Determinants of Maize Seed Selection for Climate Change Adaptation among Emerging Farmers in Mopani District, Limpopo Province, South Africa

By

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DECLARATION

I Seugnet Baloyi, student number: 11618192 hereby declare that this dissertation for Master of Science in Agricultural Economics (AGMAAE) submitted to the Department of Agricultural Economics and Agribusiness, Faculty of Science, Engineering and Agriculture, University of Venda has not been submitted previously for any degree at this or another university. It is original in design and in execution, and all reference material contained therein has been duly acknowledged.

Signature:  Date: 26 February 2023

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DEDICATION

This study is dedicated to my amazing parents, Mr. N.T. and Mrs. N.A. Baloyi, who have been a constant source of inspiration. To my husband, Mr. M.Z. Zitha, who has provided emotional support that has allowed me to confidently venture into the world and reach my full potential, to my beautiful children, Nikanor and Chara Zitha, and my lovely siblings, Lindy and Rivoningo Baloyi.

ABSTRACT

Maize is a crucial crop in the Mopani District of South Africa, playing a vital role in food security, economic development, and alleviation of poverty. As a staple crop in the region, maize is an important source of food for the local population and a significant economic activity for farmers. Farmers tends to select seed varieties for desired benefits such as adapting to the changing climatic conditions. The main aim of the study was to investigate the determinants of maize seed selection for climate change adaptation among emerging farmers in Mopani district. The study used quantitative research method. A simple random sampling was used to select the participants of the study. Data was collected through structured questionnaire from a sample of 208 emerging maize farmers. Descriptive Statistics was used to analyze and describe socio-economic characteristics of farmers within the study area. A multinomial Logit Model was used to examine factors influencing choice of maize seed varieties among emerging farmers and to determine the influence of climate change knowledge on selection of maize seed varieties. The results of the study showed that the majority of farmers were males, with the dominating age group being between 41 to 50 years and had between 6 and 10 years of farming experience. Grading and standardization of maize during the marketing phase had a significant impact on the selection of the red seed variety, and that awareness of climate change also had a significant impact on the selection of seed varieties. It was recommended that continuous efforts be made to promote awareness of climate change among farmers.

Key words: Adaptation, Climate change, Emerging farmers, Maize, Seed variety, Selection.

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ABBREVIATIONS AND ACRONYMS

AFSG	African Smallholder Farmers Group
CIMMYT	International Maize and Wheat Improvement Centre
DAFF	Department of Agriculture, Forestry and Fisheries
DALRRD	Department of Agriculture, Land Reform, and Rural Development
FAO	Food and Agriculture Organisation
HSRC	Human Sciences Research Council
IMV	Improved Maize Variety
IPCC	Intergovernmental Panel on Climate Change
NASA	National Aeronautics and Space Administration
NGO	Non-Governmental Organisation
OPVs	Open Pollinated Variety
SSA	Sub-Saharan Africa
TASAI	The African Seed Access Index
UNFCCC	United National Framework Convention on Climate Change
WMO	World Meteorological Organization

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND

Maize is the main cereal crop in South Africa, and it is grown under different environmental conditions throughout the country (Macauley, 2015). It is important for food security, generating income, and rural employment (Shiferaw *et al.,* 2011). A successful maize production depends on the combination of a seed variety and the use of inputs that sustain its characteristics within different environment (Matebolo *et al.,* 2017). In South Africa, maize was first introduced in 1655 and is now one of the most important crops for human consumption (Sihlobo, 2018).

Climate change and weather variability are threatening agricultural production in Sub-Saharan Africa with regular droughts, and floods contributing to food insecurity, and water scarcity, as well as famine (Mendelsohn, 2009). Farmers use different types of maize seed as a mechanism to reduce climate change's negative impacts towards their production (Lahmar *et al.,* 2021). According to Tesfaye *et al*. (2018), using drought tolerant crops and better crop management practices have been proposed as a solution to mitigate losses due to climate change and improve crop yields. Cairns *et al*. (2013) found that drought tolerant maize varieties in Sub-Saharan Africa can withstand high temperatures.

Agriculture in Limpopo is greatly impacted by weather and the quality of rainy seasons, making it vulnerable to the effects of climate change (Maponya, 2013). The province faces other challenges such as poverty, unemployment, and food insecurity, which exacerbates the impact of climate change (Duba, 2010). There are fears that these changes may go beyond the limit of adaptation in some areas of Limpopo. The region is classified as semi-arid, making it susceptible to droughts (M'marete, 2018). Rainfall in Limpopo is known to be highly inconsistent both in space and time (Maponya, 2013), possibly due to the region's strong elevation differences. Around the world, maize is grown in different varieties with one important difference being its color (Ameen and Owusu-Sekyere, 2017). Different colors of maize kernels can range from white to yellow to red to black. Most of the maize grown in the United States is yellow, while

people in Africa, Central America, and the Southern United States prefer white maize (Ranum *et al.,* 2014). The feed industry primarily uses yellow maize in the manufacturing of animal feed, but since people in Sub-Saharan Africa are used to the consumption of white maize, the preference for white maize is simply a matter of tradition (Ranum *et al.,* 2014). The United States lead the world in maize production and trade (United States Department of Agriculture, 2022). China has been a significant source of uncertainty in the world's maize trade in some years, the country went from being the second-largest exporter to occasionally importing substantial quantities (Ranum *et al.,* 2014). A large maize producer, Mexico processes much of its production of white maize into human food products but has turned to imported yellow maize for livestock feed to support increased meat production (USDA, 2014). According to Kurt *et al*. (2016), farmers' lack of understanding of new maize seed varieties could be contributing to low yields and poor adoption of these quality varieties. Improving maize production is important for food security, and this can be achieved through better agricultural practices and availability of quality seed varieties (Hepelwa, 2013). However, farmers often do not adopt seed varieties developed by national and international agricultural research centers, partly because their needs are different and they require maize seeds with various traits and characteristics (Awotide *et al*., 2012). These farmers have trouble finding maize seeds that meet their specific requirements (Insight, 2014). They also lack knowledge of the positive traits of improved seed varieties and thus continue to use traditional varieties, which they prefer for their aromatic and sweet taste (RLDC, 2009). Access to improved seeds is crucial for increasing agricultural productivity among smallholder farmers (URT, 2013). Mabhaudhi *et al*. (2019) stated that farmers in KwaZulu-Natal Province, South Africa, classify maize varieties based on their physical characteristics, uses, yield, and drought tolerance**,** resistance to pests and diseases, and even color. The study further mentioned that farmers often associate different colors, such as white, yellow, and red, with different qualities and uses, with each color being preferred for a particular purpose (Mabhaudhi et., 2019).

1.2 STATEMENT OF THE RESEARCH PROBLEM

Maize is a critical crop in South Africa, where it serves as a primary source of carbohydrates for both humans and animals (Ngobeni *et al*., 2011; Undie *et al*., 2012). In Limpopo Province, maize is especially important, as it is a staple crop and a significant source of income for farmers (Stats SA, 2017). However, climate change is posing significant threats to maize production in the region (FAO, 2013). Changes in temperature and rainfall patterns, increased pest and disease pressures, and unpredictable weather events such as droughts and floods are affecting crop yields and quality (Mabhaudhi *et al*., 2019). In response to these challenges, farmers in Limpopo Province need access to diverse and climate-resilient maize seed varieties (Nyamani, 2010). The selection of suitable seed varieties is influenced by a variety of factors, including seed affordability, seed availability, and farmers' knowledge of climate change and its impacts on agriculture (Kurt *et al*., 2016). However, the availability and accessibility of quality seed is often limited in the region, especially for farmers who lack the resources and networks to access the formal seed system (Lanka *et al*., 2017). Therefore, the study sought to investigate the determinants of maize seed selection for climate change adaptation among emerging farmers in Mopani District.

1.3 RATIONALE OF THE STUDY

A report by the Limpopo Department of Agriculture and Rural Development (2015) noted that the agricultural sector is a key driver of economic growth in the province. The report identifies several factors that contribute to the importance of agriculture in the region, including its potential for job creation, its role in meeting food security needs, and its ability to generate income for rural communities. A study conducted by Ngobeni *et al*. (2015) found that maize production provides a source of food, income, and employment for the Mopani district. The demand for maize has been increasing as the population grows, which has led to increased use in animal feed and commercial food production such as corn flakes (Kolady, 2015). To feed the growing population and ensure sustainable food security, it is necessary to grow high-yielding maize varieties. Therefore, it was imperative to conduct the study to investigate the factors influencing the selection of maize seed varieties to adapt to unfavorable changing climatic conditions.

1.4 RESEARCH OBJECTIVES AND QUESTIONS

The main objective of the study was to investigate the determinants of maize seed selection for climate change adaptation among emerging farmers in Mopani District, Limpopo Province, South Africa.

1.4.1 Specific Objectives were:

i. To identify and describe socio-economic characteristics of emerging maize farmers in Mopani District.

ii. To examine factors influencing choice of maize seed varieties among emerging farmers.

iii. To determine the influence of climate change knowledge on selection of maize seed varieties.

1.4.2 Research questions

i. What are the socio-economic characteristics of emerging maize farmers in Mopani District?

ii. What are the factors influencing choice of maize seed varieties?

iii. Does climate change knowledge influences farmers' selection of maize varieties?

1.5 CONCEPTUAL FRAMEWORK OF THE STUDY

In South Africa, climate change is threatening the food security and nutrition as the population rises (HSRC, 2014). According to United National Framework on Climate Change (2021), climate change is caused by human activities such as the burning of fossil fuels, deforestation, increasing livestock farming, and greenhouse gas emissions. Climate change has negatively impacted maize production which has led to reduced maize productivity, loss of income, high production costs, and deprived livelihood (EPA, 2010). Farmers resort to different maize varieties for climate change

adaptation, socio-economic characteristics of farmers and technical factors were found to significantly influence maize seed selection (Mutanyangwa, 2017). The conceptual framework below (figure 1.1) provides a direction in which the study took to address its objectives. Firstly, the study identified the socio-economic characteristics of farmers producing maize and subsequently examined factors that significantly influence the selection of seed variety for climate change adaptation. Lastly, the study investigated the influence of climate change knowledge on selection of maize seed varieties, for desired benefits. The study made several recommendations that will be useful in enhancing maize production and improved climate change adaptation.

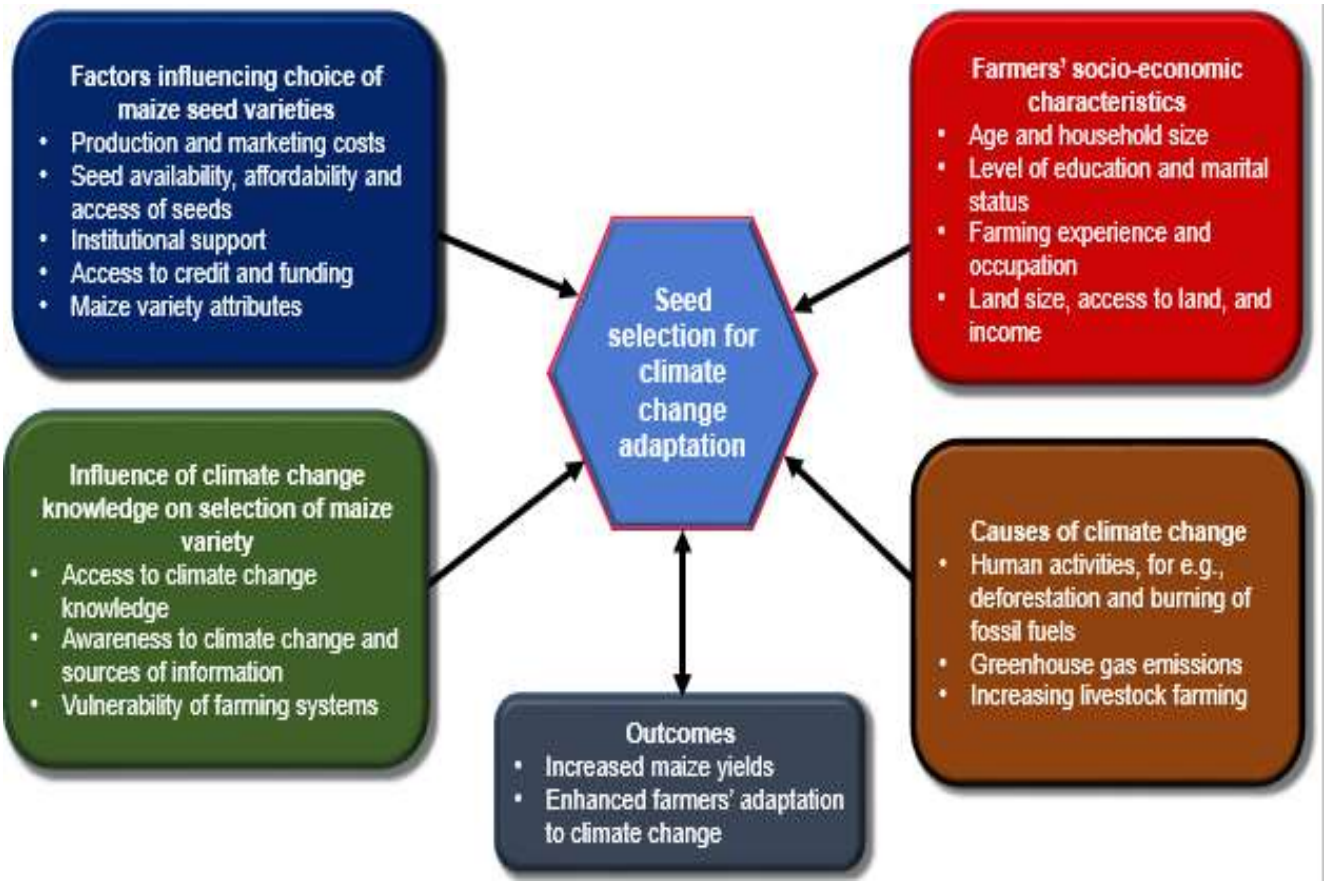

Figure 1.1: Conceptual framework, adapted from Nyamani, 2010.

1.6 OPERATIONAL DEFINITIONS OF KEY TERMS AND CONCEPTS

1.6.1 Climate change

Climate change is any change in climate over time, whether due to natural variability or because of human activity (IPCC, 2007).

1.6.2 Adaptation

Adaptation refers to the process of adjusting or changing to suit new or different conditions, situations, or environments (IPCC, 2007).

1.6.3 Emerging farmers

Emerging farmers are farmers who relies on state and semi-state institutions for support and finance, they consume and sell a part of their harvest (Aliber *et al*., 2012).

1.6.4 Food security

Food security is defined as the ability of a person to obtain food that meets their nutritional needs and food preferences, regardless of their physical, social, or economic circumstances (WHO, 2018).

1.6.5 Seed selection

Seed selection is the choice of seed for the desired crop. Seeds may be selected in several places at different times and may assume different forms (Rice *et al.,* 2011).

1.7 LIMITATION AND DELIMITATION

The limitation of the study included inadequate funds to cover a wider range. While the delimitation of the study was that only emerging farmers in the Mopani district were considered for the study.

1.8 OUTLINE OF THE RESEARCH

This study was logically divided into five chapters. Chapter one provided the introduction of the study. It further provided the research problem statement and the objectives of the study. Chapter one was followed by chapter two which gave an insight

from previous pertaining the subject being investigated. Chapter three provided the methodology which the study followed to achieve its objectives. Chapter four presented and discussed the findings of the study while chapter five concluded on the findings and further gave recommendations.

CHAPTER TWO

CONSUMER BEHAVIOUR THEORY AND LITERATURE REVIEW

2.1 INTRODUCTION

This chapter presents the review of literature on the determinants of seed selection for climate change adaptation among emerging farmers. It provides an insight on the issues relating to the study objectives. This study also provides an overview of the factors that influence emerging farmers' decisions when selecting seeds, including personal, psychological, and social factors.

2.2 THEORY OF CONSUMER BEHAVIOUR

The study is framed using the Theory of Consumer Behaviour, which is concerned with how consumers make decisions to allocate their resources among various products and services. The Theory of Consumer Behaviour is relevant in many contexts, including agriculture, where farmers must make decisions about which crops to plant and which seeds to use for optimal yield and productivity. Climate change has become a major concern for the agricultural sector, as changing weather patterns and extreme weather events have significant impacts on crop production. Maize, in particular, is an important staple crop for many countries, and its yield is affected by changes in temperature and rainfall patterns. To adapt to these changes, farmers must select maize seeds that are resilient to changing climate conditions and that can provide high yields in these challenging environments. This research reviewed the literature on the Theory of Consumer Behaviour and its application in agriculture, with a focus on the selection of maize seeds for climate change adaptation.

2.2.1 Adoption of consumer behavior theory for socio-economic characteristics of farmers

The Theoretical Framework for this study draws on the Theory of Consumer Behavior. This theory provides a useful framework for understanding the factors that influence consumers' decision-making processes when selecting products. In this case, the

focus is on seed selection for climate change adaptation among emerging farmers. According to the Theory of Consumer Behavior, consumers' decisions are influenced by a range of factors, including personal, psychological, and social factors. Personal factors such as age, gender, education, and income level may influence their decision-making processes. Psychological factors such as attitudes, beliefs, and values may also play a role in seed selection. For example, emerging farmers who value environmental sustainability may be more likely to choose seeds that are adapted to local environmental conditions. Social factors such as family, peers, and community networks may also be important determinants of seed selection among emerging farmers. For instance, a farmer may choose to plant the same seeds as their neighbor or fellow farmers in their community to ensure social acceptance and access to information on local seed varieties.

2.2.2 Adoption of theory of consumer behavior relating to factors influencing choice of maize seed varieties

The Theory of Consumer Behaviour suggests that the decision-making process is influenced by a range of factors including personal, psychological, social, and environmental factors. In this study, factors such as cost, quality, availability, market demand, and level of awareness about different seed varieties may influence the choice of maize seed varieties among emerging farmers. These factors are linked to the concepts of perceived value and perceived risk, which are central to the Theory of Consumer Behaviour. Perceived value refers to the perceived benefits of a product relative to its price, while perceived risk refers to the degree of uncertainty associated with a product. Farmers' decision-making process can be influenced by their assessment of the perceived value and perceived risk of different maize seed varieties.

2.2.3 Adoption of consumer behaviour theory relating to the Influence of climate change knowledge towards climate change adaptation

Climate change knowledge can also be examined through the lens of the Theory of Consumer Behaviour. Farmers' knowledge of climate change can affect their perception of the benefits and risks associated with different maize seed varieties. Climate change can also be considered as an external factor that affects farmers'

decision-making process, which is a key component of the Theory of Consumer Behaviour.

2.3 REVIEW ON SOCIO-ECONOMIC CHARACTERISTICS OF EMERGING MAIZE FARMERS

2.3.1 Review on age and household size of farmers

Research has shown that the age of the household head has a positive but insignificant effect on farmers' preference for improved maize seed varieties due to the belief that age is linked to experience with agricultural technologies (Sigigaba *et al*., 2021). According to a study conducted in Zimbabwe by Muchena *et al*. (2021), age has a significant effect on the adoption of improved maize varieties for climate change adaptation. The study found that younger farmers are more likely to adopt improved maize varieties due to their greater openness to new technologies and their higher level of education. A study by Nchembi (2017) found that the average household size of those surveyed was about six people, which is higher than the average household size of five people in the country. Njuguna *et al*. (2015) stated that households have a labor source which is necessary for farming activities. The size of the household is a crucial source of labor, especially during peak farming times like weeding and harvesting, when an even amount of labor is needed. Additionally, large household sizes in rural areas require more people to be involved in agriculture to meet the needs of the household (Feng, 2008). However, Kudi *et al*. (2011) reported that the larger the household size, the lower the adoption of good maize varieties. This could be due to the fact that larger household sizes often lead to more financial constraints, leaving the household with limited funds to purchase production inputs and new technologies (Audu and Aye, 2014). Another study by Sigigaba *et al*. (2021) in Zimbabwe found that household size has a significant positive effect on the adoption of improved maize varieties for climate change adaptation.

2.3.2 Review on Level of education and marital status for farmers

Research by AGRA (2018) showed that farmers' level of education impacts their decision making and therefore affects their choice of quality maize seed varieties. A study by Mwabu (2016) found that educated farmers have better access to information

about quality maize seeds and are able to process and use that information more effectively. A study on adoption had indicated that education increases the likelihood of farmers choosing to use quality seeds, meaning that better-educated farmers are more likely to plant high-quality varieties of maize (Salasya *et al*., 2017). This highlights the significance of providing smallholder farmers with education through extension and training programs. Mutanyangwa (2017) showed that despite having a high literacy rate with 28.7% of farmers having only primary education and the rest having secondary education, data from other sources indicated that most of the population has only completed primary education and very few have finished secondary or tertiary education (Temu *et al*., 2019). Another study by Monela (2014) found that 60.5% of farmers in Mbeya and Morogoro had completed primary education and only 1% had completed tertiary education. However, it was noted that male farmers were generally more educated than female farmers regardless of their level of education. Research in Nigeria (Adeogun *et al*., 2010) showed that young farmers are energetic and take time to gather information about improved technologies. Additionally, a study by Busari *et al*. (2015) found that younger farmers tend to be more innovative than older farmers.

Ntshangase (2014) found that married farmers tend to be more stable in their farming activities compared to unmarried ones. Umar *et al*. (2014) noted that the marital status of farmers positively impacts their choice of maize variety, with married farmers having more responsibilities towards meeting the basic needs of their family, especially in terms of feeding. However, Kalinda *et al*. (2014) found that married smallholder farmers were less likely to choose improved maize varieties compared to single farmers, which may be because married farmers tend to be older. A study by Rehima *et al*. (2013) suggests that the age of the head of the household of smallholder farmers affects their choice of maize varieties. Amare and Oosthuizen (2020) found that education level and household income were significant determinants of maize adoption in Ethiopia. They found that farmers with higher levels of education were more likely to adopt improved maize varieties. A study conducted by Kim and Yoo (2021) found that education level had a significant positive effect on the adoption of improved maize varieties among farmers in Tanzania.

2.3.3 Farming experience and occupation

In a study by Nchembi (2017), farmers have an average of 19 years of farming experience, with the least amount of experience being two years and the most being 60 years. This indicates that farmers gained considerable knowledge and skills in agriculture and technology over time. Johannes *et al*. (2010) suggested that with more experience, farmers are better equipped to assess the benefits of new technologies and thus increase the rate of adoption. In terms of using quality maize varieties, farmers can draw on their experience to make informed decisions. Afolami *et al*. (2015) indicated that being fully dedicated to farming suggests that it is a primary source of livelihood for farmers. Recent research by Oluwafemi *et al*. (2020) found that farmers' level of experience significantly influences their adoption of improved maize seed varieties. The study showed that farmers with more experience tend to have a better understanding of the advantages and disadvantages of using improved maize seeds and are therefore more likely to adopt them.

2.3.4 Review on land size, access to land, and income of farmers

Maponya and Mpandeli (2014) found that there were few farmers with land larger than 30 hectares, with 68% of respondents farming on communal land. Baloyi (2010) conducted a study on farmers in Limpopo Province and found that in the Capricorn district, 19% acquired their land through land reform, 3% bought it with loans from financial institutions, and 4% inherited from family members. Maponya (2021) discovered that many respondents were not using their land to its full potential due to lack of farm infrastructure, with the farmers citing a lack of water and irrigation infrastructure as the major constraint. Maponya and Mpandeli (2014) discovered that the number of farmers with land larger than 30 hectares was relatively low and 68% of respondents farmed on communal land. Baloyi (2010) indicated that in Capricorn district, 19 percent of farmers have acquired their land through the land reform process, and three percent of farmers in the survey financed their purchase of land with loans from financial institutions, while four percent inherited their land from family members. Maponya (2021) revealed that because of lack of farm infrastructure, most respondents are not utilizing their land to its full potential, water and irrigation

infrastructure were identified by the farmers as major constraints preventing them from utilizing the land to its fullest potential.

It was stated by Beyene *et al*. (2015) that farmers who have larger plots of land are more likely to use high-quality maize seed varieties as they have a greater focus on profit. On the other hand, Lyimo (2014) found that farmers with larger farms have more resources to experiment with new technologies, as they can dedicate a portion of their land to testing new seed varieties. The size of the farm was found to influence the adoption of different agricultural technologies, including the use of good maize seeds and other inputs, leading to higher yields per area (Simtowe *et al*., 2012).

2.4 FACTORS INFLUENCING CHOICE OF MAIZE SEED VARIETIES

2.4.1 Farmers' overview on production and marketing costs of their maize produce

Mutua *et al*. (2020) investigated the cost-effectiveness of using different seed varieties in maize production in Kenya. The study found that although improved maize seed varieties had higher production costs than local seed varieties, the higher yields obtained from improved seed varieties made them more cost-effective in the long run. A study by Onwonga *et al*. (2021) found that farmers who used improved seed varieties and practiced good agronomic practices had higher profitability than those who used local seed varieties and did not practice good agronomic practices. Kariuki *et al*. (2020) examined the factors that influence smallholder maize farmers' choice of seed varieties in Kenya. They found that high seed prices and limited access to credit were significant barriers to farmers' adoption of improved seed varieties.

2.4.2 Influence of seed availability, affordability, and access on the selection of seed variety

Farm households view availability of maize seed in terms of its abundance in the market, and a lack of access to different types of maize seed varieties is seen as a significant constraint (Nyamani, 2010). Maize seed is considered accessible to farmers if it can be obtained easily in the area without incurring high additional costs, such as transportation expenses. ASFG (2011), limited availability of good quality seed is a

common problem for farmers in rural areas in many countries. The study found that initiatives aimed at sustainable local seed production have improved access to appropriate, affordable, and timely seeds. High-quality seed of well-adapted, productive crops is essential for farmers to produce high-quality crops (Kurt *et al*., 2016). Efforts to involve the private sector in ensuring efficient seed production and distribution in developing countries have led to increased yields (FAO, 2009). Katengeza *et al*. (2012) stated that market accessibility affects the choice of maize variety. Feleke and Zegeye (2016) found that small-scale maize farmers who live far from market centers are less likely to choose maize varieties compared to those who live close by. The lack of proper road infrastructure is a common hindrance for rural small-scale farmers (Guei *et al*., 2011), and this view is supported by Tura *et al*. (2010), who found that market access affects the choice of maize variety. Makwela *et al*. (2021) in the Mogalakwena Municipality in South Africa found that 80% of the farmers in the area lacked access to local markets for obtaining maize seeds, and they had to travel an average of 42 km to reach the seed market. The high transportation costs prevent farmers from using high-quality seeds, leading to reduced returns from maize production. As a result, farmers living far from the market are less likely to adopt improved varieties.

2.4.3 Institutional support

In semi-arid areas, most smallholder farmers rely on rain-fed agriculture and have limited access to irrigation systems (Apata *et al*., 2009). This results in uneven rainfall distribution, with an average of 500mm or less per year, which leads to low crop yields and increased vulnerability for smallholder farmers (Beloe *et al.*, 2010). Smallholder farmers must make crucial crop decisions during a particular season, and they require access to information about seasonal weather forecasts to adapt to changing weather patterns (Maponya, 2013). However, South African farmers are resource-limited and lack institutional support, which means they do not receive the necessary support from extension officers (Mudhara, 2013). According to Ngqaka (2019), extension officers play a crucial role in supporting smallholder farmers by providing them with updated information on new technologies and advanced seeds. Asrat *et al*. (2019) found that access to extension agents can have a significant impact on farmers' choices. Extension services are a vital source of information and farmers who have contact with

extension officers are able to stay informed on new ideas and advancements throughout the year (Bamire *et al*., 2010).

2.4.4 Access to credit and funding opportunities

Nkohla (2016) highlighted that farmers still face difficulties in obtaining credit for various reasons, such as the unfavorable loan conditions offered by the Land Bank. Hedden-Dunkhorst *et al*. (2011) reported that lack of information and distance from bank branches hinder rural households from accessing credit. The study by Ncube *et al*. (2020) found that smallholder farmers in Zimbabwe face various obstacles when trying to access credit, including collateral requirements, interest rates, loan duration, and loan processing time. Pote (2018) found that the South African government has established several state-owned credit institutions in former homelands, but farmers often blame their inability to select quality maize seeds on the lack of access to credit. Nyamani (2010) stated that farmers who have access to credit are more likely to buy high-quality maize seeds. Agwu *et al*. (2012) pointed out that the lack of funding opportunities among farmers is one of the major challenges to agricultural productivity.

2.4.5 Maize varietal attributes preferred by emerging farmers

2.4.5.1 High yield potential

Asrat *et al*. (2019) stated that farmers consider high yield to be the top priority when selecting maize varieties. This is due to the importance of maize in providing food security and reducing poverty, as noted by Rugumamu (2014). Additionally, Gardear (2013) noted that smallholder maize farmers grow high-yield varieties for both human and animal consumption. Previous studies have also highlighted the significance of high yield in maize selection for farmers. Mapfumo *et al*. (2011) found that maize yield was the most important selection criteria among smallholder farmers in Zimbabwe. Dey *et al*. (2012) conducted in India revealed that farmers prioritize yield as the most important attribute when choosing maize varieties. These studies reinforce the findings of Asrat *et al*. (2019) and Gardear (2013), further emphasizing the importance of high yield in maize selection for farmers to support food security and reduce poverty.

2.4.5.2 Drought tolerance

Burke *et al*. (2011) showed that emerging maize farmers tend to prefer drought-tolerant varieties due to their reliance on natural rainfall. In areas with limited rainfall, such as

central Tanzania (Temu *et al*., 2011), drought resistance is a crucial factor in the adoption of high-quality maize varieties. This preference for drought-tolerant crops is driven by the difficulty of avoiding drought, as noted by Kassie *et al*. (2013). Temu *et al.* (2011) emphasized the positive impact that drought-tolerant maize can have on the yields of smallholder farmers. This is consistent with the findings of other studies, such as those conducted by Mapfumo *et al*. (2011) and Dey *et al*. (2012), which showed that maize yield is the primary selection criteria for farmers.

2.4.5.3 Pest and disease resistance

As noted by Asrat *et al*. (2019), resistance to pests and diseases is a significant factor in the selection of maize varieties by farmers. This is further supported by Ngwira and Khonje (2015), who found that the lack of access to inputs like insecticides often leads farmers to choose pest and disease-resistant varieties of maize. The relationship between pest and disease resistance and maize production in smallholder farming is emphasized by Oyekale and Idjesa (2019), who found that diseases and pests are a major contributor to low maize yields in this context. This is consistent with previous research, such as a study by Mapfumo *et al*. (2011) which showed that maize yield was the most important selection criteria among smallholder farmers in Zimbabwe. The importance of pest and disease resistance in the selection of maize varieties by farmers can also be seen in studies conducted in other countries**.**

2.5 INFLUENCE OF CLIMATE CHANGE KNOWLEDGE ON SELECTION OF MAIZE SEED VARIETIES

2.5.1 Access to climate change knowledge

Access to information on climate change is crucial for farmers to make informed decisions about sustainable maize production. Indigenous knowledge alone may not be enough to effectively adapt to climate change (Tarchiani *et al*., 2017). The effectiveness of climate change information depends on its accessibility and design for local farmer needs, as well as its trustworthiness and ease of use (WMO, 2011). Climate information services, which provide scientific weather and climate information, are needed but difficult for smallholder farmers in Africa to access (Bessah, 2021).

Farmers in Niger who had access to fertilizers and larger arable land benefited more from climate forecasts and were able to improve maize yield by planting later to avoid drought (Roudier *et al*., 2016). However, farmers in Ivory Coast struggled to adapt to climate change as they had no access to climate change information due to a lack of communication facilities (Diouf *et al*., 2019). Jain (2014) revealed that ethno-meteorological knowledge is important for farmers to adapt to climate change, as there are significant gaps in scientific knowledge. Farmers are more likely to trust traditional forecasts based on historical patterns, observations, and signs over scientific forecasts, as they value their own experiences (Nkowa, 2014). Orlove *et al*. (2010) found that farmers in South Africa, Zimbabwe, and Botswana heavily rely on indigenous predictions when making agricultural decisions, such as choosing crops, managing land, and implementing management strategies. Indigenous knowledge is seen as practical, dynamic, and open to incorporating new elements, making it more accessible and trusted by farmers (Kolawole *et al*., 2014). Additionally, farmers in Malawi and Botswana find traditional forecasts to be more accurate and easier to understand than scientific forecasts, which require education, training, and financial investment (Mavhura, 2013)**.**

2.5.2 Awareness of climate change and sources of information

The ability of maize farmers to efficiently manage the risks posed by climate change is enhanced through their use of climate information, which allows them to adopt suitable adaptation strategies (Vaughan *et al*., 2017). Climate information is made available to farmers in Niger through radio and television broadcasts (Tarchiani *et al*., 2017). Farmers in South Africa are cognizant of the effects of climate change and have already started taking steps to mitigate its risks (Ndhleve *et al*., 2017). Despite high levels of awareness about climate change in the Niger Delta, farmers are not well-informed about its adverse effects (Taddeus *et al*., 2011). Muema *et al*. (2018) found that factors like age of the household head, gender, and vulnerability to drought hinder farmers in Kenya from accessing climate information services, while household size, income, farm size, livelihood activity, access to radio and television, and access to quality seeds increase their ability to access climate information services. Tarchiani *et al*. (2017) reported that maize farmers in Ivory Coast have no access to climate information due to the lack of communication facilities. Simelton *et al*. (2013) found

that small maize farmers in developing countries who rely on rain-fed agriculture face significant challenges due to climate variability, particularly changes in temperature and rainfall. Mugula and Mkuna (2016) investigated smallholder farmers' perceptions of climate change, taking into account their experiences and local knowledge. Despite their limited education, these farmers were able to recognize changes in temperature and rainfall (Okonya *et al*., 2013). Other studies have shown that farmers' understanding of climate change is impacted by various institutional factors, such as media outlets (such as newspapers, radio, and television) and access to peer-to-peer extension services (Amadou, 2015). . According to CIMMYT (2018) farmers' choices of maize seeds are affected by their perceptions of future climate events. This is backed up by other research that shows that farmers' beliefs about the climate impact their choices on how to adapt to the changes (Speranza and Ricks, 2015). Farmers with a positive outlook on future rainfall may choose to plant varieties that mature in the middle and have higher yields, even if they don't know when they can sow them (Mukherjee and Howden, 2017). Climate change is a complex and multifaceted issue that is caused by a number of factors. Some of the key causes of climate change include: Greenhouse gases: Greenhouse gases, such as carbon dioxide, methane, and nitrous oxide, trap heat in the atmosphere and cause global temperatures to rise (NASA, 2021). The largest source of greenhouse gas emissions is the burning of fossil fuels for energy and transportation, but other sources include deforestation, agriculture, and industrial processes (IPCC, 2013). Land use changes, such as deforestation and urbanization, can also contribute to climate change by altering the Earth's ability to absorb and reflect heat (Malhi *et al*., 2013). Natural processes, such as volcanic eruptions and changes in solar radiation, can also contribute to climate change (Le Quéré *et al*., 2016).

2.5.3 Vulnerability of farming systems to climate change

Nhamo *et al*. (2020), South Africa is facing a shortage of water due to its semi-arid location and is particularly susceptible to the effects of climate change. Knox *et al*. (2012) reported that Southern Africa is expected to be severely impacted by climate change, with Zimbabwe being one of the areas most affected. Nyikahadzoi *et al*. (2012) noted that farmers in sub-Saharan Africa are already facing many challenges, including soil degradation and weak markets, and that the effects of climate change

will only exacerbate these difficulties. Vermeulen *et al*. (2012) also pointed out that the impact of changing climates on crops will depend on various factors, such as soil fertility management, seed choice, and market access. Additionally, the study by Waldan *et al*. (2019) showed that farmers' past experiences with specific varieties can impact their future decisions in agriculture. Giller *et al*. (2011) emphasized that farmers are vulnerable to the impacts of climate change, but the extent of their vulnerability depends on various factors that make farms unique. Kolawole *et al*. (2014) indicated that small-scale farmers often face challenges in utilizing seasonal forecasts due to limited access to information. Goddard *et al*. (2010) found that better communication and collaboration with media is necessary to improve access to information. The availability of climate information is also affected by the number of meteorological stations as stated by Ogallo (2010). Despite the vast amounts of information generated from seasonal forecasts, they are rarely incorporated into policies or decision-making, and need to be made more useful for decision makers through dialog and translation (Goddard *et al*., 2010). Hansen *et al*. (2011) found that information is often general and presented late, in technical language that is not easily understood, and lacking specific information on timing of rainfall. The state of seasonal forecast systems is also seen as embryonic, with forecasts not well developed or digitalized, and presented as probabilities rather than risks (Ogallo, 2010; Chidzambwa and Mason, 2018). Despite the increase in forecasting skills in Africa, Goddard *et al*. (2010) noted the risk of inexpert interpretation of limited inputs from seasonal forecasts available online. Overall, it is suggested that a better channel for climate information is needed.

2.6 SUMMARY OF LITERATURE REVIEW

The chapter reviewed studies on the socio-economic characteristics of emerging maize farmers. Studies relating to factors influencing the selection of maize seed varieties for the purpose of climate change adaptation were also reviewed. The chapter also looked into studies that investigated the influence of climate change knowledge towards the selection of maize seed varieties.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter gave the description of the study area, and explained the methodology employed to carry out the study. This chapter also covered the ethical standards followed during the study.

3.2 DESCRIPTION OF THE STUDY AREA

Agriculture in Limpopo Province is seen as a cornerstone of the province's economy (Ubisi, 2015). The study was conducted in the Mopani district, located within the north-eastern quadrant of the Limpopo Province, South Africa. Mopani District comprises five local municipalities namely: Greater Giyani, Greater Letaba, Greater Tzaneen, and Maruleng. The Mopani district which is a Lowveld region contributes significantly towards the activity of agriculture on the provincial level. The district has a total population of 1,092,507 and 296,320 households (Stats SA, 2021). However, this district is characterized by low rainfall between 400mm to 900mm, resulting in limited water resources causing severe water shortages and regular drought conditions particularly in the lower-lying areas of the district. Briggs (2021) suggests that the climate in the study area is classified as a humid subtropical (dry winter, hot summer). The study area was chosen since maize farming in the study area significantly contributes towards improved livelihoods through consumption or as a form of income generation.

Figure 3.1: Map showing Limpopo District municipalities

Source: https://oursouthafrica.wikispaces.com/The+Nine+Provinces (Retrieved on 18 December 2021).

Figure 3.2: Map indicating study areas in Mopani District.

Source: https://oursouthafrica.wikispaces.com/The+Nine+Provinces (Accessed on 18 December 2021)

3.3 RESEARCH DESIGN

De Vaus (2002) indicated that the research design is the strategy chosen for integrating the various components of the study in a coherent and logical way, therefore, ensuring that the researcher will successfully address the research problem. The study used quantitative research method. Quantitative research deals with quantifying and analyzing variables to get results (Apuke, 2017). This type of design was suitable for the study as the study sought to understand the in-depth of factors influencing the selection of maize seed varieties for climate change adaptation purposes.

3.4 POPULATION, SAMPLING PROCEDURES, AND DATA COLLECTION

The study population was maize emerging farmers within Mopani district. As reported by the DALRRD (2020), Mopani District had an estimated number of 450 maize emerging farmers during data collection period. The method used in this study is a simple random sampling technique to select a sample of 208 farmers from a population of 450 emerging maize farmers. Simple random sampling is a statistical method used to select a representative sample from a larger population (Trochim and Donnelly, 2008). In simple random sampling, each member of the population has an equal chance of being selected for the sample without any bias or preference. The study used Rao soft sample size calculator to calculate the appropriate sample size. This approach ensured that the sample was representative of the population of maize emerging farmers in Mopani district, as each farmer had an equal chance of being selected for the study. The face-to-face interviews were conducted with the selected sample of 208 farmers. Table 3.1 below shows farmers' population by Local municipality. Primary data was collected using questionnaires which were administrated to the participants. Questionnaire consisted of both opened-ended and closed-ended questions. Secondary data was collected from journal articles, books and governmental or organizational websites.

Table 3.1: Farmers' population in the Mopani district per Local municipality

Local municipality	Population	Proportional sample size
Greater Giyani	135	62
Greater Letaba	79	37
Greater Tzaneen	101	46
Maruleng	96	43
Ba-Phalaborwa	39	20
	450	**208**

Source: author's computation (2022).

3.5 DATA ANALYSIS

Data was captured using the Statistical Package for Social Sciences (SPSS Version 27). In the study, the following methods of data analysis were used: Descriptive Statistic Analysis, and Multinomial Logit Model.

3.5.1 Objective (i): To identify and describe socio-economic characteristics of emerging maize farmers in Mopani District

Objective (i) was analyzed using the descriptive statistic. Frequencies, percentages, and tables on demographic information such as age, marital status, gender, level of education, off-farm source of income, land size, and farming experience. The purpose of using this type of analytical tool was to summaries the data by describing the basic features of the data in the study, and to provide simple summaries of the variables and measures (Rawat, 2021).

3.5.2 Objective (ii): To examine factors influencing choice of maize seed varieties for climate change adaptation among emerging farmers

To determine factors that influence farmers' choice of the maize seed varieties as addressed by the second objective, a Multinomial Logit Model was used. Multinomial Logit Model was used to predict categorical placement in or the probability of category membership on a dependent variable based on multiple independent variables (Garson, 2011). In Multinomial Logit (MNL), the selection of maize seed variety is denoted by K, choice probability of K alternative for each farmer is computed as follows:

$$P(Y_i = \frac{K}{X^i}) \quad = \frac{e^{zik}}{\sum_{j=1}^{k} e^{z_{ij}}} \quad = \frac{eX_{iB_i}}{\sum_{j=1}^{k} ex_{iB_j}}$$

Analytically, the model can be expressed as below:

$$Y_i = \beta_0 + \sum_{i}^{12} = 1\ \beta_i X_i + \varepsilon_i$$

- Where the dependent variable Y_i is the maize varieties (white, red, yellow, and landrace maize varieties).
- The explanatory variables X_1 …… X_j represents factors influencing the selection of maize seed varieties, β' are parameters to be estimated and ε_i is an error term accounting for unobserved characteristics and measurement errors.

Table 3.2: Description of explanatory variables for factors affecting the selection of seed varieties

Variable	Name description	Type of measurement	Expected sign
X_1	Age group	0= 20 years and less; 1= 21-30; 2= 31-40 and 3= 41-50; 4= more than 50 years	+
X_2	Level of education	0= never attended; 1=primary school; 2-=secondary school; 3=tertiary	+
X_3	Full-time farming	0=yes; 1= no	+
X_4	Farming experience	0= 1-5 years; 1= 6-10 years; 3= more than 10 years	+
X_5	Pest outbreak	0=Yes; 1= no	_
X_6	Disease outbreak	0=Yes; 1= no	_
X_7	Different harvesting skills	0=Hand harvesting; 1=harvesting with hand tools; 2= harvesting with machinery	+
X_8	Market availability	0=Yes; 1=no	+
X_9	Maize grading and Standardization	0=Yes; 1=no	+
X_{10}	Funds availability	0=Yes; 1=no	+
X_{11}	Seed accessibility	0=Yes; 1=no	+
X_{12}	Seed availability during planting season	0=Yes; 1=no	+
X_{13}	Seed affordability	0=affordable; 1=not affordable	+
X_{14}	Attributes of seeds	0=High yield; 1=disease resistance; 2=pest resistance; 3= early maturity; 4= storage	+

Source: author's computation, 2022.

3.5.3 Objective (iii): To determine the influence of climate change knowledge on selection of maize varieties

Objective (iii) was also analyzed using Multinomial Logit Model. In Multinomial Logit (MNL), the selection of maize seed variety is denoted by K, choice probability of K alternative for each farmer is computed as follows:

$$P(Y_i = \frac{K}{X^i}) \quad = \frac{e^{zik}}{\sum_{j=1}^{k} e^{z_{ij}}} \quad = \frac{eX_{iB_i}}{\sum_{j=1}^{k} eX_{iB_j}}$$ (Makwela *et al.,* 2021)

Empirically, the model can be expressed as follows;

$$Y_i = \beta_0 + \sum_i^{12} = 1\ \beta_i X_i + \varepsilon_i$$

- Where the dependent variable Y_i is the maize varieties ((white, red, yellow, and landrace maize seed variety).
- The explanatory variables X_1 …… X_j represents the climate change knowledge among farmers, β' are parameters to be estimated and ε_i is an error term accounting for unobserved characteristics and measurement errors.

Table 3.3: Description of explanatory variables for climate change knowledge influencing the selection of seed varieties

Variable	Name description	Type of measurement	Expected sign
X_1	Awareness of climate change	0=Yes; 1= no	+
X_2	Climate change sources	0= Television/ radio; 1= newspaper; 2=neighbors; 3= extension officers	+
X_3	Causes of climate change	0= Human activities; 1= consumerism; 2= increasing livestock farming; 3= changes in the Earth's orbit and rotation; 4= variations in solar activity; 5= changes in the Earth's reflectivity	+
X_4	Impacts of climate change	0= Food insecurity; 1= reduction in maize production; 2= increased incidence of pest attacks; 3= limitations of water availability; 4=loss of income; 5= high production costs	–
X_5	Rainfall observation	0= Increasing; 1= decreasing; 2= constant; 3= didn't observe	+
X_6	Temperature observation	0=Increasing; 1= decreasing; 2= constant; 3= didn't observe	+
X_7	Drought-occurrence observation	0= Increasing; 1= decreasing; 2= constant; 3= didn't observe	+
X_8	Flood-occurrence observation	0= increasing; 1= decreasing; 2= constant; 3= didn't observe	+
X_9	Climate change intervention Training	0= Yes; 1= no; 2= not sure	+

Source: author's computation, 2022.

3.6 ETHICAL CONSIDERATIONS

Ethical clearance was obtained from the University of Venda Research Ethics Committee. Thereafter, written permission to conduct the study was sought from the Mopani district. Meetings with community leaders, the local extension officers, Ward Councilors, and Traditional leaders (Indunas) were also held to gain easy access to

the community. This cleared the way towards securing the informed consent of the farmers to participate in the study. The consent form that explains to the farmers what the study focused on as well as their obligations and rights (Appendix C) were given to them. The participants were not forced to participate in the study. Participants were informed that they were free to choose whether they can withdraw from the study without any negative repercussions. Participants had a right to discontinue their participation at any time due to non-compliance, illnesses, adverse reactions, and other factors.

3.7 DISSEMINATION PLAN

Hard copies of the study results will be issued to the concerned participants. The findings of the study will also be shared through publications and conference presentations.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 INTRODUCTION

This chapter presents the findings of the study. The findings of the study in this chapter are presented following the sequence of the objectives as outlined in chapter one. The chapter also discusses the findings of each objective.

4.2 OVERVIEW OF SOCIO-ECONOMIC CHARACTERISTICS OF FARMERS WITHIN THE STUDY SAMPLE

Table 4.1: Distribution of socio-economic characteristics among farmers

Variables	Frequency	Percentage
Gender		
Male	141	67.7
Female	67	32.3
Age group		
21 – 30 years	24	11.5
31 – 40 years	62	30.0
41 – 50 years	79	37.7
>50 years	43	20.8
Household size		
0 – 5	87	42.3
6 – 10	109	52.3
>10	11	5.4
Marital status		
Married	131	63
Single	55	26.4
Divorced	2	1
Widowed	20	9.6
Full- time farmer		
Yes	179	86.1
No	29	13.9
Level of education		
Never attendant	7	3

Primary level	19	9
Secondary level	100	49
Tertiary level	82	39
Farming experience (in years)		
1 – 5	57	27.4
6 - 10	94	45.2
>10	57	27.4
Off-farm source of income		
Yes	161	77.4
No	47	44.6
Off-farm source of income		
Full-time farmer	26	12.5
Part-time worker	59	28.6
Pensioner	4	1.8
Social child grant	78	37.5
Remittances	41	19.6
Land size (ha)		
<1	11	5.3
1 - 5	65	31.3
6 – 10	89	42.8
11 – 19	43	20.7

Source: Survey results (2022-23)

4.2.1 The distribution of gender, age group and household size among farmers

The results from Table 4.1 show that male farmers were dominant in the study sample accounting to 67.7% while female only accounted to 32.3%. Regarding farmers' age, the results of the study uncovered that the dominant age group was 41 to 50 years, accounting for 37.7%, followed by those between the ages of 31–40 years, accounting for 30% and the least group were those of ages between 21–30 years, accounting for 11.5%. In terms of household size, the study revealed that most household size was between 6 to 10 members, accounting for 52.3%, while the least group had a household size of more than 10 (5.4%).

4.2.2 Presentation of the marital status, level of education, and farming experience among farmers

Pertaining the marital status among farmers, the study revealed that most farmers were married at 63%, followed by those that were single at 26.4%. The results also revealed that the least group of farmers were those who were divorced, accounting to 1%. The results in Table 4.1 shows that most farmers had attained secondary education (49%), followed by those who had tertiary education, accounting to 39%. Those who were found not to have attained any form of education accounted to 3%. Regarding farming experience, the study results show that most farmers had between 6 and 10 of farming experience. From the results, it can be observed that farmers with more than 5 years of farming experience account to 72.6% that could have been largely influenced by the age group of farmers as 50% of them were aged 40 years and above.

4.2.3 Presentation of the off-farm source of Income and land size owned by farmers

In the study sample, 77.4% of emerging maize farmers had off-farm source of income, while 22.6% didn't have any off-farm source of income. The study indicates that the majority of farmers producing maize in the study sample had no off-farm source of income. From the study, it was revealed that most farmers received their off-farm income from social child grant at 37.5%, followed by working part-time at 28.6%, and the least group of farmers were pensioners at 1.8%. From the study, the results revealed that most farmers had land size of between 6 and 10 hectares (42.8%), followed by those who owned between 1 and 5 hectares.

4.3 Presentation of multinomial logistic regression results on factors influencing choice of maize seed varieties among emerging farmers

Table 4.2: Summary of Multinomial results

		N	Marginal Percentage
Varieties grown	White variety	104	50.0%
	Red variety	80	38.5%
	Yellow variety	3	1.4%
	Landrace	21	10.1%
Valid		208	100.0%

Source: Study results, 2022/2023.

Table 4.2 above provides a breakdown of the different varieties of maize seed varieties grown by 208 farmers who participated in a study. The study identified four maize varieties, namely white, red, yellow, and landrace. The white seed variety was the most grown, representing 50%. The red variety was the second most common, accounting for 38.5%. The yellow variety and landrace were less commonly grown, with only 1.4% and 10.1%. Overall, the results suggest that the white and red varieties are the most popular choices among maize farmers in the study sample.

4.3.1 Presentation of results pertaining factors affecting selection of maize seed varieties

The estimation of the multinomial logit model for this study was assumed by standardizing one category, which is normally referred to as the ‘‘base category’’ and in this analysis, the base category was white seed variety. The model explained the relationship between selection of maize seed varieties and factors influencing such selection (see Table 4.3 below). The dependent variable was maize seed varieties (white, red, yellow, and landrace). The study used the Nagelkerke test to evaluate the goodness of fit of the logistic regression model. The Nagelkerke r-squared value of 0.631 shows the 63.1% of variance in the outcome that is explained by the predictor variables, showing that the model used in the analysis was appropriate. Factors that were found to significantly influence the selection of maize seed selection are attributes of seeds, and funds availability at 10% level of significance; age group of farmers, different harvesting skills, seed affordability, level of education, funds availability, and seed accessibility at 5% level of significance; and seed accessibility, seed availability purchase during planting season, market availability, and maize grading and standardization at 1% level of significance.

Table 4.3: Parameter estimates of Multinomial Logistic climate change adaptation model

Explanatory variable	Maize seed varieties					
	Red		Yellow		Landrace	
	Coefficients	P-level	Coefficients	P-level	Coefficients	P-level
Intercept	. 695	.607	9.403	.977	-1.741	.472
Age group	1.470	.011**	-.596	.580	-.444	.193
Level of education	-0.188	.414	.103	.012**	-.522	.176
Full-time farmer	.285	.557	-11.030	.973	.989	.158
Farming experience	.280	.214	-.042	.959	.256	.491
Pest outbreak	-12.878	.982	-2.901	.999	-12.808	.391
Disease outbreak	-11.892	.983	-13.470	.996	-10.903	.192
Different harvesting skills	2.245	.050**	1.657	.707	-1.675	.900
Market availability	15.879	.944	.928	.007***	18.143	.993
Maize grading and standardization	.704	.038**	-.038	.114	1.628	.002***
Fund's availability	.283	.353	.353	.017**	.962	.059*
Seed accessibility	.589	.010*	.962	.700	.962	.040**
Seed availability purchase during planting season	1.567	.004***	1.143	.960	.120	.500
Seed affordability	.779	.035**	-10.377	.962	.958	.102
Attributes of seeds	-.031	.822	1.354	.074*	.120	.618
Diagnostics						
Base category	White variety					
Number of observations	208					
LR chi-square	105.764					
-2 Log likelihood	345.350					

Cox and Snell (0.535), Nagelkerke (0.631), McFadden (0.333); Note ***, **, *. Significant at 1%, 5% and at 10% probability level, respectively

Source: Survey results (2022/2023)

4.3.2 Discussion of factors affecting selection of maize seed varieties for climate change adaptation among emerging farmers

4.3.2.1 Discussion on factors affecting the selection of the red variety

The study found significant and positive relationships between the selection of red maize seed variety and several factors for the purposes of adapting to climate change. Factors that were deemed significant in influencing the selection of red maize seed variety were age group of farmers, different harvesting skills, maize grading and standardization during marketing phase, seed accessibility, and seed availability during planting season, and seed affordability. Pertaining to age group of farmers, results in Table 4.3 shows that age group significantly influenced the selection of red seed maize variety at 5% level of significance. The results also revealed that as the age group of farmers increases, the probabilities of selecting a red seed stand a chance of being selected by 1.47 units. The findings of this study are in line with the study conducted by Sigigaba *et al*. (2021), who also found that farmer's age has a positive influence on farmers' selection of maize seed varieties. Rehima *et al*. (2013) also discovered that age is among the factors that influence smallholder famers on maize varietal choices. Relating to maize harvesting skills, the study also revealed that it significantly influences the selection of red seed variety at 5% level of significance. The study uncovered that farmers within the study sample preferred mostly hand harvesting, and that had a positive relationship with selecting red seed variety. In concurrence, Johannes *et al*. (2010), supports that farmers who acknowledge new information, including new technologies in farming tend to get more knowledge about farming. Base on this sentiment, more harvesting skills means knowledge of various seed varieties and knowing which seed to use for which yielding style.

Grading and standardization of maize during marketing phase significantly influenced the selection of red seed variety at 5% level of significance. The red seed variety was found to possess a better grading characteristic than yellow variety, which positively influences its selection over the yellow variety. This implies that farmers prefer red variety for its attributes that positively gives them an advantage in the market during grading and standardization. In a similar study conducted by Li *et al*. (2019), it was revealed that maize grading and standardization play a crucial role in ensuring that the

maize produced is of high quality and meets market standards. Concerning seed accessibility, results in Table 4.3 show that seed accessibility significantly influenced the selection of red seed maize variety at 10% level of significance. The study also revealed that as seed accessibility increases, the likelihood of farmers choosing the red seed variety also increases. It was stated by (URT, 2013) that seed accessibility is a critical factor in determining farmers' choice of maize seed. As such, farmers' access to various seeds determines the kind of seeds they will utilize. Thus, farmers' selection of the red seed variety is positively linked with its accessibility in the shelf during planting season. Obtaining seeds timely offers farmers an opportunity to adjust their production to favorable climatic conditions. Tesfaye and Tirivayi (2021) found that smallholder farmers in Ethiopia who had better access to seeds had significantly higher maize productivity than those who did not have access to seeds. The authors emphasized the importance of strengthening seed systems to improve smallholder farmers' productivity and food security.

When it comes to seed availability, the study in Table 4.3 revealed that it significantly influenced the selection of red seed variety at 1% level of significance. This suggests that red seed variety is positively selected based on its availability during the planting season. It was noted by FAO (2017) that seed availability plays a crucial role in farmers' decision-making regarding the use of specific seed variety. Just like the accessibility of seed, its availability timeously improves the efficiency of farmers in deciding on the mechanisms to adapt to climate change. Van Rooyen *et al*. (2017) found that smallholder farmers in South Africa valued maize varietal diversity and were willing to adopt new seed varieties if they were readily available and suited to local conditions.

Seed affordability has a significant impact on farmers' choice of maize seed variety at 5% level of significance. The results suggest that the more affordable the red seed variety deem among farmers the better chance of being selected. The affordability of seed maize positively contributes to a minimized production costs, giving farmers more options to adapt to climate change. Access to affordable seeds is crucial for farmers, particularly in developing countries where many face financial constraints and limited access to credit. In a study conducted in Malawi by Chirwa *et al*. (2016) also revealed that seed affordability was a major determinant of maize seed selection among farmers for their agronomic and economic needs. Consequently, in Tanzania it was found that

farmers prioritized seed affordability to meet their agronomic requirements (Tittonell *et al*., 2015). The affordability of red seed variety presents cost friendly opportunity to adapt to climate change, hence its high likelihood of being selected.

4.3.2.2 Discussion on factors affecting choice of yellow variety

The study results show that the selection of yellow seed variety was significantly influenced by factors such as level of education, the availability of seeds in the market, availability of funds, and the attributes of the seeds. The factors in question influenced the selection of yellow variety for the purposes of climate change adaptation. Level of education was found to statistically influence the selection of yellow seed variety at 5% level of significance. The results suggest that as farmers attain more level of education a yellow seed variety stands a better chance of being selected. A positive relationship between attaining a level of education and the selection of yellow seed variety could imply that farmers are aware of the characteristics that yellow seed variety possess that could significantly assist farmers in adapting to climate change. In line with the findings of the study, the study by Mutanyangwa (2017), also pointed out that farmers' education has a significant impact on the selection of seed varieties for desired benefits. Literate farmers are in a better position to know the characteristics of the yellow variety for the purposes of climate change adaptation. This study found that farmers with higher levels of education were more likely to adopt improved maize varieties, which were perceived to have higher yields, better resistance to pests and diseases, and better drought tolerance. The study also found that education positively influenced farmers' access to information and their ability to analyze and compare different varieties (Alemu and Abera, 2018).

The results in Table 4.3 shows that market availability influences the selection of yellow seed variety at 1% level of significance. This suggests that market availability plays a crucial role in farmers' selection of yellow seed variety for climate change adaptation. With wider market range and increased demand for yellow maize by consumers, farmers are more likely to choose them. This highlights the importance of market demand for yellow maize seed variety as it affects the choice of farmers, ensuring that they won't face spoilage or wastage of their produce. The results indicate that there is a strong connection between market availability and the choice of yellow seed variety,

showing that farmers choose yellow maize due to market demand. A study conducted by Smith *et al*. (2020) found that market availability was a significant factor in small-scale farmers' selection of crops in sub-Saharan Africa. Another study by Johnson *et al*. (2019) explored the impact of market demand on farmers' choice of crops in Southeast Asia and found similar results. These findings reinforce the need for policies and initiatives that support the market accessibility of climate-resilient crops, such as yellow maize, to help farmers adapt to changing climate conditions. From the study, farmers' selection of yellow seed variety and funds availability is statistically significant at 5% level of significance. The results of the study suggest that having access to funds positively influence farmers' selection of yellow maize variety for climate change adaptation. In a similar study conducted by Muricho *et al*. (2017) it was found that if farmers have access to funds, they are more likely to choose yellow maize seeds as their crops. So in this case, the findings of the study shows that having access to funds significantly influences farmers to select the yellow variety. This could mean that yellow variety is expensive than red and landrace hence farmers consider it when they have money. It means farmers with funds or money may adopt to climate change through yellow due to its cost's implications. In terms of attributes of seeds, the results show that the relationship between seed attributes and the selection of yellow seed variety is statistically significant at 10% level of significance. This shows that seed attributes, such as high yield, pest resistance, and drought tolerance, may have a positive impact on farmers' selection of yellow seed variety for climate change adaptation. A study conducted by Akponikpé (2018) also discovered that seed yield, seed size, and seed color, drought tolerance, and pest and disease tolerance were important attributes that influenced farmers' seed selection decisions for maize in Benin.

4.3.2.3 Discussion on factors affecting choice of landrace variety

The study discovered a significant and positive association between the choice of landrace seed variety and various factors for adapting to climate change. Factors deemed to statistically influence the selection of landrace for the purposes of adapting to climate change were maize grading and standardization, availability of funds, and access to seeds. The results of the study showed a significant relationship between maize grading and standardization and the selection of landrace seed variety at 1% level of significance. This suggests that quality control measures, such as grading, and standardization of maize seeds significantly influence the seed variety that the farmer

will choose. The results show that from the study sample, farmers would select landrace variety for its ability to meet the grading and standardization requirements in the face of climate change. A study conducted in Cameroon by Kanu and Ikomey (2015) found that farmers use seed varieties with improved grading and standardization abilities to enhance their customer's confidence. Pertaining availability of funds, the results indicate a positive and significant association between the selection of landrace variety and availability of funds at 10% level of significance. The results imply that selection of landrace stands a better chance when farmers have access to funds. It could be because it's expensive. Muricho *et al*. (2017) found that the availability of funds played a limited role in farmers' seed selection decisions in Kenya, with factors such as seed availability and seed quality being more important. In terms of seed accessibility, the results of the study showed a significant relationship between seed accessibility and the choice of landrace maize seed variety at a significance level of 5%. As the availability of maize seed increases, the likelihood of farmers selecting landrace seed variety also increases. A study by Anderson *et al.* (2019) investigated the impact of seed accessibility on farmers' seed choices in rural areas of Sub-Saharan Africa. The study found that seed accessibility was positively associated with seed adoption and use. In particular, the study found that improved seed distribution systems, increased availability of high-quality seeds, and strengthened seed policies were key drivers of seed accessibility. These findings suggest that investments in seed accessibility can help farmers access a wider range of seed options and improve their seed choices.

4.4 Multinomial logistic regression results on climate change knowledge on selection of maize seed varieties

4.4.1 Presentation of results pertaining farmers' knowledge on climate change

The estimation of the multinomial logit model for this study was assumed by standardizing one category, which is normally referred to as the ''base category'' and in this analysis, the base category is white seed variety. The model explained the relationship between selection of maize seed varieties and factors influencing climate change knowledge on selection of maize seed varieties (see Table 4.4 below). The

dependent variable was maize seed varieties (white, red, yellow, and landrace). The study used the Nagelkerke test to evaluate the goodness of fit of the logistic regression model. The Nagelkerke r-squared value of 0.689 shows the 68.9% of variance in the outcome that is explained by the predictor variables, showing that the model used in the analysis was appropriate. Climate change knowledge that significantly influenced the selection of maize seed selection relates to climate change awareness, temperature observation, and impacts of climate change at 10% level of significance; climate change sources, impacts of climate change, climate change awareness, flood, and drought-occurrence observations at 5% level of significance; and climate change awareness, and rainfall observation at 1% level of significance.

Table 4.4: parameter estimates of multinomial logistic climate change adaptation model

Explanatory variable	Maize seed varieties					
	Red		Yellow		Landrace	
	Coefficients	P-level	Coefficients	P-level	Coefficients	P-level
Intercept	. 695	.607	9.403	1.741	-1.741	.472
Climate change awareness	1.000	.007***	4.950	.060*	2.429	.010**
Climate change sources	-.596	.027**	1.646	.839	-.620	.218
Causes of climate change	.023	.856	-.413	.596	.027	.913
Impacts of climate change	.616	.025**	.995	.056*	1.048	.066*
Rainfall observation	.400	.383	-2.098	.009***	-2.214	.810
Temperature observation	-.133	.645	-.236	.010**	.170	.757
Drought-occurrence observation	-.003	.993	-.351	.729	-.998	.067*
Flood-occurrence observation	.272	.215	.429	.666	-.036	.942
Climate change intervention training	-.410	.345	5.635	.595	1.182	.217

Diagnostics

Base category	White variety
Number of observations	208
LR chi-square	112.972
-2 Log likelihood	387.012

Cox and Snell (0.647), Nagelkerke (0.689), McFadden (0.547); Note ***, **, * Significant at 1%, 5% and at 10% probability level, respectively

Source: Survey results (2022/2023)

4.4.2 Discussion on the influence of climate change knowledge towards the selection of red seed variety

The study revealed that there is a significant relationship between farmers' knowledge about climate change and their choice of red seed variety. Knowledge relating to climate change awareness, impacts of climate change, and sources of information on climate change has a significant influence of farmers' selection of the red variety. Climate change awareness statistically influenced the selection of red seed variety at 1% level of significance. Increase in the knowledge of climate change has a positive influence on the selection of red variety as a maize of choice. A study that investigated the adoption of maize seed variety found that farmers' knowledge relating to their farming conditions significantly influenced the type of maize to consider (Sarwar *et al*., 2020). The results in Table 4.4 show a significant and negative association between farmers' knowledge of the sources of climate change and selection of a red variety at 5% level of significance. The implication of the results is that knowledge of sources of climate change doesn't trigger farmers in selecting the red seed variety. A study conducted in Kenya found that while farmers were aware of the impacts of climate change on their crops, they continued to use traditional farming practices and preferred traditional seed varieties because they were more familiar with these practices and trusted them more (Mwaura, 2015).

Being aware of the impacts of climate change by farmers significantly influenced the selection of red seed variety at 5% level of significance. This significant relationship indicates that an increase in the knowledge of the impacts of climate change is positively associated with the selection of the red seed variety. This implies that knowledge of the impacts of climate change influences farmers to select red variety for its ability to withstand such impacts. The same was revealed in a study by Nkalubo *et.al*. (2012) who indicated that observation of impacts of climate change has led farmers to choose specific seed variety for their survival.

4.4.3 Discussion on the influence of climate change knowledge towards the selection of yellow seed variety

The study showed that climate change knowledge influencing the selection of yellow seed variety as an ideal choice was being aware of climate change, rainfall observation, impacts of climate change, and temperature observation. The results of the study show that farmers' possession of climate change knowledge had a positive and significant influence on the selection of the yellow maize seed variety at 10% level of significance. The results imply that farmers' knowledge about the climate change increases the likelihood of selecting the yellow seed variety. Studies have shown that farmers' decision-making on seed selection can be influenced by various factors such as access to information on climate change and its impacts (Gbetibouo and Hassan, 2009; Bebber *et al*., 2011). This highlights the importance of providing farmers with accurate information relating to climate change ranging from its impacts, causes and mitigation measures to build a resilience capacity of farmers.

Farmers' knowledge about the impacts of climate change influenced the choice of yellow maize seed variety at 10% level of significance. The results indicate that farmers' knowledge about the impacts of climate change prompts them to select the yellow seed variety for its desired benefits. Climate change impacts on the production of specific commodities differently, hence farmers who are familiar with the impacts of climate change select yellow variety for desired benefits. In a study by Francis *et al*. (2013), it was articulated that one's knowledge about the impacts of climate change eventually influence the types of commodities farmers would venture into. Their production level has been influenced by the impacts of climate change which could also emanate from the severe impacts that farmers have encountered in the past.

Pertaining rainfall observation for over the five years production cycles (2017-2021), the results from the study sample shows that there is a statistically significant relationship between rainfall observation and the selection of yellow maize seed variety at 1% level of significance. The results also revealed a negative relationship between rainfall observation and the choice of yellow seed variety. This means that as farmers continue to observe the rainfall pattern, the likelihood of them choosing the yellow seed variety decreases. The findings suggest that observation of the rainfall pattern leads to an informed decision relating to the type of commodity a farmer can venture into in

the face of climate change. In a study conducted in Kenya relating to the selection of quality seed for improved production, it was revealed that farmers with limited access to weather variability information suffered production loss more than their counterparts (Muema *et al*., 2018).

Regarding the observation of the temperature pattern, the study reveal that the selection of the yellow seed variety was negatively influenced by such observation at 10% level of significance. The results imply that a continuous observation of the temperature pattern by farmers within the study sample decreases the likelihood of selecting a yellow seed variety as a commodity of choice. Several studies have shown the severe impact that the gradual increase in the temperatures has on the crop growth and productivity which eventually implicates on the selection of seed variety for their resistance ability to the adverse impact of climate change (Asseng *et al*., 2013). Fekadu and Erenstein (2020) found that higher temperatures were associated with lower maize yields in Ethiopia, and suggested that farmers may need to adapt their seed selection decisions to cope with changing climatic conditions.

4.4.4 Discussion on the influence of climate change knowledge towards the selection of landrace seed variety

The study found that a positive relationship exists between farmers' knowledge of climate change and their choice of landrace maize seed varieties. Additionally, the study revealed that farmers' awareness of climate change, understanding of its impacts, and observation of the drought occurrence for the past five seasons (2017-2021) significantly influenced the landrace seed selection among farmers. The awareness of climate change statistically influenced the selection of landrace seed variety at 5% level of significance. That improved knowledge of climate change among farmers increases the likelihood of selecting landrace as a commodity of choice. A study which was conducted in China which also investigated the relationship between climate change awareness and selection of maize seed selection for climate change adaptation discovered that farmers who were more aware of climate change were more likely to adopt drought-tolerant maize varieties (Li *et al*., 2015). Farmers' knowledge of the impact of climate change was found to statistically and negatively influence the selection of a landrace variety at 10%. The results suggest that farmers with knowledge of the impacts of climate change towards maize are well set about the variety that

withstands the adverse impact of climate change, hence their selection for other varieties over the landrace. A study conducted in Kenya found that farmers who were more aware of the impacts of climate change were more likely to adopt drought-resistant maize varieties and other climate-resilient practices (Olukosi and Owolabi, 2015). The results indicate a negative relationship between the selection of landrace maize variety and drought-occurrence at 10% level of significance. The results show that observing drought occurrence influences farmers to opt for other seed varieties than the landrace variety. The decision behind farmers opting for the landrace variety less every time they observe drought occurrence could be because landrace variety is less drought tolerant than other varieties. The findings of the study are contrary to that of Demissie *et al.* (2012) who noted that landrace variety was preferred by farmers for its drought tolerance as compared to commercial varieties**.**

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

The chapter presents a summary of the study findings, as well as its conclusions and recommendations, in accordance with the study objectives.

5.2 SUMMARY

Regarding the socio-economic characteristics of farmers, the results revealed that most farmers were male, and between the ages of 41 to 50 years. The study also revealed that majority of farmers were married and had secondary education. The study discussed the factors affecting the selection of maize seed varieties among emerging farmers for climate change adaptation. The selection of seed varieties (red, yellow, and landrace) was found to be significantly influenced by different factors. Factors that significantly influenced the selection of seed varieties included age group of farmers, harvesting skills, maize grading and standardization during the marketing phase, seed accessibility, and seed availability during the planting season, seed affordability, level of education, availability of funds, market availability, and seed attributes. Pertaining age of farmers, the study revealed that older farmers were more likely to grow red maize. When it comes to harvesting skills, the study found that farmers who had better harvesting skills were more likely to adopt yellow and landrace seed variety, as they were able to better handle and preserve the quality of the maize during the harvesting process. The results of the study showed that farmers also preferred red variety and landrace for the purposes of meeting the market standards. According to the results, the affordability of seed was found to be a significant determinant of the type of seed that farmers chose to grow. In areas where red seed variety was more affordable, farmers were more likely to choose it over other varieties. On the other hand, in areas where red maize seed was more expensive, farmers were more likely to choose other varieties of seed. Regarding level of education, the results found it to have a significant influence on the selection of yellow maize seed variety for adaptation to climate change, with higher levels of education leading to a higher likelihood of selecting yellow seed variety. It was uncovered that farmers with higher

levels of education are more aware of the characteristics of the yellow variety that could assist in adapting to climate change. Pertaining the availability of funds, the results revealed that it played a significant role in the selection of yellow maize seed variety among farmers. It was found that farmers who have a higher level of education tend to choose yellow seed variety, likely due to the attributes of the variety and its accessibility. It was noted that farmers who have a higher level of education and better access to market tend to choose yellow seed variety, likely due to the attributes of these seeds. These attributes could include: high yield yields compared to other varieties, which can result in more profits for farmers, better storage and transport which can reduce losses due to spoilage or damage during transit; resistance to pests and diseases, which can reduce the need for costly pesticides and other chemicals; consumer demand and marketability.

With respect to climate change knowledge influencing farmers' seed selection, the study revealed that the awareness of climate change, impacts of climate change, sources of climate change information, farmers' observation of rainfall and temperature patterns, and drought-occurrence had a statistically significant impact on farmers' selection of maize seed varieties. The study found a positive relationship between farmers' knowledge of climate change and their seed selection decisions, specifically for the yellow seed variety and landrace seed variety. The results showed that farmers with more knowledge of climate change and its impacts were more likely to select yellow maize seed variety, while observing rainfall and temperature patterns decreased the likelihood of selecting the yellow seed variety. On the other hand, knowledge of climate change and drought occurrence negatively influenced the selection of landrace maize seed variety, with drought occurrence reducing the likelihood of selecting the landrace variety.

5.3 CONCLUSION

The main objective of this study was to investigate the determinants influencing the selection of maize seed varieties among emerging maize farmers in Mopani district. The study intended to respond to three specific research questions. The study uncovered that farmers select red, yellow and landrace varieties depending on a specific desired benefit towards climate change adaptation. First the study intended to determine and identify socio-economic characteristics, the predictor variables of the

said characteristics were level of education, and age group of farmers. Regarding the age group of farmers, the results revealed that the dominant age group was between 41 and 50 of age. While most farmers within the study sample had achieved secondary education. The study aimed to examine the factors influencing choice of maize seed varieties among farmers in Mopani district. The study discovered that several factors influenced the choice of maize seed varieties for climate change adaptation. The selection of maize seed varieties was significantly influenced by factors such as the age group of farmers, advanced harvesting skills, maize grading and standardization during marketing phase, seed accessibility and availability, level of education, seed affordability, availability of funds, and the attributes of seeds. The study also sought to determine the influence of climate change knowledge on selection of maize seed varieties. The study uncovered that indeed farmers' knowledge about climate change, their understanding of its impacts, climate change sources, observation of the temperature and rainfall patterns, and observation of drought occurrence over the past five years significantly influenced the selection of maize seed varieties for the desired benefits. The study sought to identify the determinants of maize seed selection for climate change adaptation and the determinants were found to be age group of farmers, advanced harvesting skills, maize grading and standardization during marketing phase, seed accessibility and availability, level of education, seed affordability, availability of funds, and the attributes of seeds.

5.4 RECOMMENDATIONS

The recommendations of the study are as follows:

5.4.1 Farmers should be equipped with various harvesting skills and harvesting equipment that can enhance their chances to preserve quality and grades required in the market.

5.4.2 Farmers may be assisted with necessary production inputs that will enhance the production quality that satisfies the market standards.

5.4.3 Farmers should be assisted to identify specific maize seed variety that possess attributes suitable for environmental conditions within their operational regions.

5.4.4 Farmers can be assisted with availing varieties of seeds within their regions to ensure ease accessibility.

5.4.5 Farmers can be linked with various market wherein they can sell their produce.

5.4.6 Continuous efforts should be made to promote climate change awareness and various adaptation and mitigation mechanisms that can assist farmers and other key role players within agricultural sector.

5.4.7 Farmers should be supported in accessing information on weather variability timely.

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APPENDIX A: PERMISSION LETTER

Limpopo Department of Agriculture and Rural Development
Mopani
0826

Dear Sir/Madam

REQUEST FOR PERMISSION TO CONDUCT RESEARCH

I am a master's student at the University of Venda, Faculty of Science, Engineering and Agriculture under the Department of Agricultural Economics and Agribusiness, currently undertaking a study entitled: The Determinants of Maize Seed Selection for Climate Change Adaptation among emerging farmers in Mopani District, Limpopo Province, South Africa.

The aim of this study is to investigate the determinants of maize seed selection for climate change adaptation among emerging farmers in Mopani District, Limpopo Province, South Africa. The following ethical standards will be followed throughout the research process; Informed consent, voluntary participation, and freedom to withdraw without any penalty, and names of participants will not be mentioned during discussions.

Thank you in advance.

Yours Sincerely,

Ms. S Baloyi

APPENDIX B: PERMISSION LETTER TO TRADITIONAL LEADERS (INDUNA)

Dear Sir/Madam

REQUEST FOR PERMISSION TO CONDUCT RESEARCH

I am a master's student at the University of Venda, Faculty of Science, Engineering and Agriculture under the Department of Agricultural Economics and Agribusiness; and I am expected to conduct a research study as a requirement for the degree. I kindly request your permission to conduct this study in your area.

The topic for my research is: "The Determinants of Seed Selection for Climate Change Adaptation in Mopani District, Limpopo Province, South Africa". The study involves the use of a structured questionnaire to collect data. The following ethical standards will be followed throughout the research process; Informed consent, voluntary participation, and freedom to withdraw without any penalty, and names of participants will not be mentioned during discussions.

Thanking you in anticipation.

Yours truly,

Ms. S. Baloyi

APPENDIX C: LETTER OF CONSENT FOR RESPONDENTS

My name is Seugnet Baloyi. I am a student doing Master of Science in Agriculture (MSCAEC) in the Department of Agricultural Economics and Agribusiness at the University of Venda. I am conducting a research on The Determinants of Maize Seed Selection for Climate Change Adaptation among Emerging Farmers in Mopani District, Limpopo Province, South Africa.

You have been selected to participate in this study because you are one of the farmers who produce maize. You will unfortunately not benefit from your participation as an individual, however, it is envisioned that your participation and findings of this study will contribute towards ensuring a sustainable agriculture.

This research is for academic purposes only and by participating in this study, you agree that this information may be used for this research purpose including dissemination through research report, publications, and conferences.

Your participation is voluntary, and you can withdraw at any time without penalty. Your responses will be kept confidential. By completing the survey, you indicate that you voluntarily participate in this research.

For further information, you may contact my supervisor, Dr M. Tshikororo on the following numbers:

Cell number: 071 205 9868
Office number: 015 962 8226

....

Signature of respondent Date

CONSENT FORM

University of Venda

Topic: The Determinants of Maize Seed Selection for Climate Change Adaptation among Emerging Farmers in Mopani District, Limpopo Province, South Africa.

The consent form is designed to check that you understand the purposes of the study, you are aware of your rights as a participant and to confirm that you are willing to take part.

Please tick if appropriate	Yes	No
The nature of the study has been described to me.		
I understand that I am free to refuse to take part if I wish		
understand that I may withdraw from the study at any time without having to provide a reason		
I have received sufficient information about the study for me to decide whether to take part		
I know that I can ask for further information about the study from the research team.		
I understand that all information arising from the study will be treated as confidential.		
I know that it will not be possible to identify any individual respondent in the study report, including myself.		
I agree to take part in the study		
Name: ..... Date:		
Signature:		

APPENDIX D: PARTICIPANT REGISTER

Faculty of Science, Engineering and Agriculture

Department of Agricultural Economics and Agribusiness

Number	Date	Name of respondent	Place	Contact number	Signature

APPENDIX E: STRUCTURED QUESTIONNAIRES

DEPARTMENT OF AGRICULTURAL ECONOMICS AND AGRIBUSINESS

Questionnaire Number: .....

Interview Date: .....

Area of respondent: .....

SECTION A: To determine the socioeconomic characteristics of emerging farmers in Mopani district.

1. What is your gender?

a) Male	0
b) Female	1

2. What is your home language?

a) Xitsonga	0
b) English	1
c) Tshivenda	2
d) Other	3

3. Age group

a) 20 years and less	0
b) 21 - 30 years	1
c) 31 - 40 years	2
d) 41 – 50 years	3
e) More than 50 years	4

4. Marital status

a) Married	0
b) Single	1
c) Divorced	2
d) Widowed	3

e) Other (specify)	4

5. Household size

a) 0 – 5	0
b) 6 – 10	1
c) More than 10	2

6. What is your level of education?

a) Never attended	0
b) Primary level	1
c) Secondary level	2
d) Tertiary level	3
e) Other (specify)	4

7. Are you a full-time farmer?

a) Yes	0
b) No	1

8. Annual income from farm (in Rands) per season

a) <5000	0
b) 5001 – 15 000	1
c) 15 001 – 20 000	2
d) 20 001 – 25 000	3
e) More than 25 000	4

9. How long have you been farming?

a) 1-5 years	0
b) 6-10 years	1
c) More than 10 years	2

10. Do you have an off-farm source of income?

a) Yes	0
b) No	1

11. What sources of income do you have off-farm?

a) Full-time worker	0
b) Part-time worker	1
c) Pensioner	2
d) Social child grant	3
e) Remittances	4
f) Other (specify)	5

12. Do you own the land you use for farming?

a) Yes	0
b) No	1

13. If no, what is your arrangement?

a) Freehold Tenure system	0
b) Inheritance Tenure system	1
c) Communal Land Tenure system	2
d) Gift Tenure system	3
e) Rent Tenure system	4
f) Tenants at government will	5
g) Other (specify)	6

14. Land size

a) Less than 1ha	0
b) 1 – 5ha	1
c) 5 – 10ha	2
d) 11 – 19ha	3

e) More than 20ha	4

SECTION B: To examine factors influencing choice of maize seed variety

15. How do you plant your maize?

a) Machine-planting	0
b) Hand-planting	1
c) Both	2
d) Other (specify)	3

16. What type of farming do you practice?

a) Rainfed farming	0
b) Irrigated farming	1
c) Both	2

17. What is your main source of water for maize irrigation?

a) Rain	0
b) Boreholes	1
c) Dam	2
d) Taps	3
e) River	4
f) Other (specify)	5

18. Which method do you use for irrigation?

a) Sprinkler	0
b) Furrow	1
c) Drip	2
d) Centre pivot	3
e) Rotation	4

f) Other (specify)	5

19. What problems do you face growing maize in this area?

a) Drought	0
b) Difficult to get inputs	1
c) Pests	2
d) Soil fertility	3
e) Shortage of labour	4
f) Theft	5
g) Disease outbreak	6
h) Other (specify)	7

20. Have you ever experienced drought?

a) Yes	0
b) No	1

21. Have you ever experienced pests' outbreak?

a) Yes	0
b) No	1

22. Have you ever experienced shortage of labour?

a) Yes	0
b) No	1

23. Have you ever experienced theft in your farm?

a) Yes	0
b) No	1

24. Have you ever experienced a disease outbreak?

a) Yes	0
b) No	1

25. Which disease(s) have you experienced the most in your maize production?

a) Bacterial Stalk Rot	0
b) Black Bundle Disease and Late Wilt	1
c) Charcoal-Rot	2
d) Common Rust	3
e) Downy Mildews	4
f) Other (specify)	5

26. Have you ever experienced Bacterial Stalk Rot in your maize production?

a) Yes	0
b) No	1

27. Have you ever experienced Black Bundle Disease and Late Wilt in your maize?

a) Yes	0
b) No	1

28. Have you ever experienced Charcoal-Rot in your maize?

a) Yes	0
b) No	1

29. Have you ever experienced Common Rust in your maize?

a) Yes	0
b) No	1

30. Have you ever experienced Downy Mildews in your maize?

a) Yes	0

b) No	1

31. Which pests affect your maize production the most?

a) Maize stalk borer	0
b) Worms	1
c) Black maize beetle	2
d) Maize snout beetle	3
e) Spotted maize beetle	4
f) Other (specify)	5

32. Have you ever experienced Maize stalk borer in your maize?

a) Yes	0
b) No	1

33. Have you ever experienced worms in your maize?

a) Yes	0
b) No	1

34. Have you ever experienced Black maize beetle?

a) Yes	0
b) No	1

35. Have you ever experienced maize snout beetle?

a) Yes	0
b) No	1

36. Have you ever experienced spotted maize beetle?

c) Yes	0
d) No	1

37. What methods are you using to combat maize pests?

a) Pesticides	0

b) Insecticides	1
c) Herbicides	2
d) Other (specify)	3

38. What methods are you using to combat maize diseases?

a) Pesticides	0
b) Insecticides	1
c) Herbicides	2
d) Other (specify)	3

39. What are the reasons for your seed selection?

i. Affordability

a) Yes	0
b) No	1

ii. Easy to maintain?

a) Yes	0
b) No	1

iii. Accessibility?

a) Yes	0
b) No	1

iv. Other (Specify) _____

_____

40. Have you experienced any production effects from pests?

a) Yes	0
b) No	1

41. Have you experienced any production effects from diseases?

a) Yes	0
b) No	1

42. How have pests affected your production?

a) Maize failure	0
b) Reduced the quality of maize	1
c) Caused injury	2
d) Pests eat up leaves of maize	3

43. How have diseases affected your production?

a) Maize failure	0
b) Reduced the quality of maize	1
c) Caused injury	2
d) Pests eat up leaves of maize	3

44. Do maize varieties require different harvesting skills?

a) Yes	0
b) No	1

45. If yes, which harvesting skill(s) do you possess?

a) Hand harvesting	0
b) Harvesting with hand tools	1
c) Harvesting with machinery	2
d) Other (specify)	3

46. What source of labour do you use in your farming activity?

a) Household labour	0
b) Hired labour	1
c) Both	2

47. Do you have access to electricity?

a) Yes	0
b) No	1

48. Do you have access to the markets?

a) Yes	0
b) No	1

49. What type of road do you use to the market?

a) Tarmac	0
b) Rough	1
c) Other (specify)	2

50. What is your target market?

a) Hawkers	0
b) Wholesalers	11
c) Middlemen	2
d) retailers	3
e) local supermarkets	4
f) Other (specify)	5

51. What marketing arrangement do you use for selling your maize?

a) High-value market	0
b) Informal market	1
c) Contractual	2
d) Other (specify)	3

52. Is your maize graded before marketing?

a) Yes	0
b) No	1

53. Do you keep farming records?

a) Yes	0
b) No	1

54. Are you able to access credit from any source?

a) Yes	0
b) No	1

55. What is the distance from point of production to the nearest market?

a) 1 – 30 km	0
b) 31 – 60 km	1
c) 61 – 90 km	2
d) More than 90 km	3

56. Who provide transportation from the farm to the destination?

a) Transporter	0
b) Self-transport	1
c) Collective transport	2
d) Buyers transport for themselves	3
e) Other (specify)	4

57. What general problem do you experience in moving your produce?

a) Lack of transport	0
b) Small size of transport	1
c) High transport cost	2
d) Other (specify)	3

58. Are the seeds accessible?

a) Yes	0

b) No	1

59. Is seed available for purchase during the planting season?

a) Yes	0
b) No	1

60. Is the price of seeds affordable?

a) Affordable	0
b) Not affordable	`1
c) Other (specify)	2

61. Do you have knowledge of maize varieties?

a) Yes	0
b) No 00	1

62. Do you get agricultural extension services in your area?

a) Yes	0
b) No	1

63. Do you have access to agricultural information?

a) Yes	0
b) No	1

64. If yes, which medium do you possess?

a) Extension agent	0
b) Radio or television	1
c) Other (specify)	2

65. Do you belong to any organisation?

a) Yes	0

d) No	1

66. Do you receive input subsidy?

a) Yes	0
b) No	1

67. Which variety did you grow?

a) White variety	0
b) Red variety	1
c) Yellow variety 2	2
d) Improved maize3 variety	3
e) Landrace/local	4
f) Other (specify)	5

68. What are the attributes of your maize seed?

a) High yield	0
b) Disease resistance	1
c) Pest resistance	2
d) Early maturity	3
e) Storage	4
f) Other (specify)	5

69. What was the reason for your choice?

a) Accessibility	0
b) Affordability	1
c) Other (specify)	2

SECTION C: To determine the influence of climate change knowledge on selection of maize varieties.

70. Are you aware of climate change?

a) Yes	0
b) No	1
c) Not sure	2

71. From which source did you hear about climate change?

a) Television/radio	0
b) Newspaper	1
c) Neighbours	2
d) Extension officers	3
e) Other	4

72. What do you think are the causes of climate change?

a) Human activities, for e.g., deforestation, greenhouse emissions and burning out of fossil fuels	0
b) consumerism	1
c) Increasing livestock farming	2
d) Changes in the Earth's orbit and rotation	3
e) Variations in solar activity	4
f) Changes in the Earth's reflectivity	5
g) Not sure	6

73. Do you know the impacts of climate change?

a) Yes	0
b) No	1
c) Not sure	2

74. What are the impacts of climate change that you know?

a) Food insecurity	0
b) Reduction in maize production	1
c) Increased incidence of pest attacks	2
d) Limitations of water availability	3
e) Loss of income	4
f) High production costs	5
g) Other (specify)	6

75. What has been your observation of rainfall for the past 5 years to date according to your memory?

a) Increasing	0
b) Decreasing	1
c) Constant 2	2
d) Didn't observe	3

76. What has been your observation of temperature for the past 5 years to date according to your memory?

a) Increasing	0
b) Decreasing	1
c) Constant	2
d) Didn't observe	3

77. What has been your observation of drought-occurrence for the past 5 years to date according to your memory?

a) Increasing	0
b) Decreasing	1
c) Constant	2
d) Didn't observe	3

78. What has been your observation of flood-occurrence for the past 5 years to date according to your memory?

a) Increasing	0
b) Decreasing	1
c) Constant	2
d) Didn't observe	3

79. Have you ever been trained on climate change interventions?

a) Yes	0
b) No	1

80. Can you adapt to climate change?

a) Yes	0
b) No	1
c) Not sure	2

81. What adaptation measures have you used to deal with the changes in temperature?

a) Crop and variety diversification	0
b) Changing dates of planting	1
c) Build water harvest scheme	2
d) Other (specify)	3

82. If you did not adapt, what made you not to adopt adaptation measures?

a) Lack of information	0
b) Lack of inputs	1
c) Drought/water shortage	2
d) Do not see the need	3
e) Other (specify)	4