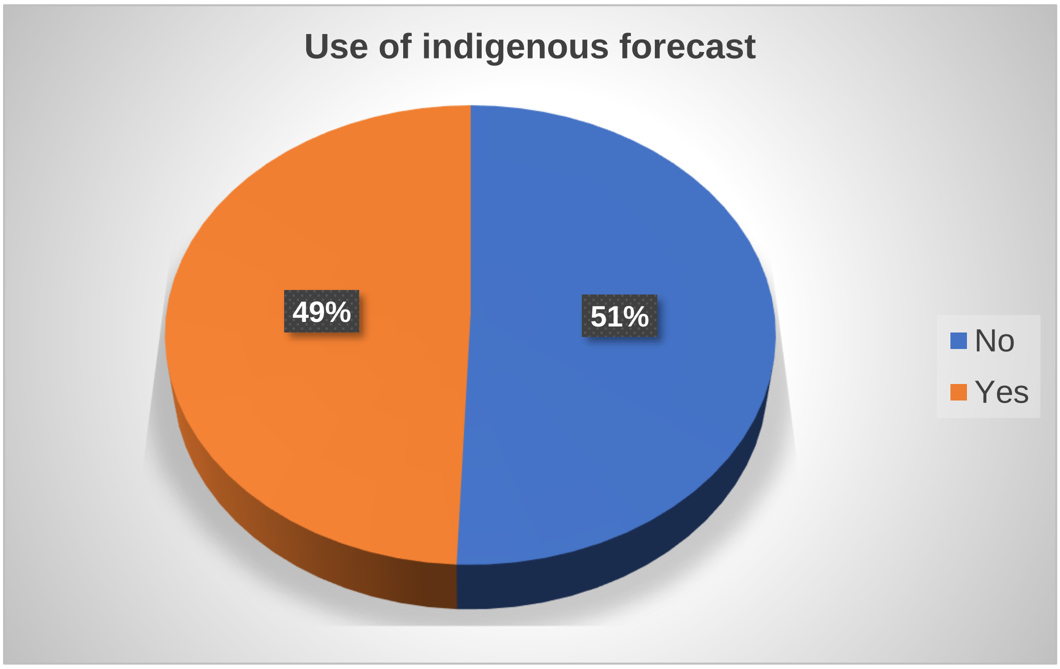

Figure 4.5: Use of indigenous forecast (n=150)

Source: Field survey (2021)

Figure 4.6 above depicts that from 150 sampled small-scale maize farmers, 49% of the respondents use indigenous forecast for climate and 51% of the respondents do not use indigenous forecast for the climate in the study area. Small-scale maize farmers rely on indigenous climate forecasting methods for planning agricultural activities and to cope with climate variability and change (Zievogel *et al*., 2010). Kirui *et al*. (2014), found that older farmers preferred indigenous knowledge over modern climate information services. Hence the use of indigenous forecasts might affect the exposure of the farmers to climate information services.

4.7. Exposure to climate information services

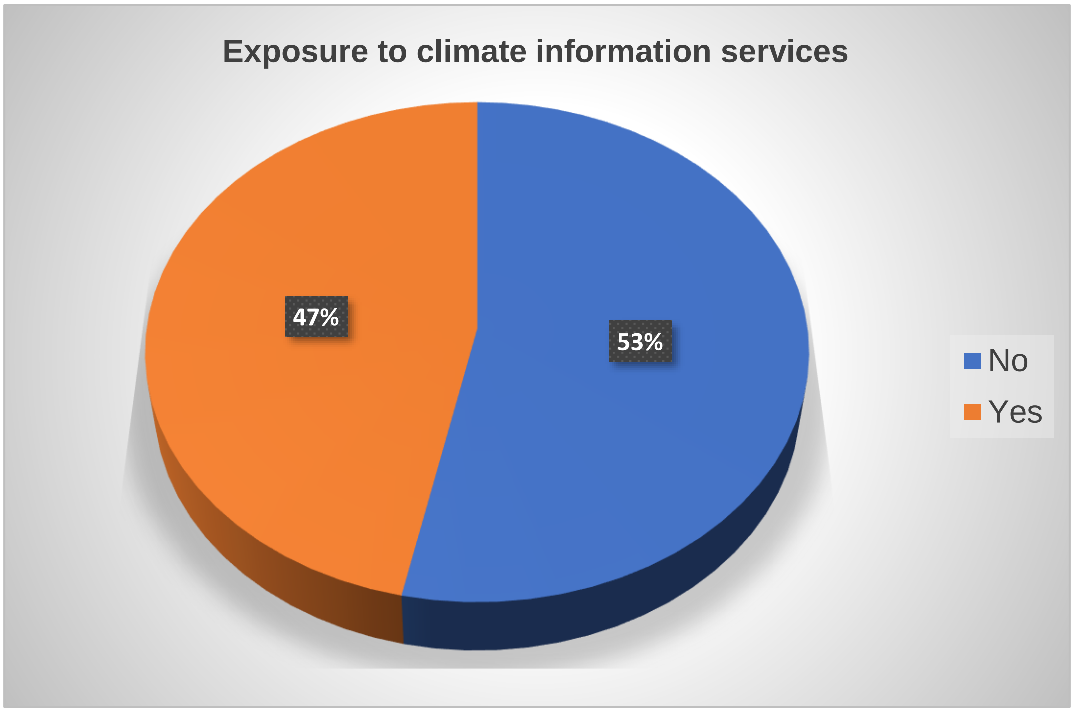

Figure 4.6: Exposure to climate information services (n=150)

Source: Field survey (2021).

Figure 4.7 shows that the majority (53%) of the small-scale maize farmers were not exposed to climate information services whiles (47%) were exposed to climate information services. Climate information is important in mitigating the effects of climate change on agriculture productivity. The majority of the small-scale maize farmers in Makhuduthamaga Local Municipality were not exposed to climate information services because most of them were old. Age is a key factor in determining farmers' accessibility to climate information services, with younger farmers being more likely to access climate information as compared to older farmers (Muema *et al.,* 2018; Kirui *et al.,* 2014).

4.8. Temperature Changes

Table 4.1: Small-scale maize farmers' perception of changes in temperature in Makhuduthamaga Local Municipality.

	Frequency	Percent (%)
Increased	118	78.7
Decreased	5	3.3
Altered climate range/more or less extreme	11	7.3
No change	6	4.0
Don't know	6	4.0
Others	4	2.7
Total	150	100

Sources: Field survey (2021)

Most of the small-scale maize farmers interviewed perceived long-term temperature changes. About 78.7% of the farmers perceive that the temperature in Makhuduthamaga Local Municipality is increasing and 3.3% noticed the contrary, decreasing temperature.

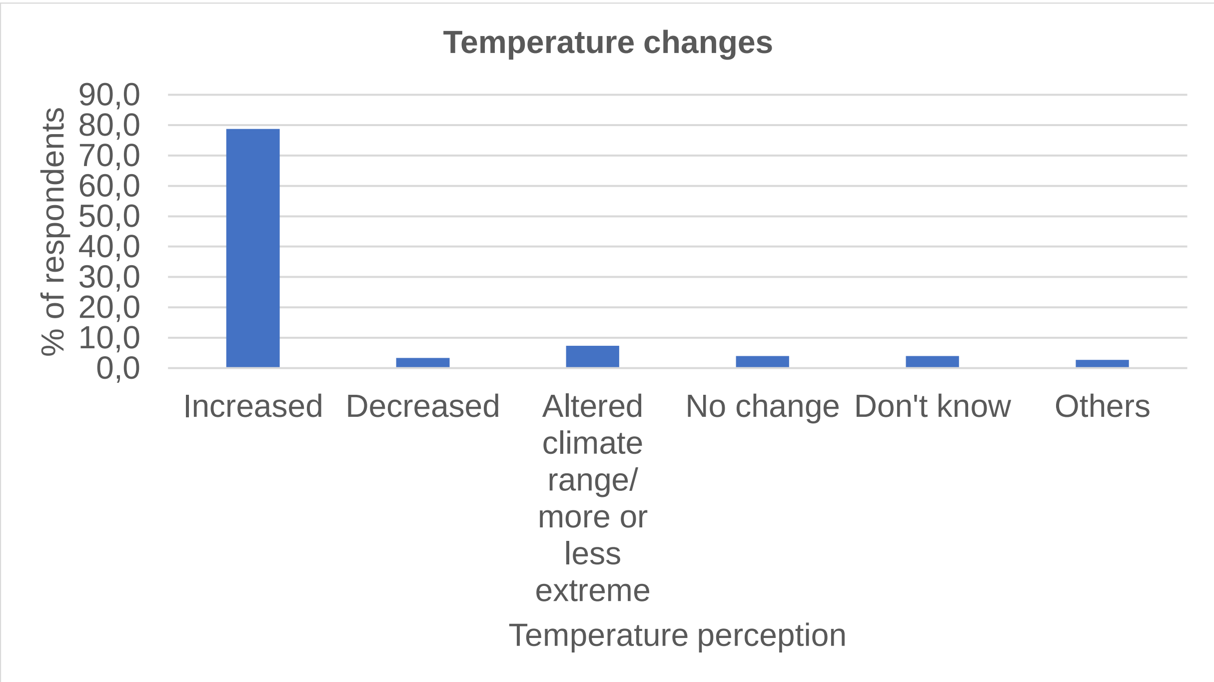

Figure 4.7: Small-scale maize farmers' perception on changes in temperature (n=150)

Source: Field survey (2021)

Figure 4.8 above depicts that from 150 sampled small-scale maize farmers, 78.7% perceive temperature in Makhuduthaga Local Municipality to be increasing, 3.3% perceive the temperature to be decreasing, 7.3% altered climate range (more or less extreme), 4% did not notice a change in temperature, another 4 % did not know if the temperature has increased or decreases and lastly 2.7% was characterised as others.

4.9. Rainfall changes

Table 4.2: Small-scale maize farmers' perception of changes in rainfall in Makhuduthamaga Local Municipality.

	Frequency	Percent (%)
Increased	6	4
Decreased	93	62
Change in timing of rains(earlier/later/erratic)	19	12.7
Change in frequency of droughts/floods	9	6
No change	7	4.7
Don't know	9	6.0
Others	7	4.7
Total	150	100

Source: Field survey (2021)

Most of the small-scale maize farmers interviewed perceived long-term changes in rainfall. About 62% of the farmers perceive that rainfall in Makhuduthamaga Local Municipality is decreasing and 4% noticed the contrary, increasing rainfall.

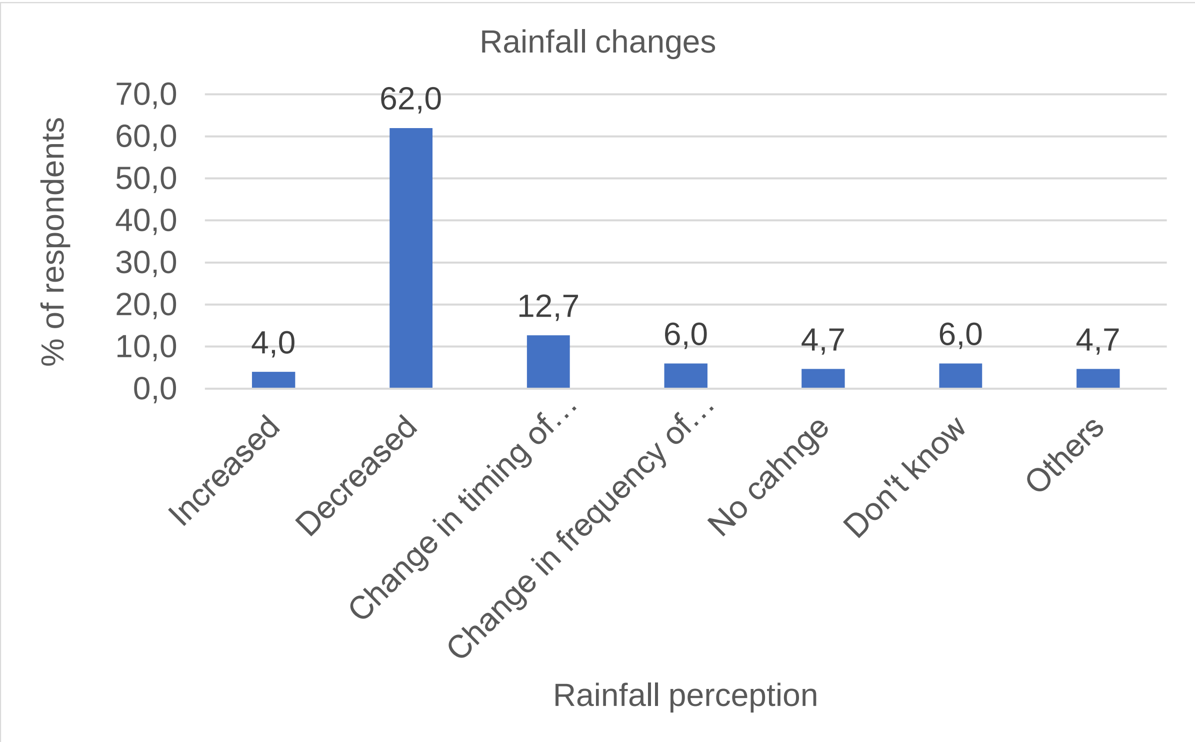

Figure 4. 8: Small-scale maize farmers' perception of changes in rainfall (n=150)

Sources: Field survey (2021)

Figure 4.9 above depicts that from 150 sampled small-scale maize farmers, 4% perceive rainfall in Makhuduthamaga Local Municipality to be increasing, 62% perceive rainfall to be decreasing, 12.7% noticed a change in the timing of rains, 6% noticed a change in frequency of droughts or floods, 4.7% did not notice any change, 6.0% do not know if the rainfall has increased or decreases and lastly 4.7% was characterised as others. Small-scale maize farmers' perception of rainfall changes is important in reducing the climate change impacts as well as increasing the small-scale maize farmers' willingness to pay for changing planting dates in the face of climate change. According to the findings of the study conducted by Ibrahim *et al*. (2019), the majority of the maize farmers (85.33%) perceived that the climatic conditions have changed 14.67% perceived that there was no change in the climatic conditions. The results of the study conducted by Baudoin *et al*. (2014) revealed that most of the farmers noticed a delay in the rainy season by 2 months. Half of the farmers observed erratic rainfalls during the rainy season.

4.10. Small-scale farmers' willingness to pay for changing planting dates

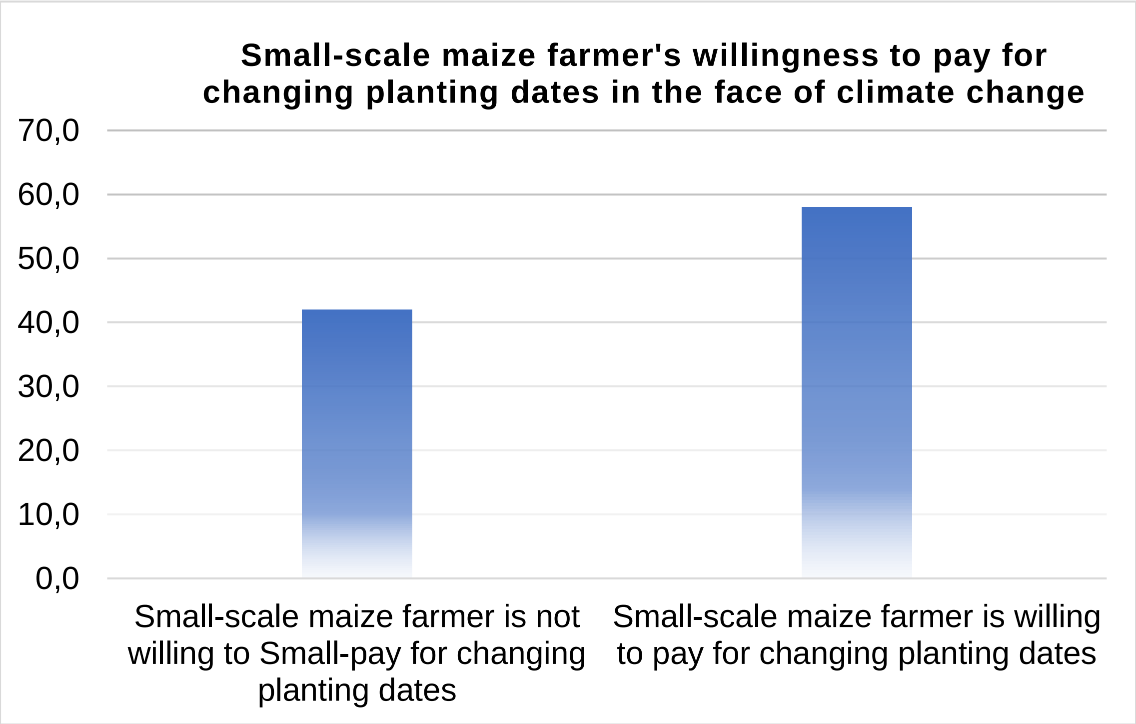

Figure 4.9: Proportion of willingness to pay for changing planting dates in the face of climate change (n=150)

Source: Field survey (2021)

Small-scale maize farmers ‘willingness to pay for changing planting dates is presented in figure 4.10. The table shows that the majority (58%) of the small-scale maize farmers were willing to pay for changing planting dates in the face of climate change whiles (42%) were not willing to pay for changing planting dates. Willingness to pay in this study was defined as the extent to which the small-scale maize farmers are willing to sacrifice in changing planting dates as a result of climate change. In this case, the willingness to pay does not necessarily mean monetary payment. To adapt agriculture to climate change, farmers need to perceive climate change first. Perception is a necessary prerequisite for climate change adaptation (Frank *et al.,* 2011; Tripathi, 2016).

Table 4.3. Frequency table for continuous variables (n=150)

	Total	Minimum	Maximum	Mean	Std. Deviation
Household size	150	1	19	6.53	3.197
Age of the small-scale maize farmer	150	30	88	63.38	15.073
Total income per year	150	10000	500000	91460.69	80617.223
Farm size	150	1	12	2.63	1.77

Source: Field survey (2021)

4.11. Household size

The above table presents the analysis of the household size of the small-scale maize farmers in Makhuduthamaga Local Municipality. From the sample size of 150 small-scale maize farmers, the results show that the maximum house was 19 and the minimum being 1. The average mean is 6.53 implying that most of the households consist of 7 members on average. According to the Living Conditions Survey of Households 2014/2015 Stats SA (2017), the household average size in South Africa was 3.3%, which disagrees with the results of this study as the average household size was found to be 6.53. Household size plays a major role in providing labour force as input for agricultural activities (Balew *et al*., 2014).

4.12. Age

Table 4.2.2 shows the age distribution of farmers in the study area. The ages of the small-scale maize farmers ranged between 30 and 88 years. Most of the small-scale maize farmers were of the adult age group. A study conducted by Maponya (2013) argues that the age of the farmer does not influence climate adaptation methods, but rather the experience of the farmer.

4.13. Total income

The above table represents the analysis of the total yearly income of the small-scale maize farmer. The results show that the minimum total income of the small-scale maize farmer was R10000, the maximum being R500000 per year.

4.14. Farm size

The results of the study indicate that the maximum land size that small-scale maize farmers utilized for maize production is 12 hectares and the minimum land size utilised for maize production is 1 hectare.

4.3. Probit regression model results

In this section, the results of the test for significance and non- significance of the determinants of willingness to pay for changing planting dates in the face of climate change among small-scale maize farmers are shown in Table 4.3. The probit regression model was employed to determine the factors influencing small-scale maize farmers' willingness to pay for changing planting dates in the face of climate change. Empirical results from the probit regression analysis obtained at the Stata package revealed that out of twelve explanatory variable variables, seven were significant. The significant variables include age, years of farming, total output, exposure to climate information services, and use of indigenous forecasts.

Table 4.4. Diagnostic to assess the degree of multicollinearity of sampled small-scale maize farmers in Makhuduthamaga Local Municipality, Limpopo Province (n=150)

Explanatory variable	Collinearity Statistics	
	VIF	1/VIF
Farm size	3.65	0.27
Marital Status	3.00	0.33
Market oriented	1.84	0.54
Age	1.69	0.59
Years of farming	1.59	0.63
Educational level	1.51	0.66
Level of income	1.33	0.75
Exposure to climate information services	1.22	0.82
Household size	1.20	0.83
Total output	1.16	0.86
Gender	1.14	0.88
Use of indigenous forecast	1.13	0.88
Mean VIF	**1.71**	**0.67**

Source: Survey data (2021)

To check for multicollinearity, the variance inflation factor (VIF) was conducted for the above variables. The baseline is that if the variable exceeds 10 then there is a multicollinearity problem. The VIF results for all variables were less than 10 with an average of 1.71 and an inverse variance inflation factor of 0.67. This shows that the above econometric problem did not exist among the variables. The degree of multicollinearity was all assessed using IBM SPSS Version 26.0 package software.

Table 4.5: Probit regression model results

WTPFCPD	dy/dx	Coefficient	Robust Std Err.	Z	P>|z|
Const.		-3.151	2.135	1.00	0.140
Age	0.001	0.479*	0.226	2.111	0.074
Gender	-0.121	0.148	0.228	0.643	0.517
Educational level	-0.148	1.050***	0.332	3.163	0.012
Marital status	-0.014	-0.009	0.019	0.473	0.638
Household size	-0.005	0.039	0.117	0.333	0.918
Market oriented	0.023	-0.202	0.438	0.430	0.666
Years of farming	-0.011	-0.438*	0.113	3.876	0.0001
Total output of maize produced in 2020 (kg)	0.012	2.130***	0.749	2.843	0.019
Level of income	0.281	1.397***	0.472	2.958	0.002
Exposure to climate information services	0.277	0.796**	0.364	2.186	0.029
Use of indigenous forecast	0.262	1.365***	0.508	2.687	0.007
Farm size	0.065	-0.202	0.469	0.430	0.666
Number of observations: 150 Prob > Chi2:0.0000 Wald Chi2 (12): 57.8 Pseudo R-squared: 0.66 Log pseudo likelihood: -65.45 ***,**,* represent 1%, 5% and 10% level of significance respectively					

Source: Stata and Survey data (2021)

4.3.1. Significant variables

4.3.1.1 Age of the small-scale maize farmers

The age of the small-scale maize farmer is statistically significant at 10% level and was found to have a positive effect on the farmers' willingness to pay for changing planting dates in the face of climate change. The age of the small-scale maize farmer contributes positively to farmers' willingness to pay for changing planting dates in the face of climate change with a marginal effect of 0.001. This implies that a unit increase in the age of the small-scale farmer increases the probability of the small-scale maize farmers' willingness to pay for changing planting in the face of climate change by 0.1%. The findings of the study are in line with the results of Hassan and Nhemachena (2008), who found that the age of the household head is positively related to climate change adaptation measures.

4.3.1.2 Educational level of the small-scale maize farmer

The educational level of the small-scale maize farmer is statistically significant at 1% level and was found to have a positive effect on the farmers' willingness to pay for changing planting dates in the face of climate change. The educational level of the small-scale maize farmer contributes positively to farmers' willingness to pay for changing planting dates in the face of climate change with a marginal effect of 0.148. This implies that a unit increase in the educational level of the small-scale farmer increases the probability of the small-scale maize farmers' willingness to pay for changing planting in the face of climate change by 14.8%. The findings are in line with the results of Zongo *et al*. (2016) who found that educational level significantly influences the farmer's willingness to adopt climate change adaptation measures.

4.3.1.3 Level of income of the small-scale maize farmer

Level of income of the small-scale maize farmer is statistically significant at 1% level and was found to have a positive effect on the farmers' willingness to pay for changing planting dates in the face of climate change. The level of income of the small-scale maize farmer contributes positively to farmers' willingness to pay for changing planting dates in the face of climate change with a marginal effect of 0.28. This implies that a unit increase in the level of income of the small-scale farmer increases the probability of the small-scale maize farmers' willingness to pay for changing planting in the face of climate change by 28%. The results are in line with the findings of Hassan and

Nhemachena (2008), who found that income level influence promotes farmers' willingness to adopt climate adaptation measures.

4.3.1.4. Years of farming

The number of years small-scale maize farmer has spent cultivating crops on the farm is considered to be their farming experience. The findings of this study are contrary to the expected outcome in chapter 3 since years of farming of the small-scale maize farmer is statistically significant at 5% and has a negative effect on the farmers' willingness to pay for changing planting dates in the face of climate change. The marginal effect of years of farming was 0.011, implying a unit increase in years of farming of the small-scale maize farmer will decrease the probability of the farmers' willingness to pay for changing planting dates by 1.1 %. The findings of this study are not in line with Hassan and Nhemachena (2008), who argue that the number of years of farming increases the probability of the farmers' willingness to adapt to climate change.

4.3.1.5. Total output of maize produced in 2020 (kg)

Total output is statistically significant at 1% level and was found to have a positive effect on the farmers' willingness to pay for changing planting dates in the face of climate change. This positive effect is the same as expected in chapter 3 since the total output contributes positively toward farmers' willingness to pay for changing planting dates in the face of climate change although with a marginal effect of 0.012. This implies that a unit increase in the total output increases the probability of the small-scale maize farmers' willingness to pay for changing planting in the face of climate change by 1.2%. Mathangu (2016), concluded that there is a positive correlation between farm size and total output in smallholder agriculture. Thus, total output is influenced by the farm size.

4.3.1.6. Exposure to climate information services.

Climate information services are vital tools for climate change adaptation for small-scale farmers in Sub-Saharan Africa (Tall *et al.,* 2014). Climate information is necessary for the projection of short-term climate indicators such as daily, monthly, and seasonal weather forecasts and long-term projections that entail decadal, multi-decadal, and centennial time scales (Wilkinson *et al*., 2015; Singh *et al*., 2016).

The findings of the study reveal that small-scale maize farmers' exposure to climate information services is statistically significant at 1% level and was found to have a positive effect on the farmers' willingness to pay for changing planting dates in the face of climate change. This positive effect is the same as the expected outcome in chapter 3 since small-scale maize farmers' exposure to climate information services contributes positively toward farmers' willingness to pay for changing planting dates in the face of climate change with marginal effects of 0.277. This implies that a unit increase in the exposure to climate information services increases the probability of the small-scale maize farmers' willingness to pay for changing planting in the face of climate change by 27.7%. The findings of this study are in line with the results of Ouédraogo *et al.* (2018), awareness of climate information had a positive effect on the willingness to pay.

4.3.1.7. Use of indigenous forecast.

Small-scale farmers rely on indigenous seasonal forecasts developed from natural indicators (Vogel and Brien, 2006). Indigenous knowledge also referred to as "traditional knowledge, is a body of knowledge built on observation of natural indicators by different communities over a period of time". The information acquired from the use of indigenous weather forecasts is used to make informed decisions in agriculture, medicine, food production and preservation, soil, and water management (Roncoli and Ingram, 2002). This knowledge is passed from generation to generation, and it differs from one community to another. Indigenous climate forecast predicted through observation and interpretation of natural phenomena is among the traditional knowledge that small-scale farmers used. Some small-scale farmers prefer scientific climate forecasts to indigenous forecasts hence, both indigenous and scientific climate forecasts have various strengths and weaknesses. Therefore, a combination of the two is recommended to enhance farmer adaptation to climate change (Russo *et al.,* 2013). Small-scale maize farmers use indigenous forecasts as an endogenous system of climate information. This form of climate forecast guides the small-scale maize farmers on planting dates. Endogenous seasonal climate forecast is determined by moon, cloud, and wind (Mabe *et al.,* 2014)

The findings of the study reveal that small-scale maize farmers' use of indigenous forecast is statistically significant at 1% level and was found to have a positive effect on the farmers' willingness to pay for changing planting dates in the face of climate change. This positive effect is the same as the expected outcome in chapter 3 because the use of indigenous forecast contributes positively to farmers' willingness to pay for changing planting dates in the face of climate change with marginal effects of 0.262 This implies that a unit increase in the use of indigenous forecasts increases the probability of the small-scale maize farmers' willingness to pay for changing planting in the face of climate change by 23,2, 2%.

4.3.2. Insignificant variables.

The results from the probit regression model show that out of twelve explanatory variables five variables were insignificant. The insignificant variables of the model include gender, household size, marital status, farm size, and market orientation of the small-scale maize farmers. These variables are not as important as the significant variable in the study but that does not mean the variables are irrelevant. The variables are insignificant in the study because there is no evidence that supports their impact on the farmers' willingness to pay for changing planting dates in the face of climate change in Makhuduthamaga Local Municipality.

4.4. Hypothesis testing and model fitness.

The log pseudo likelihood ratio of -65.45 in Table 4.3.1 above indicates that the socio-economic characteristics of the small-scale maize farmers affect their willingness to pay for changing planting dates in the face of climate change. Therefore, the null hypothesis, which states that the socio-economic characteristics of small-scale maize farmers in Makhuduthamaga Local Municipality do not affect their willingness to pay for changing planting dates in the face of climate change, is rejected. The model was predicted at 66%. This simply means that 66% of variations of the small-scale maize farmers' willingness to pay for changing planting dates was explained by the included independent variables, whereas the remaining 34% were not explained in the model due to external factors as a result of complexity in human behaviour.

4.5. Chapter summary.

This chapter has provided an overview of the socio-economic characteristics of small-scale maize farmers through descriptive statistics. The socio-economic variables that influence willingness to pay for changing planting dates in the face of climate change among small-scale maize farmers were also presented in this chapter. Moreover, small-scale maize farmers' willingness to pay for changing planting dates in the face of climate change was shown. The following chapter will summarise, conclude, and outline policy and recommendations based on the findings of the study.

CHAPTER 5: SUMMARY, CONCLUSION, AND RECOMMENDATIONS

5.1. Introduction

This chapter reviews the main findings of the study, summarises the discussion on the findings, and makes a conclusion based on the findings from the descriptive and empirical analyses of the study. This chapter also makes recommendations in light of the findings of the study.

5.2. Summary

The research was carried out at Makhuduthamaga Local Municipality from three villages in the Greater Sekhukhune District: Tikathone, Setebong, and Kutupu. The study's goal was to find out what factors influence small-scale maize farmers' willingness to pay for shifting planting dates in the face of climate change in the study area. The study had two goals: the first was to identify and describe the socioeconomic characteristics of small-scale maize farmers in Sekhukhune district, and the second was to identify factors influencing small-scale maize farmers' willingness to pay for changing planting dates in the face of climate change in Makhuduthamaga Local Municipality, Sekhukhune District, Limpopo Province. The study hypothesised that the socio-economic characteristics do not affect the small-scale maize farmer’s willingness to pay for changing planting dates in the face of climate change.

The study used primary data, which was collected using well-structured questionnaires from the sample size of 150 small-scale maize farmers in Makhuduthamaga Local Municipality. Descriptive statistics was used to identify and describe the socio-economic characteristics of small-scale maize farmers in Makhuduthamaga Local Municipality. The descriptive results for the demographic characteristics showed that most of the small-scale maize farmers were 63 years and the majority (60%) of farmers were female. This simply means that most small-scale maize farmers in Makhuduthamaga Local Municipality are females, and the respondents were mostly adults and elderly people, this implies that the majority of youth are not involved in maize farming. The farm size that the farmers utilised during production ranges between 1ha and 12ha. It was further revealed that 25% of the farmers never attended school, 19% have primary education, 22% have secondary education but did not complete matric, 19% matriculated and 15% have tertiary education. This implies that most of the small-scale maize farmers in the study area are literate. The descriptive results showed that the majority (58%) of the small-scale maize farmers were willing to pay for changing planting dates in the face of climate change whiles (42%) were not willing to pay for changing planting dates.

The empirical results revealed that some of the explanatory variables have statistically positive significance, while others have statistically negative significance; however, others were not statistically significant. It was indicated that seven variables were significant including age, educational level, level of income, years of farming, total output, exposure to climate information services, and use of indigenous forecast from twelve explanatory variables included in the model.

5.3 Conclusion

The hypothesis of the study was that the determinant factors do not influence the small-scale maize farmers' willingness to pay for changing planting dates in the face of climate change. The study rejects the null hypothesis that states that small-scale maize farmers in Makhuduthamaga Local Municipality are not willing to pay for changing planting dates in the face of climate change and accepts the alternative hypothesis which states that small-scale maize farmers in Makhuduthamaga Local Municipality are willing to pay for changing planting dates in the face of climate change.

5.4. Recommendations

The following recommendations were made as part of the corrective measures in relation to the findings of the study to improve farmers' willingness to pay for changing planting dates as an adaptive strategy to climate change. The South African government should implement comprehensive support for small-scale maize farmers concerning climate awareness and exposure to climate information strategies. The majority (53%) of the small-scale maize farmers were not exposed to climate information services whiles (47%) were exposed to climate information services. Hence this study recommends an improvement in small-scale maize farmers' exposure to climate information services.

5.4.1 Improvement in education

The educational level of the small-scale maize farmer was found to have a positive significant influence on the farmers' willingness to pay for changing planting dates in the face of climate change. The educational level of the small-scale maize farmers could be enhanced through policy intervention. Thus, it is important that the government invest in education systems to increase small-scale farmers' knowledge about climate change and climate adaptation strategies. This study emphasises the importance of government policies and strategic investment plans that support improved small-scale maize farmers' accessibility to climate forecasting, and research about appropriate farm-level climate adaptation technologies especially in areas where dryland farming currently predominates.

5.4.2 Improvement in income generating activities

The level of income of the small-scale maize farmer was found to have a positive significant influence on the farmers' willingness to pay for changing planting dates in the face of climate change. It is important for government officials to provide small-scale maize farmers with incentives and subsidies such as fertilizers, modified seeds, pesticides, and insecticides that will increase the yield and improve production. Furthermore, expansion in off-farm income generating activities, which will lead to an increase in farmer's level of income should be prioritized.

5.4.3. Increase total output

The empirical results revealed that total output was found to be positively and statistically significant to small-scale maize farmers' willingness to pay for changing planting dates in the face of climate change. It was outlined in the literature that total output is influenced by farm size. It is important that the government provide agricultural training to the farmers through workshops, farmers weekly, and support groups where small-scale maize farmers will be provided with the necessary training to improve their knowledge and skills on how to better their agricultural production.

5.4.4. Years of farming

The empirical results showed that years of farming was found to be negatively statistically significant which implies that it decreases the probability of the small-scale maize farmers' willingness to pay for changing planting dates in the face of climate change. Most of the experienced small-scale maize farmers are old, hence they are reluctant to adopt scientific climate adaptation measures since they make production decisions based on their previous knowledge. The study, therefore, recommends that government officials must assist small-scale maize farmers through climate change awareness and educate them about weather patterns and climate change adaptation strategies.

5.4.5 Improvement in climate change awareness

The use of indigenous climate forecast was found to be positively and statistically significant to small-scale maize farmers' willingness to pay for changing planting dates in the face of climate change. There is a need for small-scale maize farmers to be taught about scientific climate forecasts. The study, therefore, recommends that government officials must assist small-scale maize farmers through climate change awareness and educate them about weather patterns so that they will be able to know when to produce.

5.4.6. Improvement in climate information services

Exposure to climate information services was found to be positively and statistically significant to small-scale maize farmers' willingness to pay for changing planting dates in the face of climate change. This implies that some of the small-scale maize farmers were exposed to climate information services. The study, therefore, recommends that there should be policies designed to address the dissemination of climate information among small-scale maize farmers. Climate information services delivery should be tailored to meet the needs of different socioeconomic groups including male and female small-scale maize farmers that may need such information for adaptation purposes.

5.4. Area of further study

The study focused on the factors influencing small-scale maize farmers' willingness to pay for changing planting dates in the face of climate change. The recommendations regarding this study were outlined for further studies, which will assist in broadening the study in the future.

This study was mainly focused on small-scale maize farmers of Makhuduthamaga Local Municipality in Sekhukhune District of Limpopo Province. These farmers do not necessarily represent the total population of small-scale maize farmers in South Africa, hence, generalising the results might not be possible. A study can be conducted based on the whole district, Limpopo Province as well as all nine provinces of South Africa that have small-scale maize farmers, since the results of this study focused solely on farmers at Makhuduthamaga Local Municipality.

There are other relevant issues to climate change that are not addressed in this study. Hence, there are areas for further research that need to be considered in the future: Since the focus of this study was on farmers' willingness to pay for changing planting dates as an adaptation strategy to climate change, there is a need for research on farmers willingness to pay for other climate change adaptation strategies as well as mitigation strategies in Makhuduthamaga Local Municipality.

REFERENCES

Abid, M., Scheffran, J., Schneider, U.A., Elahi, E., (2019). Farmer perceptions of climate change observed trends and adaptation of agriculture in Pakistan. Environ. Manag. 63 (1), 110-123.

Acquah, H.D.G., (2011). Farmer's perception and adaptation to climate change: A willingness to pay analysis.

Ade´gnandjou, M. R. F., & Barjolle, D. (2018). Farmers' adaptation strategies to climate change and their implications in the Zou Department of South Benin. Environments, 5, 15–24

Agovino, M., Casaccia, M., Ciommi, M., Ferrara, M. and Marchesano, K., (2019). Agriculture, climate change and sustainability: The case of EU-28. *Ecological Indicators*, *105*, pp.525-543.

Ahmad, I., Ahmad, B., Boote, K., Hoogenboom., G. (2020). Adaptation strategies for maize production under climate change for semi-arid environments. *European journal of Agronomy. 115(2020)*

Alam, M.M., Siwar, C., Talib, B.A. and Wahid, A.N., (2017). Climatic changes and vulnerability of household food accessibility. International Journal of Climate Change Strategies and Management.

Amare, A. and Simane, B., (2017). Determinants of smallholder farmers' decision to adopt adaptation options to climate change and variability in the Muger Sub basin of the Upper Blue Nile basin of Ethiopia. *Agriculture & food security*, *6*(1), pp.1-20.

Anderson, R., Bayer, P.E. and Edwards, D., (2020). Climate change and the need for agricultural adaptation. *Current opinion in plant biology*.

Arbuckle Jr., J.G., Morton, L.W., Hobbs, J., (2013). Farmer beliefs and concerns about climate change and attitudes toward adaptation and mitigation: evidence from Iowa. Climatic Change 118 (3-4), 551-563

Bain, P. G., Hornsey, M. J., Bongiorno, R., & Jeffries, C. (2012). Promoting pro-environmental action in climate change deniers. Nature Climate Change, 2(8), 600–603

Balew, S., Agwata, J., & Anyango, S. (2014). Determinants of adoption choices of climate change adaptation strategies in crop production by small scale farmers in some Region of Central Ethiopia. Journal of Natural Sciences Research, 4(4), 1–16.

Baloyi, R. T. Belete, A., Hlongwane, J.J., and Masuku, M. B. 40 (2012). Technical efficiency in maize production by small-scale farmers in Ga-Mothiba of Limpopo province, South Africa. African Journal of Agricultural Research 7, pp. 478-5482.

Baudoin, M.A., Sanchez, A.C. and Fandohan, B., (2014). Small scale farmers' vulnerability to climatic changes in southern Benin: the importance of farmers' perceptions of existing institutions. *Mitigation and Adaptation Strategies for Global Change*, *19*(8), pp.1195-1207

Brown, T.C. and Gregory, R., (1999). Why the WTA–WTP disparity matters. *Ecological economics*, *28*(3), pp.323-335.

Bureau for Food and Agricultural Policy (BFAP). (2016). BFAP Baseline: Agricultural outlook 2016-2025. Pretoria: Bureau for food and agricultural policy.

Carr, E.R. and Thompson, M.C., (2014). Gender and climate change adaptation in agrarian settings: Current thinking, new directions, and research frontiers. *Geography Compass*, *8*(3), pp.182-197.

Challinor, A. J., Watson, J., Lobell, D. B., Howden, S. M., Smith, D. R., & Chhetri, N. (2014). A meta-analysis of crop yield under climate change and adaptation. *Nature Climate Change*, 4(4), 287–291.

Dai, A, Trenberth, K. E, & Qian T. (2004): A Global Dataset of Palmer Drought Severity Index for 1870-2002: Relationship with Soil Moisture and Effects of Surface Warming. Journal of Hydrometeorology, 5: 1117-1130.

DEA. Long-Term Adaptation Scenarios Flagship Research Programme (LTAS) for South Africa. Pretoria, South Africa: Department of Environmental Affairs; 2013.

Denkyirah, E.K., Okoffo, E.D., Adu, D.T. and Bosompem, O.A., (2017). What are the drivers of cocoa farmers' choice of climate change adaptation strategies in Ghana? *Cogent Food & Agriculture*, *3*(1), p.1334296

Department of Agriculture, Forestry and Fisheries (DAFF). (2016b). Trends in the agricultural sector 2015. Pretoria: Government printers.

Department of Agriculture, Land Reform and Rural Development, (2017). A profile of maize.

Department of Water Affairs and Forestry (2002) National Eutrophication Monitoring Programme: Implementation Manual. 201 pp

Deressa, T.T., Hassan, R.M., and Ringler, C. (2011). Perception of and adaptation to climate change by farmers in the Nile basin of Ethiopia, *Journal of Agricultural Science*, 149: 23–31.

Dethier, J.J. and Effenberger, A., (2012). Agriculture and development: A brief review of the literature. *Economic systems*, *36*(2), pp.175-205.

Dharmarathna, W.R.S.S., Herath, S., and Weerakoon, S.B., (2014). Changing the planting date as a climate change adaptation strategy for rice production in Kurunegala district, Sri Lanka. *Sustainability science*, *9*(1), pp.103-111.

Djoudi, H., Locatelli, B., Vaast, C., Asher, K., Brockhaus, M. and Basnett Sijapati, B., (2016). Beyond dichotomies: Gender and intersecting inequalities in climate change studies. *Ambio*, *45*(3), pp.248-262.

DWAF: (1996), Draft of South African Water Quality Guidelines. Volume 7: Aquatic Ecosystems, Department of Water Affairs and Forestry, Pretoria.

Ebi KL, Padgham J, Doumbia M et al (2011) Smallholder adaptation to climate change in Mali. Clim Chang 108(3):423–436.

EnviroGIS. (2009). Crop Suitability, Crop Rotation Scheduling and Land Use Planning: Nebo Agricultural Hub. EnviroGIS Pty Ltd, Pretoria.

Esham, M., Garforth, C., (2013). Agricultural adaptation to climate change: insights from a farming community in Sri Lanka. Mitig. Adapt. Strategies Glob. Change 18 (5), 535-549.

Fernando, R. (2011). Logit, Probit and Tobit: Models for Categorical and Limited Dependent Variables: PLCS/RDC Statistics and Data Series at Western.

FCCC, U., (2007). Impacts, Vulnerabilities and Adaptation in Developing Countries. In *UN FCCC-United Nations Framework Convention on Climate Change. Bonn*.

Frank, E., Eakin, H., & López-Carr, D. (2011). Social identity, perception, and motivation inadaptation to climate risk in the coffee sector of Chiapas, Mexico. *Global Environmental Change*, 21(1), 66- 76.

Gbetibouo, G.A., Ringler, C. and Hassan, R., (2010), August. Vulnerability of the South African farming sector to climate change and variability: An indicator approach. In *Natural resources forum* (Vol. 34, No. 3, pp. 175-187). Oxford, UK: Blackwell Publishing Ltd.

Guernier V, Hochberg M E, Guegan J-F. (2004). Ecology drives the worldwide distribution of human diseases. PLOS Biology. Oxford. 2(6): pp. 740 – 746.

Gosnell, H., Gill, N., Voyer, M., (2019). Transformational adaptation on the farm: processes of change and persistence in transitions to 'climate-smart' regenerative agriculture. Global Enviro. Change 59.101965

Guo, R., Li, Y., Shang, L., Feng, C. and Wang, X., (2021). Local farmer's perception and adaptive behavior toward climate change. *Journal of Cleaner Production*, *287*, p.125332.

Harris, R., (2010). Gender aspects of climate change in the US gulf coast region. Gender and Climate Change: An Introduction. Earth scan, London, pp. 152–157.

Hassan, R., Nhemachena, C., (2008). Determinants of African farmers' strategies for adapting to climate change: multinomial choice analysis. African Journal of Agricultural and Resource Economics 2 (1), 83–104.

Ibrahim, N., Mensah, K.T., Alhassan, H., Adzawla, W. and Adjei-Mensah, C., (2019). Analysis of smallholder farmers 'perceptions on climate change, preference and willingness-to-pay for seasonal climate forecasts information in savelugu municipality, Ghana.

Ingram, K.T., Roncoli, M.C. and Kirshen, P.H. (2002). Opportunities and constraints for farmers of West Africa to use seasonal precipitation forecasts with Burkina Faso as acase study. Agricultural Systems, 74, 331–349.

IPCC (Intergovernmental Panel on Climate Change), (2001). Climate Change: The Scientific Basis. http://www.ipcc.ch (Accessed June 2006).

IPCC. (2007). Climate Change 2007: Synthesis Report. Contribution of Working Group I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.

IPCC (2007b). Summary for Policymakers. In, S. Solomon, D. Qin, M. Manning, Z. Chen, M.Marquis, K.B. Averyt, M. Tignor and H.L. Miller (Eds.). Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK and New York, NY, USA.

Jamshidi, O., Asadi, A., Kalantari, K., Azadi, H. and Scheffran, J., (2019). Vulnerability to climate change of smallholder farmers in the Hamadan province, Iran. *Climate Risk Management*, *23*, pp.146-159.

Kaijser, A. and Kronsell, A., (2014). Climate change through the lens of intersectionality. *Environmental politics*, *23*(3), pp.417-433.

Kirui, V.C., Waiganjo, M. and Cheplogoi, S., (2014). Evaluating access and use of dissemination pathways for delivering climate information and services to women farmers in semiarid Kenya. *International Journal of Advanced Research*, *2*(9), pp.44-53.

Knox, J., Hess, T., Daccache, A., & Wheeler, T. (2012). Climate change impacts on crop productivity in Africa and South Asia. *Environmental Research Letters,* 7(3), 034032. https://doi.org/10.1088/1748-9326/7/3/034032

Kom, Z., Nethengwe, N.S., Mpandeli, N.S. and Chikoore, H., (2020). Determinants of small-scale farmers' choice and adaptive strategies in response to climatic shocks in Vhembe District, South Africa. *GeoJournal*, pp.1-24.

Lobell, D. B., Burke, M. B., Tebaldi, C., Mastrandrea, M. D., Falcon, W. P., & Naylor, R. L. (2008). Prioritizing climate change adaptation needs for food security in 2030. Science, 319(5863), 607–610.

Lobell, D.B., Roberts, M.J., Schlenker, W., Braun, N., Little, B.B., Rejesus, R.M. and Hammer, G.L., (2014). Greater sensitivity to drought accompanies maize yield increase in the US Midwest. *Science*, *344*(6183), pp.516-519.

Mabe, F.N., Nketiah, P. and Darko, D., (2014). Farmers' willingness to pay for weather forecast information in savelugu-nanton municipality of the northern region. *Russian Journal of Agricultural and Socio-Economic Sciences*, *36*(12), pp.34-44.

Mangani, R., Tesfamariam, E., Bellocchi, G. and Hassen, A., (2018). Modelled impacts of extreme heat and drought on maize yield in South Africa. *Crop and Pasture Science*, *69*(7), pp.703-716.

Maponya, P. I. (2013). Climate change and agricultural production in Limpopo: Impacts and adaptation options (PhD thesis, P.108) Environmental Management, University of South Africa, Pretoria, South Africa

Maponya, P., & Mpandeli, S. (2013). Coping with climate change variability in Limpopo province, South Africa. Peak Journal of Agricultural Science, 4, 54–64.

Mathangu, H.T. (2016). Market Participation of Smallholder Sunflower Farmers in Sekhukhune District of Limpopo Province, South Africa. MSc Thesis. Turfloop: University of Limpopo.

McOmber, C., Panikowski, A., McKune, S., Bartels, W. and Russo, S. (2013). Investigating Climate Information Services through a Gendered Lens. CCAFS Working Paper no. 42, CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Copenhagen, Denmark. Available online at www.ccafs.cgiar.org

Mensah E., Kyei-Baffour N., Ofori E., Obeng G. (2009) Influence of Human Activities and Land Use on Heavy Metal Concentrations in Irrigated Vegetables in Ghana and Their Health Implications. In: Yanful E.K. (eds) Appropriate Technologies for Environmental Protection in the Developing World. Springer, Dordrecht.

Moeletsi, M.E. and Walker, S., (2012). Rainy season characteristics of the Free State Province of South Africa with reference to rain-fed maize production. *Water SA*, *38*(5), pp.775-782.

Mokone, N.W. (2016). Economic Contribution of Backyard Gardens in Alleviating Poverty in the Rural Communities of Bojanala Platinum District Municipality in

Mpandeli, S., Nesamvuni, E. and Maponya, P. (2015). Adapting to the Impacts of Drought by Smallholder Farmers in Sekhukhune District in Limpopo Province, South Africa. Journal of Agricultural Science, Vol.7 (2). North West Province. MSc Thesis. Pretoria: University of South Africa

Muema, E., Mburu, J., Coulibaly, J., Mutune, J., (2018). Determinants of access and utilisation of seasonal climate information services among smallholder farmers in Makueni County, Kenya. Heliyon 4 (11), 00889.

National Agricultural Marketing Council (NAMC), (2020). Agricultural sector contribution to South Africa's Gross Domestic Product (GDP)

Naveenkumar, K.L., Sen, D. and Khanna, V.K., (2018). Effect of Maize Production in a Changing Climate: Its Impacts, Adaptation, and Mitigation Strategies through Breeding. *Open Access Journal of Oncology and Medicine*, *2*(4), p.2018.

Ndambiri, H.K., Ritho, C.N. and Mbogoh, S.G., (2013). An evaluation of farmers' perceptions of and adaptation to the effects of climate change in Kenya

Nema, P., Nema, S. and Roy, P., (2012). An overview of global climate changing in current scenario and mitigation action. *Renewable and Sustainable Energy Reviews*, *16*(4), pp.2329-2336

Nhemachena, C., & Hassan, R. M. (2007). Micro-level analysis of farmers' adaptations to climate change in Southern Africa. IFPRI Discussion Study No 714, Washington D.C, IFPRI.

Nkoana, M.A., Cholo, M.S., Hlongwane, J.J. and Belete, A., (2019). Determinants of households' willingness to pay for water and electricity in Moletjie under Aganang municipality, Limpopo province, South Africa. *Journal of Agribusiness and Rural Development*, (1 [51]).

Ntanos, S., Kyriakopoulos, G., Chalikias, M., Arabatzis, G., Skordoulis, M., Galatsidas, S., Drosos, D., (2018b). A social assessment of the usage of renewable energy sources and its contribution to life quality: the case of an attica urban area in Greece. Sustainability 10 (5), 1414

Nuss, E.T. and Tanumihardjo, S.A., (2010). Maize: a paramount staple crop in the context of global nutrition. *Comprehensive reviews in food science and food safety*, *9*(4), pp.417-436.

OECD, (2016a). Agriculture and Climate Change: Towards Sustainable, Productive and Climate-Friendly Agricultural Systems. OECD Meeting of Agriculture Ministers, Bachground note.

Ouédraogo, M., Barry, S., Zougmoré, R.B., Partey, S.T., Somé, L. and Baki, G., (2018). Farmers' willingness to pay for climate information services: Evidence from cowpea and sesame producers in Northern Burkina Faso. *Sustainability*, *10*(3), p.611.

Palinkas, L.A., Horwitz, S.M., Green, C.A., Wisdom, J.P., & Duan, N. (2015). Purposeful Sampling for Qualitative Data Collection and Analysis in Mixed Method Implementation Research. Springer Science & Business Media: New York. 42(5):533-44.

Park, M., Hagishima, A., Tanimoto, J., & Chun, C. (2013). Willingness to pay for improvements in environmental performance of residential buildings. Building and Environment, 60, 225

Pienaar, R., Neitz, A.W. and Mans, B.J., (2018). Tick paralysis: solving an enigma. *Veterinary Sciences*, *5*(2), p.53.

Porwollik, V., Müller, C., Elliott, J., Chryssanthacopoulos, J., Iizumi, T., Ray, D.K., Ruane, A.C., Arneth, A., Balkovič, J., Ciais, P. and Deryng, D., (2017). Spatial and temporal uncertainty of crop yield aggregations. *European Journal of Agronomy*, *88*, pp.10-21.

Rao, C.R., Raju, B.M.K., Rao, A.S., Rao, K.V., Rao, V.U.M., Ramachandran, K., Venkateswarlu, B., Sikka, A.K., Rao, M.S., Maheswari, M. and Rao, C.S., (2016). A district level assessment of vulnerability of Indian agriculture to climate change. *Current Science*, pp.1939-1946.

Rurinda, J., van Wijk, M.T., Mapfumo, P., Descheemaeker, K., Supit, I. and Giller, K.E., (2015). Climate change and maize yield in southern Africa: what can farm management do? *Global change biology*, *21*(12), pp.4588-4601.

Shiferaw, B., Prasanna, B.M., Hellin, J. and Bänziger, M., (2011). Crops that feed the world 6. Past successes and future challenges to the role played by maize in global food security. *Food security*, *3*(3), pp.307-327.

Simiyu, S.W., (2014). *Factors influencing maize production among small scale Farmers in Kenya, A caseof Bungoma central sub county* (Doctoral dissertation).

Singh, C., P. Urquhart, and E. Kituyi. (2016). From pilots to systems: Barriers and Enablers to Scaling Up the Use Of Climate Information Services In Smallholder Farming Communities. CARIAA Working Paper no. 3. International Development Research Centre, Ottawa, Canada and UK Aid, London, United Kingdom. Available online atwww.idrc.ca/cariaa. ISSN: 2292-

Statistics South Africa (StatsSA)., (2011). Census 2011 Statistical Release P0301.4, Pretoria, Statistics South Africa.

Statistics South Africa (Stats SA). (2015b). Quarterly Labour Force Survey: Quarter 3 2015. Pretoria: Government printers.

Stern, R., Asari, A.A. and Sugahara, K.N., 2006. Hyaluronan fragments: an information-rich system. *European journal of cell biology*, *85*(8), pp.699-715.

Statista., (2019) South Africa: Distribution of gross domestic product (GDP) across economic sectors from 2009 to 2019[Online]. Available at https://www.statista.com/statistics/371233/south-africa-gdp-distribution-across-economic-sectors/

Stocker, T.F., Qin, D., Plattner, G.K., Alexander, L.V., Allen, S.K., Bindoff, N.L., Bréon, F.M., Church, J.A., Cubasch, U., Emori, S. and Forster, P., (2013). Technical summary. In *Climate change 2013: the physical science basis. Contribution of*

Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (pp. 33-115). Cambridge University Press.

Tall, A., Hansen, J., Jay, A., Campbell, B., Kinyangi, J., Aggarwal, P.K. and Zougmore, R. (2014). Scaling up climate services for farmers: Mission Possible. Learning from good practice in Africa and South Asia. CCAFS Report No. 13. Copenhagen: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Available online at www.ccafs.cgiar.org

Tanumihardjo, S.A., McCulley, L., Roh, R., Lopez-Ridaura, S., Palacios-Rojas, N. and Gunaratna, N.S., (2020). Maize agro-food systems to ensure food and nutrition security in reference to the Sustainable Development Goals. *Global Food Security*, *25*, p.100327

Tripathi, A., (2016). How to encourage farmers to adapt to climate change? *Delhi: Institute of Economic Growth*.

Trenberth, K.E., Jones, P.D., Ambenje, P., Bojariu, R., Easterling, D., Tank, A.K., Parker, D., Rahimzadeh, F., Renwick, J.A., Rusticucci, M. and Soden, B., (2007). Observations: surface and atmospheric climate change. Chapter 3. Climate change, pp.235-336.

Truelove, H.B., Carrico, A.R., Thabrew, L., (2015). A socio-psychological model for analyzing climate change adaptation: a case study of Sri Lankan paddy farmers. Glob. Environ. Change-Human Pol. Dimensions 31, 85-97.

Ubisi, N.R., Mafongoya, P.L., Kolanisi, U. and Jiri, O., (2017). Smallholder farmer's perceived effects of climate change on crop production and household livelihoods in rural Limpopo province, South Africa. *Change and Adaptation in Socio-Ecological Systems*, *3*(1), pp.27-38.

UNFCCC (2011). Application of methods and tools for assessing impacts and vulnerability and developing adaptation responses. Background paper by the UNFCCC Secretariat. FCCC/SBSTA/2011/INF.13. UNFCCC, Bonn, Germany.

Van Aelst, K. and Holvoet, N., (2016). Intersections of gender and marital status in accessing climate change adaptation: Evidence from rural Tanzania. *World development*, *79*, pp.40-50.

Van Averbeke, W., (2013). 1 Improving smallholder canal irrigation in Vhembe: Setting the research agenda. *Obtainable from*, p.1.

Vogel1, C. and O ‘Brien, K. (2006). Who can eat information? Examining the effectiveness of seasonal climate forecasts and regional climate-risk management strategies. Climate research, Vol. 33, 111–122.

Wale, E., Nkoana, M.A. and Mkuna, E., (2022). Climate change-induced livelihood adaptive strategies and perceptions of forest-dependent communities: The case of Inanda, KwaZulu-Natal, South Africa. *Trees, Forests and People*, *8*, p.100250.

Wiebe, K., Robinson, S., Cattaneo, A. (2019). Climate change, agricultural and food security: impacts and the potential for adaptation and mitigation. *Sustainable Food and Agriculture, Elsevier. Pp.55-74*

Wilkinson, E., Budimir, M., Ahmed, A. K., and Ouma, G. (2015). Climate information andservices in BRACED countries, (1), 1–20

Wreford, A., Ignaciuk, A. and Gruère, G., (2017). Overcoming barriers to the adoption of climate-friendly practices in agriculture.

Zhang, K., Kimball, J.S., Nemani, R.R., Running, S.W., Hong, Y., Gourley, J.J. and Yu, Z., (2015). Vegetation greening and climate change promote multidecadal rises of global land evapotranspiration. *Scientific reports*, *5*(1), pp.1-9.

Ziervogel, G.; Opere, A. Integrating meteorological and indigenous knowledge-based seasonal climate forecasts in the agricultural sector: Lessons from participatory action research in sub-Saharan Africa. Clim. Chang. Adapt. Afr. Learn. Pap. Ser. 2010, 1, 1–24.

Ziervogel, G., New, M., Archer van Garderen, E., Midgley, G., Taylor, A., Hamann, R., Stuart-Hill, S., Myers, J. and Warburton, M., (2014). Climate change impacts and adaptation in South Africa. *Wiley Interdisciplinary Reviews: Climate Change*, *5*(5), pp.605-620.

Zongo, B., Diarra, A., Barbier, B., Zorom, M., Yacouba, H. and Dogot, T., (2016). Farmers' perception and willingness to pay for climate information in Burkina Faso.

APPENDIX A: ETHICAL CLEARANCE

University of Limpopo
Department of Research Administration and Development
Private Bag X1106, Sovenga, 0727, South Africa
Tel: (015) 268 3935, Fax: (015) 268 2306, Email: anastasia.ngobe@ul.ac.za

TURFLOOP RESEARCH ETHICS COMMITTEE

ETHICS CLEARANCE CERTIFICATE

MEETING: **09 November 2021**

PROJECT NUMBER: **TREC/270/2021: PG**

PROJECT:

Title:	Small-Scale Maize Farmers' Willingness to Pay for Changing Planting Dates in the Face of Climate Change: A Case Study of Makhuduthamaga Local Municipality, Limpopo Province
Researcher:	LL Tau
Supervisor:	Dr M.A Nkoana
Co-Supervisor/s:	Prof J.J Hlogwane
School:	Agricultural and Environmental Sciences
Degree:	MSc Agric (Agricultural Economics)

PROF P MASOKO
CHAIRPERSON: TURFLOOP RESEARCH ETHICS COMMITTEE

The Turfloop Research Ethics Committee (TREC) is registered with the National Health Research Ethics Council, Registration Number: **REC-0310111-031**

Note:

i) **This Ethics Clearance Certificate will be valid for one (1) year, as from the abovementioned date. Application for annual renewal (or annual review) need to be received by TREC one month before lapse of this period.**

ii) **Should any departure be contemplated from the research procedure as approved, the researcher(s) must re-submit the protocol to the committee, together with the Application for Amendment form.**

iii) **PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES.**

Finding solutions for Africa

APPENDIX B: QUESTIONNAIRE

QUESTIONNAIRE SURVEY

UNIVERSITY OF LIMPOPO

FACULTY OF SCIENCE AND AGRICULTURE

DEPARTMENT OF AGRICULTURAL ECONOMICS AND ANIMAL PRODUCTION

PROJECT: SMALL-SCALE MAIZE FARMERS' WILLINGNESS TO PAY FOR CHANGING PLANTING DATES IN THE FACE OF CLIMATE CHANGE: A CASE STUDY OF MAKHUDUTHAMAGA LOCAL MUNICIPALITY, LIMPOPO PROVINCE

RESPONDENT IDENTIFICATION

QUESTIONNAIRE PARTICULARS	
Enumerator's name	
Respondent's name	
Date	
Village/Area	
Questionnaire reference number	
Contact details	

Instructions: Please mark with an X if you agree or not to complete the questionnaire. I do not wish to complete the questionnaire ____

I agree to complete the questionnaire and do so in a completely voluntary manner. I understand that my responses will be kept confidential. ______Signature ______________Date __________

SECTION A: FARMER'S CHARACTERISTCS

1. What is the name of the small-scale maize farmer?

....

2. SMALL-SCALE MAIZE FARMER'S KEY SOCIO-ECONOMIC CHARACTERISTICS

Household Size	Marital status	Gender 1= male 2=female	Age	Highest level of formal education	Employment status

Key: Use the codes mentioned in the table below to answer the table above.

Marital status	Highest level of formal education	Employment status
1 Married 2 Single 3 Divorced 4 Widowed	1 Never attended school 2 Primary level 3 Secondary level but did not complete matric 4 Matriculated 5 Tertiary level	1 Unemployed 2 Permanent employment 3 Temporarily employment 4 Contract employment

3. farmers' income in the previous year

3.1 What are your major income sources? Please rank these according to their importance, where one (1) represents the most important

Farmers' income sources	Please tick	Rank
Crop production		
Forest resources		
Livestock production		
Pensions		
Employment		
Gifts from relatives		
Social grants		

Off-farm income		
Other: specify		

3.2 **Other income sources per month in the previous year and please tick**

Farm income (R)		**Remittances (Gifts) (R)**		**Child social grants (R)**		**Employment (wages and salaries) (R)**		**Pensions (R)**		**Disability grant**		**Other specify …………………………….**	
<500		<500		<300		<1000		<1000		<700		<500	
500-1000		500-700		300-500		1000-1500		1000-2000		700-1200		500-800	
1001-1500		701-900		501-800		1501-2000		2001-3000		1201-1700		801-1100	
1501-2000		901-1200		801-1100		2001-2500		3001-4500		1701-2200		1001-1400	
2501-3000		1201-1500		1101-1400		2501-4000		4501-5500		2201-2700		1401-1700	
>3000		>1500		>1400		>4000		>5500		>2700		>1700	

3.3 Estimated total farmers ‘income per year **…………………………………. (R)**

SECTION B: MAIZE PRODUCTION AND CLIMATE CHANGE

1. How many hectares do you utilize for maize production?

…………………………………………………………………………………………..

2. For how long have you been producing maize?

…………………………………………………………………………………………..

3. How much output do you normally produce on a yearly basis?

………………………………………………………………………………………………….

4. What is the main reason for producing maize?

Consumption	Commercial purposes	Income generation	Other Specify………….

5. Do you sell your produce to the market?

Yes	No

5.1 if yes, what form of the market?

Formal market	Informal market

6. Do you have access to market information?

Yes	No

7. If yes, what is the source of market information

…………………………………………………………………………………………………..

8. Are you exposed to climate information services?

Yes	No

9. If yes, what is the source of information?

…………………………………………………………………………………………………

10. Do you use indigenous ways to forecast climate?

Yes	No

11. If yes, how do you forecast climate using indigenous ways?

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

SECTION C: PERCEPTIONS OF SMALL-SCALE MAIZE ABOUT CLIMATE CHANGE AND ITS IMPACTS ON AGRICULTURAL PRODUCTION

1. Do you really think climate is changing? Climate change will be well explained to those small-scale farmers who do not really understand ‘’what climate change is” by enumerators.

Strongly disagree=1	Disagree =2	Uncertain= 3	Agree =4	Strongly agree =5

2. Small-scale maize farmers’ perceptions of change in temperature (cold and heat) on farming/ agriculture over the last 30 years

1Yes	0 No

2.1 Have you noticed an increase in abnormal temperature in your area over the last 30 years?

2.2 Have the number of abnormal hot days increased or decreased or stayed the same during summer in your area over the past 30 years? …

Increased	Decreased	Change in timing of rains (earlier/ later/erratic)	Change in frequency of droughts/ floods	No change	Don’t know	Others

2.3 Have the number of abnormal cold days increased or decreased or stayed the same during winter in your area over the past 30 years? …

Increased	Decreased	Change in timing of rains (earlier/ later/erratic)	Change in frequency of droughts/ floods	No change	Don’t know	Others

3. Small-scale maize farmers' perceptions of change in <u>rainfall</u> pattern on farming/agriculture over the last 30 years

1Yes	0 No

3.1 Do you think there has been more rainfall during rainy season in your area over the last 30 years? ....

3.2 Have the number of rainy days increased or decreased or stayed the same during rainy season in your area over the past 30 years? …..…….

Increased	Decreased	Change in timing of rains (earlier/ later/erratic)	Change in frequency of droughts/ floods	No change	Don't know	Others

4. Small-scale maize farmers' perceptions of change in <u>drought</u> occurrences on farming/agriculture over the last 30 years

1 Yes	0 No

4.1 Have there been more droughts in your area over the past 30 years? ……

5. Small-scale maize farmers' perceptions of change in <u>floods</u> occurrences on farming/agriculture over the last 30 years

1 Yes	0 No

5.1 Have there been more floods in your area over the past 30 years? ……

6. Small-scale maize farmers' perception of change in wind occurrences on farming/agriculture over the last 30 years

1 Yes	0 No

6.1 Have the number of abnormal windy days increased in your area over the past 30 years? .....

SECTION D: SMALL-SCALE MAIZE FARMERS WILLINGNESS TO PAY FOR CHANGING PLANTING DATES IN THE FACE CLIMATE CHANGE AS AN ADAPTATION STRATEGIES

1. How important do you think changing planting dates is to maize production?

Not very important =1	Not important = 2	Uncertain =3	Important = 4	Very important=5

THANK YOU FOR PARTICIPATING IN THIS STUDY AND KINDLY INFORMING US

Appendix c: Editorial Letter

TO WHOM IT MAY CONCERN

I hereby confirm that I have proofread and edited the following thesis using Windows 'Tracking' System to reflect my comments and suggested corrections for the author to action: **SMALL-SCALE MAIZE FARMERS' WILLINGNESS TO PAY FOR CHANGING PLANTING DATES IN THE FACE OF CLIMATE CHANGE: A CASE STUDY OF MAKHUDUTHAMAGA LOCAL MUNICIPALITY, LIMPOPO PROVINCE** By Lekobane Lebogang Tau

Although the greatest care was taken in the editing of this document, the final responsibility for the work rests with the author.

Sincerely,

Sibhekisipho Fayayo

08/12/2022

Sibhekisipho Fayayo
083 502 2363 || sibhekisiphofayayo@gmail.com
BA Hons. English and Communication (MSU), MA English Language and Comparative Literature (UFH)
PhD Candidate (UP)