DETERMINANTS OF SMALLHOLDER MAIZE FARMERS' VARIETAL CHOICE: A CASE STUDY OF MOGALAKWENA LOCAL MUNICIPALITY LIMPOPO PROVINCE, SOUTH AFRICA

by

MOKGADI ANGELINA MAKWELA

A MINI-DISSERTATION

submitted in partial fulfilment of the requirements for the degree

of

MASTER OF AGRICULTURAL SCIENCE

In

(AGRICULTURAL ECONOMICS)

in the

FACULTY OF SCIENCE AND AGRICULTURE

(school of agricultural and environmental sciences)

at the

UNIVERSITY OF LIMPOPO, SOUTH AFRICA

Supervisor: Prof. I.B. OLUWATAYO

Co-supervisor: Dr. L.S. GIDI

2021

TABLE OF CONTENTS

ABSTRACT

Maize seeds differ according to varieties. The traditional maize varieties (also referred to as (Landraces) are maize varieties that have been cultivated and subjected to selection by farmers for generations. They retain a distinct identity and lack formal crop improvement. Improved maize varieties, on the other hand, are bred with characteristics such as drought and disease tolerance. This research was conducted to determine the attributes preferred by farmers when making a maize varietal choice. To be specific, the study aimed to achieve the following objectives: (i) Identify and describe socioeconomic characteristics of smallholder maize farmers' in Mogalakwena Municipality; (ii) Analyse socioeconomic characteristics of smallholder maize farmers in Mogalakwena Municipality; (iii) Identify different maize varieties grown by smallholder farmers in Mogalakwena Municipality, and (iv) determine and analyse factors influencing farmers' choice of a maize variety. Descriptive statistics and the Multinomial Logistic Regression Model were used for data analysis. The results of the study revealed that 64% of the respondents had formal education. This meant that they have the capability to grasp more information, if provided with trainings. It was found that 75% of the farmers did not have access to extension service which is supposed to play a significant role in agricultural information dissemination. The most grown maize variety was landrace varieties which constituted 59.5%. This percentage was said to be resultant from limited access to the seed market. In fact, 80% of the farmers had to travel an average of 42 kilomteres to access the market which also had a limited number of varieties. The Multinomial Logistic Regression Model revealed that only 5 variables (Educational level, farm size, yield, extension contact and knowledge of maize varieties) were significant at 1%, 5%, 1%,1% and 1%, respectively. The majority of farmers were old people with little access to extension service and an inadequate farming knowledge which lead to a high percentage of farmers continuing to grow landrace varieties. Based on the findings, this study recommend further research on attributes that influence farmers varietal choice and Government intervention in provision for resources and development of existing and new infracstrcture to encourage extension service delivery.

Keywords : Landrace, improve maize variety, smallholder farmer

ACKNOWLEDGEMENTS

God’s love is amazing and His grace is always sufficient. I cannot even imagine what would have happened to me, had He not provided me His grace. I am thankful to Him for empowering me to complete this study.

I extend my sincere gratitude to Prof. I.B. Oluwatayo , Dr. L.S. Gidi and M.E. Ralefatane for holding me by the hand throughout this study. I thank them for consistently encouraging and reassuring me that the completion of this study is possible. I truly appreciate the support, guidance and generous dissemination of your knowledge. Indeed, you have been my pillar of strength throughout my academic work. May the good Lord grant you all your heart’s desires.

I appreciate my life partner, Daniel Mothapo for the lectures and words of encouragement. Lastly, I would like to thank my family from the bottom of my heart; I thank you for your love and financial support. Without your support, this work would have struggled to see the light of day.

DEDICATION

This study is dedicated to the community that has afforded me the opportunity to learn more about the Agricultural sector, Lesodi Motlana in Mogalakwena, to my son, Reatlegile, and to God, the great Creator and Author of knowledge and wisdom, who made all this possible.

DECLARATION

I, Makwela Mokgadi Angelina, declare that this research paper entitled: Determinants of smallholder maize farmers varietal choice: a case study of Mogalakwena Local Municipality, Limpopo Province of South Africa, hereby submitted to the University of Limpopo in fulfilment of the requirements for the degree of Master of Science in Agriculture (Agricultural Economics), has not been submitted before and all sources of information used have been fully acknowledged.

Student ………………………… Date………………………

Miss Makwela, M.A.

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS

DoA	– Department of Agriculture
SADC	- South African Develepment Community
DAFF	- Department of Agriculture,Forestry and Fisheries
IFC	- International Finance Corporation
IMV	- Improved Maize Varieties
OPV	- Open Pollinated Varieties
SSA	- Sub Saharan Africa
FAO	- Food And Agriculture Organization
CIMMYT	- International Maize And Wheat Improvement Center
FAOSTAT	- Food And Agriculture Organization Statistics
ARC	- Agricultural Research Center
SANSOR	- South African National Seeds Organization
SPSS	- Statistical Package For Social Science
MNL	- Multinomial Logit
TREC	- Turfloop Research Ethics Committee

CHAPTER ONE

INTRODUCTION

1.1 Background

The grain industry is one of the largest industries in South Africa, producing between 25% and 33% of the country's total gross agricultural production (GrainSA,2015) The largest area of farmland is planted with maize, followed by wheat and, to a lesser extent, sugarcane and sunflowers. GSA (,2015) This food crop is the largest locally produced field crop, and the most important source of carbohydrates in the southern African region. South Africa is the main maize producer in the Southern African Development Community (SADC). More than 9 000 commercial maize producers are responsible for the major part of the South African crop, while the rest is produced by thousands of small-scale producers. Maize is produced mainly in the North West Province, the Free State, Limpopo, the Mpumalanga Highveld and the KwaZulu-Natal Midlands (DAFF, 2018).

Apart from being the main source of staple food for millions of citizens, the South African maize industry contributes significantly to both the upstream and downstream production inputs in South Africa's processing industries (MaizeTrust,2014). According to StatsSA (2014), the primary agriculture industry contributed 2.5% to the Gross Domestic Product (GDP) whereas the maize industry contributed 0.4% to the GDP. Maize thus plays a vital role in the manufacturing industry which contributes 13% to the total GDP of the country.

According to GSA (2015a), about 350 000 to 500 000 hectares are planted by small-scale farmers. The general practice of planting is notable during the late spring and early summer seasons, with the general optimal planting period being from October to December. Production using improved seed varieties has been identified as a precondition for achieving food security (Langyintuo *et al.,* 2000; Bernard *et al.,* 2010).

Seed variety is recognised to have the greatest ability of increasing on-farm productivity, since seed determines the upper limit of crop yields and the productivity of all other agricultural inputs (MoA, 2004; Bernard *et al.,* 2010). This means that, to increase as well as to sustain production volumes, it will be critical to find mechanisms that guarantee farmers access to improve and produce high yielding seed varieties.

According to the International Finance Corporation (IFC) (2013), the world's population is expected to reach 9.1 billion by 2050. The production of food, mainly staple crops, is expected to increase accordingly, especially for the 870 million people who are currently food insecure. This suggests that the dominant role of agriculture as the primary source of food and employment creation in the developing economies should be stepped up. A study by Alexandratos and Bruinsma (2012) indicated that agricultural production needs an increase of 60% by 2050 to meet the world's consumption demand. This means that smallholder farmers who are regarded as the potential drivers of maize production have an important role to play, with the use of improved varieties being the key driver as they have been identified as a precondition for achieving food security by (Langyintuo *et al.,* 2008).

According to Wandile (2018), in South Africa, maize was first introduced in 1655, and has since become one of the dominant food crops. Maize is regarded as the main staple food and is also used for animal feed by a majority of the residents in the country. On average, between 2.5 and 2.8 million hectares of commercial maize are planted in the country each year. Improving maize production is considered to be one of the most important strategies for food security in the developing countries. The diffusion of the Improved Maize Variety (IMV), i.e. hybrids and Open Pollinated Varieties (OPV) can greatly increase maize yield per unit of land. However, farmers' choice of maize varieties is one of the most crucial factors affecting the productivity of a crop. This is influenced by many factors that affect the farmers' varietal adoption decision (Iqbal *et al.,* 1999; Rogers, 2003). The use of hybrid maize varieties is often seen as crucial in the achievement of increased maize production, household incomes and food security among farmers in the country (Siziba *et al.,* 2013).

Since the introduction of maize in Africa in the sixteenth century, maize has been grown under a wide range of agro-ecologies and socioeconomic conditions. The status of maize as a strategic food security crop took prominence, especially following the devastating droughts of the early 1980s in eastern and southern Africa.

Modern breeding and selection of maize in Africa have been going on since as early as the first decade of 1900s. While there is reason to be encouraged by the fact that half of the developing world's non temperate maize area is devoted to planting MVs, concerns can justifiably be raised by the fact that the other half is still reserved for local varieties (also known as landraces) that have not benefited from formal plant breeding efforts.

According to Ange Mutangwa (2017), improved seed varieties developed by the national and international agricultural research centres quite often fail to get adopted by smallholder farmers, partly because farmers have different needs. They require maize seeds of diverse varieties and of multiple traits. This depends on crop variety traits or attributes, which are the performance characteristics of plant varieties that include both the production (agronomic) capacity of the plant and the consumption attributes of the product (Edmeades, 2003). Farmers encounter difficulties in obtaining maize seeds that meet their specific choices.

1.2. Problem statement

Maize is the major grain crop in South Africa. It is generally regarded as the main staple food and used also for animal feed by a majority of the residents in the country. According to Sindisiwe (2020), maize is the most produced crop in South Africa. However, other studies showed that South Africa's small-scale rain-fed agriculture is characterised by low maize productivity with estimated yields of 1.8 to 3.5 t/ha (Baloyi et.al., 2012). South Africa's smallholder maize farmers are characterised by low maize productivity and this occurs despite the availability of many maize varieties on the market (Shiferaw *et al.,* 2011).

Smallholder maize farmers experience low yield in similar ways due to similar climatic conditions and technical advice received but still experience maize yield differently due to factors such as the maize variety they grow. According to Banziger et al. (2002), 70% of smallholder farmers continue to use local and recycled maize varieties which are characterised by low yields. Yield reduction of recycled improved maize varieties is reported to be about 5 percent while that of recycled landrace varieties can be as high as 32 percent (Japhether *et al.,* 2012). This result gives an indication that the variety of maize grown has much influence on the yield to be harvested.

Maize as a staple food in South Africa has been characterised by low yield (Baloyi *et al.,* 2012). With the exponentially growing population, unfavourable climate conditions, rising maize seeds, fertilizers and maize meal prices, rural smallholder farmers' maize productivity remains low (Fanadzo *et al.,* 2009). The challenge of low yield has been tackled by most breeders of improved maize seed varieties although much focus has been on increasing yields, as well as addressing drought and disease tolerance. Smallholder farmers perceive little advantage from such improvement because such seeds are not designed for their needs (Reeves *et al.,* 2014).

According to Banziger and Cooper (2001), improving maize breeding processes cannot be accomplished without the knowledge of attributes that farmers prefer in maize or any other variety. For effective breeding, farmers' preferences of varieties should be clearly identified through interactions and collaboration between researchers and farmers. Farmers' decisions are therefore not only driven by yield and profit maximisation, but also by complex processes that are affected by several socio economic and psychological variables (Willock *et al.,* 2009). This study intends to address the following research questions:

i. What are the socio-economic characteristics of smallholder maize farmers?

ii. What are the different maize varieties grown by smallholder farmers in Mogalakwena municipality?

iii. What determines smallholder maize farmers choice of variety?

1.3. Rationale

Maize plays a crucial role in the diet of many rural and urban populations in Southern Africa. According to Sindisiwe (2020), maize is the largest locally produced field crop, and the most important source of carbohydrates in the Southern African region with South Africa being the main maize producer in the Southern African Development Community. More than 9 000 commercial maize producers are responsible for the major part of the South African crop, while the rest is produced by thousands of smallholder producers (GrainSA, 2017). However, the study conducted by Baloyi et al. (2012) indicated that there is a low maize yield under smallholder farming. This crop in particular is of great significance to the national food security of South Africa. However, production levels in South Africa continue to decline, further deteriorating the situation of increased food insecurity, (Sindisiwe, 2020). This study was motivated by the need to capture the differences in maize yields among smallholder farmers in the municipality. The selected farmers use the same method of production and acquire the same information from extension workers on how to allocate resources during the production process and also experience same climatic conditions.

Demand for maize has been rising corresponding to the exponentially growing population, increased use of maize in animal feed as well as increased use of commercial food production like the production of corn flakes (Borras *et al.,* 2016). The rise of flex crops and commodities in order to feed the increasing population and ensure sustainable food security, high yielding varieties (Improved Maize Varieties) are required.

According to the DAFF trend analysis report (2017), maize is the most important grain crop in South Africa, serving as both the major feed grain and the staple food of the majority of the South African population. About 59% of maize produced in South Africa is white and the remaining 41% is yellow maize (DAFF, 2017). Production of maize in Sub Saharan Africa (SSA) is dominated by small-scale farmers who have land rights ranging from 0.5 to 3.0 ha (Byerlee & Heisey, 1997). Although improved varieties have been developed in most of the countries in SSA, including South Africa, the majority of the smallholder farmers still rely on traditional (landrace), Open-Pollinated Varieties (OPVs) for their plantings (Aquino *et al.,* 2001; FAO & CIMMYT, 1997).

South Africa’s smallholder maize farmers are characterised by low maize productivity, despite the availability of many maize varieties on the market (Shiferaw *et al.,* 2011). Furthermore, smallholder farmers perceive little advantages from such improvement because improved varieties seeds are not designed for their needs (Reeves *et al.,* 2014).

The study conducted by Tsedeke Abate (2017) revealed that nearly 500 maize cultivars were grown in 13 African countries, South Africa included. In the 2013/2014 main crop season, 69% of the cultivars were planted and each occupied <1% of the total maize area; only two cultivars occupied >40% and four occupied >30% of the area. Approximately 32% of all the cultivars were hybrids, 23% were improved Open-Pollinated Varieties (OPVs), and 46% were local varieties, also known as landrace.

This study intended to extend information to seed producers, and extension agents about the key attributes preferred by smallholder farmers in order to provide maize seeds of the quality desired by farmers.

1.4. Aim of the study

The aim of this study is to identify and analyse the factors influencing smallholder farmer's maize varietal choice in Mogalakwena Municipality.

1.4.1. Objectives of study are to:

i. Identify and describe socioeconomic characteristics of smallholder maize farmers' in Mogalakwena Municipality

ii. Identify different maize varieties grown by smallholder farmers in Mogalakwena Municipality.iii. Determine and analyse factors influencing farmers' choice of maize variety

1.5. Organisation of the study

This study is organised into five chapters. The first chapter presents the general background of the study covering, the problem statement, research questions, rationale of the study, aim and objectives of the study. The second chapter presents the review of literature that is related to the topic of this study. Included in the second chapter are: an overview of the maize industry, importance of both the social and economic factors contributing to maize production in South Africa. The third chapter presents the research methodology, data collection and analytical techniques used in the study. Chapter four presents the results and discussion and Chapter five, being the last chapter, presents the summary of the research, conclusions drawn from the results of the research and recommendations related to the findings of the study.

CHAPTER TWO

LITERATURE REVIEW

2.1. Definition of key concepts

2.1.1. Smallholder farmer

The term 'smallholder farmer' is defined in so many different yet similar ways in all parts of the world. The definition varies from one location and farming system intensification to another. However, a smallholder farmer is generally referred to as an individual farming on a small portion of land mainly for household consumption. According to Mollel (2014), a great number of smallholder farmers practice mixed crop-livestock farming where the number of larger ruminants kept ranges between 3 and 5. Operations in such farming practices are generally sustained and dependent on household labour due to their primary focus on producing for household consumption and poverty alleviation.

Smallholder farmers are the drivers of many economies in Africa even though their potential is often not brought forward. As already indicated, smallholder farmers are defined in various ways depending on the context, country and even ecological zone. The concept 'smallholder' is interchangeably used with 'small-scale', 'resource poor' and sometimes 'peasant farmer'. In general terms, smallholder only refers to the farmer's limited resource endowment relative to other farmers in the sector. Smallholder farmers are also defined as those farmers owning small portions/plots of land on which they grow subsistence crops and one or two cash crops; they rely almost exclusively on family labour (DAFF, 2012).

Production systems of smallholder farmers often entail simple, out-dated technologies, low returns, high seasonal labour fluctuations and women playing a vital role in production. Smallholder farmers differ in individual characteristics, farm size, resource distribution between food and cash crops, livestock and off-farm activities, their use of external inputs and hired labour, the proportion of food crops sold and household expenditure patterns (DAFF, 2012).

Smallholder farmers can play an important role in livelihood creation amongst the rural poor. Even though smallholder production is important for household food security, the productivity of this sub-sector is quite low. Poor yields may be one of the reasons why urban and rural households either abandon or are uninterested in agricultural production. There is therefore a need to significantly increase the productivity of smallholder farmers to ensure long-term food security. This can be achieved by, among other aspects, encouraging smallholder farmers to pursue sustainable intensification of production through improved inputs such as the use of improved seeds and fertilizers (DAFF, 2012).

In Africa, smallholder farmers dominate the agricultural sector and contribute about 75% of agriculture production and 50% of the livestock products. Despite the presence of abundant land in places like Africa, ownership of land by smallholder farmers has been decreasing in size and is expected to continue decreasing in the long run (Masters, 2014).

According to Jayne (2014), the characterisation of smallholder farming systems refers to describing the various categories of farms, their demographics, attributes, production trends, and existing production systems. Trough characterisation, existing farming systems within a study case can be studied. Generally, the characterisation of farms/farming systems involves determination of classes of farms/farming systems, where each class exhibits different attributes.

2.1.2. Landrace maize varieties

These varieties are also called local or traditional cultivars and include recycled hybrids, OPVs which are recycled more than three seasons, and or those for which no information is available on the year of release. According to Carolyn (2019), landraces are maize varieties that have been cultivated and subjected to selection by farmers for generations, retaining a distinct identity and lacking formal crop improvement. They are local varieties of a domesticated plant species which has largely developed adaptation to the natural and cultural environment in which the plants live. Landrace varieties differ from a cultivar which has been selectively bred to conform to a particular standard of traits. Landrace populations are often variable in appearance, but they can be identified by their appearance and have a certain genetic similarity.

Landrace have continuity with improved varieties and a relatively high level of genetic variation, which is one of the advantages that these varieties have over the improved varieties. Although yield may not be as high, the stability of landraces in the face of adverse conditions is typically high; as a result, new pests or diseases may affect some. Although landraces are generally thought of as genetically stable and unchanging, it is also known that even the most ancient landraces receive constant infusions of new genes and that their characteristics are constantly changing. Recent empirical work has shown that landraces may be subjected to several distinct types of intentional selection pressure.

For example, Louette and Smale (1998) have shown that farmers in Africa select seed for replanting on the basis of yield components (e.g., ear size, ear shape, kernel number, kernel size). Selection based on these criteria tends to favour genotypes that are most productive under local conditions. At the same time, the farmers also select seed based on the characteristics of economic or cultural value and in ways that protect perceived ideal types. The presence of the second type of selection pressure helps explain how many different landraces can continue to coexist in conditions of heavy gene flow.

The cultivation of maize landraces can be lost with the passage of time as farmers adapt to changing markets and generational shifts take place (Carolyn, 2019). Maize landrace cultivation has diminished significantly within the farming households. There is a consensus that the current social, economic and physical environments are unfavourable for landrace cultivation. Among the reasons for abandonment are changes in maize cultivation technologies, shifting markets for maize and other crops, policy changes, shifting cultural preferences, urbanisation and climate change. By finding out about landrace continuity in farmers' fields and the factors driving change, we are able to better understand the context in which these landraces are currently cultivated (McLean-Rodríguez, 2019).

However, Wood and Lenné (2014) reported that traditional varieties grown by farmers (also known as landraces or local varieties), often end up being considered unimproved. According to Morris (2018). this is clearly incorrect as landraces have been subjected to numerous cycles of improvement at the hands of farmers, many of whom are skilled at identifying superior germplasm and expert at selecting individual plants that embody desired traits. Farmers' selection procedures in many ways resemble the selection procedures used in formal plant breeding programmes, and although scientific breeding methods may allow progress to be achieved more rapidly in breeders' plots than in farmers' fields, the gains made by farmers over thousands of years have been enormous.

However, landraces are generally less productive than commercial cultivars, although in recent years, they have become important as sources of genetic variability in the search of genes for tolerance or resistance to biotic and abiotic factors of interest in agriculture. The genetic diversity observed across landraces is the most important part of maize biodiversity, and local races represent an important fraction of genetic varieties of the genetic variability exhibited by this genus. Landrace cultivars are extensively used by agronomists, who recognise them as stable and discriminatory categories for the classification of samples. In order to investigate the genomic foundation of maize landraces.

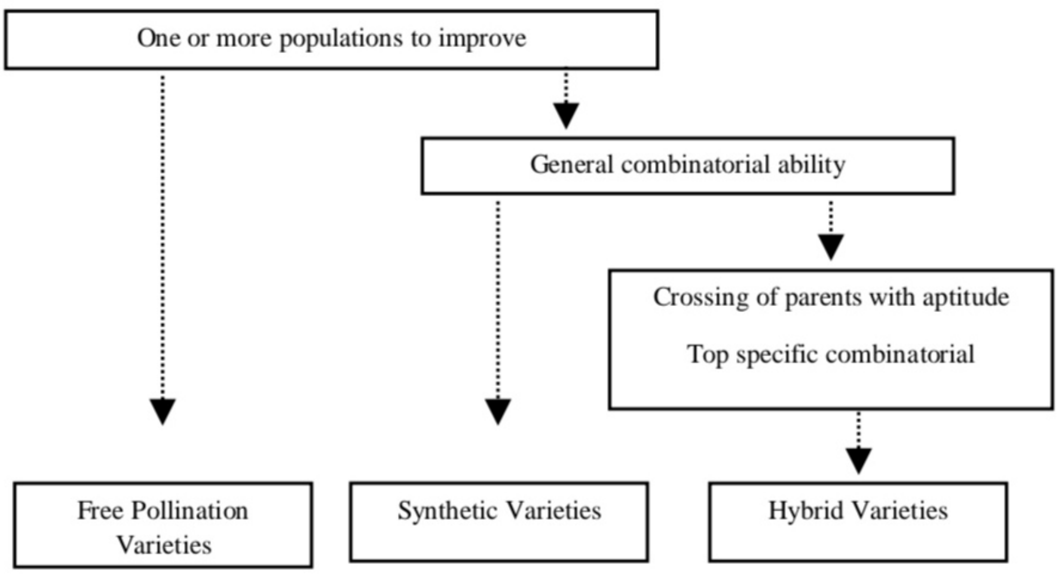
2.1.3. Improved maize varieties

According to Danso (2018), the emergence of green revolution investments in agriculture has resulted in the development and distribution of many improved crop varieties, maize included, for cultivation by farmers in all counterparts of the farming population worldwide. Above everything else, the development of improved crop varieties is geared towards increasing farm productivity and income, reducing hunger and malnutrition and minimising food insecurity, particularly in developing economies like South Africa. However, research shows that the use of improved crop varieties including maize, is relatively low among smallholder farming communities in most developing countries.

These varieties include the hybrid seeds which are freshly purchased seeds and the OPVs which are the seeds that have not been recycled for more than three seasons. They are known to contain certain traits that are improved over their parents, such as being pest and disease resistant, drought resistant and overcome other possible stresses. The improved varieties are known for their high yielding potential. Production using improved seed varieties has been identified as a precondition for achieving food security (Langyintuo *et al.,* 2000; Bernard *et al.,* 2010).

The development of maize varieties that are better adapted to new changing climatic conditions is vital for future food production (Challinor *et al.,* 2016). The United Nations Organization mentions that in the developing countries only the average of 50% of the area of maize is cultivated with modern varieties, including hybrids and improved Open-Pollinated Varieties, while in developed countries, the use of modern improved varieties is close to 100% (Challinor *et al.,* 2016).

Figure: 2.1 General scheme of genetic improvement of seeds



Source: Blanca Isabel Sánchez Toledano (2017)

Improved varieties performed significantly better than the traditional varieties (TVs) they replaced, leading to substantial production increases, higher incomes for millions of farmers who adopted the technology, and lower food prices for consumers. By convention, the products of scientific maize breeding programmes, whether OPVs or hybrids, are referred to as improved, reflecting the fact that their characteristics have systematically been altered in ways that bring economic benefits to those who grow them (Wood & Lenné, 1997).

2.2. History of maize crop

A maize crop with the scientific name, *Zea mays*, was domesticated in central Mexico and then brought to the African continent where it quickly spread to all corners of the continent in a relatively short period of 500 years. Moreover, in South Africa, this important crop was first introduced in 1655 and has since become one of the most important grain crops (Sihlobo, 2018). This crop is produced in all parts of the country. According the report by GrainSA (2017), an average of 2.8 million hectares of maize are planted every year. This accounts for large quantity of corn produce consumed by citizens in the country and part of the produce processed to finished goods.

According to Sihlobo (2018), South African maize production underwent extraordinary changes over the past century. In 1904, South Africa produced 328 000 tonnes of maize. By 1935, the production of maize in the country had grown to 1.68 million tonnes and increased to 12.9 million tonnes in the 2017/18 production season. Moreover, as a result of improvements in maize seeds and increase in number of farmers, particularly smallholder farmers, the maize yield is expected to increase each year relative to the exponentially increasing demand of maize and grain products as triggered by the rapidly growing population.

Maize crop in South Africa is produced mostly by smallholder farmers with the primary aim of ensuring food security and generating profit to allow them to procure their daily essentials and sustain their seasonal production. Moreover, there are also commercial maize farmers whose production is mainly aimed at making profit by selling to manufactures and exporting surplus produce. Maize farmers have the freedom of choice among hundreds of available existing varieties, i.e. landrace and/or improved varieties.

Given the existing different cultivars of maize available in South Africa, most of the improved (inclusive of hybrid and OPVs) maize in South Africa is grown by commercial farmers. However, these maize varieties have also been introduced to South African smallholders farming mainly for subsistence. In the attempts to increase the yield of this staple crop, and consequently improve food security, the South African government has funded several agricultural programmes during the last decade. Some of these programmes have introduced improved maize (both insect resistant and herbicide tolerant) to smallholder farmers (Jacobson & Myhr, 2013).

2.3. Maize production overview

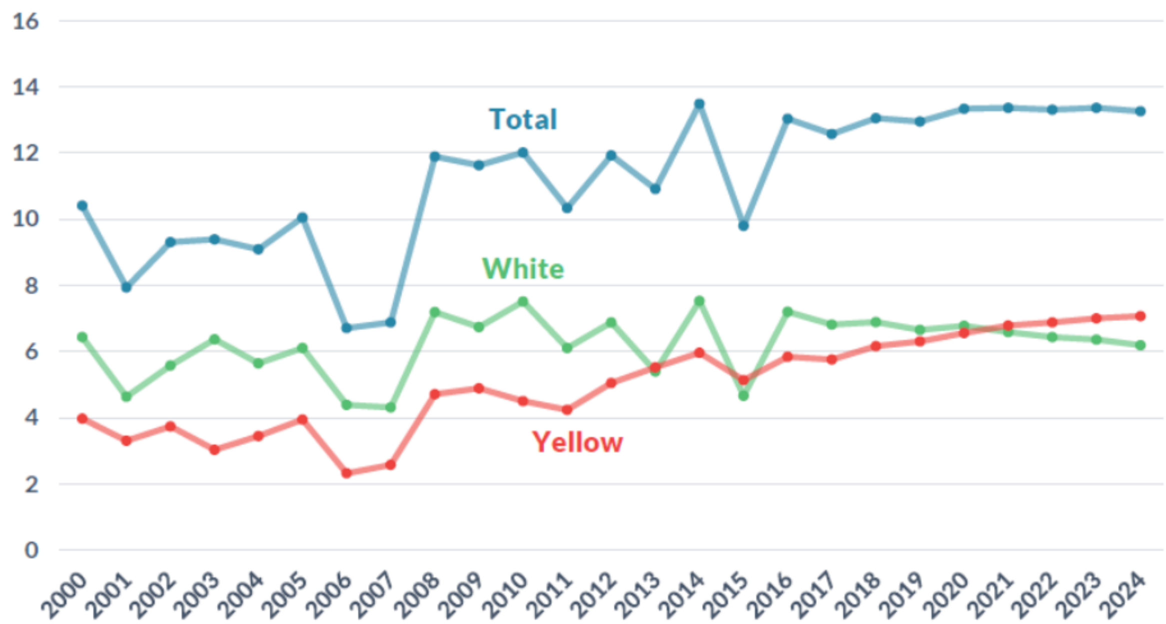
Maize has been grown under a wide range of agro-ecologies and socioeconomic conditions. The status of maize as a strategic food security crop took prominence, especially following the devastating droughts of the early 1980s in eastern and southern Africa (FAOSTAT, 2007). Modern breeding and selection of maize in Africa have been going on since as early as the first decade of the 1900s in various parts of the world. Multiple models have been used in the past decades to describe farmers' decision making process, especially in light of the emerging agricultural cultivars. It is imperative to examine the variables commonly included in the seed varietal choice in order to boost the existing body of knowledge. Variables considered to be having more influence on varietal choice include the socioeconomic characteristics and institutional factors.

According to Sihlobo (2016), the South African maize industry comprises of producers or farmers, governmental organisations and agribusinesses (i.e. trading companies, co-operatives, financial institutions, etc.). However, the umbrella producer or farmer organisation is Grain South Africa (Grain SA). The maize industry is divided into commercial and small-scale agriculture. In 2011, the number of commercial maize farmers was estimated to be 8 000 and the number of developing agricultural farmers remain unknown (Tshilambuli, 2011). Due to the exponentially growing population, the number of maize farmers and area to planted maize are expected to increase in the coming years to meet the consumers' demand for maize produce.

The SA region was home to a total of 187 maize cultivars (38% of the SSA total) that comprised 79 hybrids, 15 OPVs, and 93 local cultivars. Nearly 43% of the cultivars were hybrids, with OPVs and local cultivars comprising 8% and nearly 50%, respectively. The average maize area under hybrids was a little over 50%, with nearly 5% OPVs. Thus, the total maize area under modern cultivars was about 55%, with unnamed and unidentified cultivars (Local cultivars) occupying about 39% and a little over 6%, respectively.

According to James (2013), the potential implications of introducing GM crops into smallholder agriculture are diverse, including economic, sociological and environmental consequences. Depending on specific circumstances, including the type of crop, trait, and when relevant, co-technology (such as specific herbicides to which the GM crop is resistant), GM crops can be beneficial to the farmer, through its reductions of yield loss or increasing yield stability. This includes the introduction of improved maize varieties and the OPVs. Below is a figure depicting the South African maize production statistics and predictions up to the production season of 2024.

Figure 2.2: South African maize production, 2000–2024



Source: BFAP, 2015

From the figure above, maize production in different seasons and different maize cultivars grown show that from the year 2000, the production of white maize as compared to the production of yellow maize was higher until the production season of 2015. In 2015, the production of yellow maize which is most commonly used for the production of animal feed was almost equivalent to the production output of the maize which is the common staple food for many Africans. This could be due to changing climates since they affect production. Moreover, the above production graph shows the increasing production of yellow maize from season 2020 to 2024. This could be as a result of an increased number of livestock farmers in the efforts of ensuring food security in the country and limiting imports of such produce. It is also a good indication of the growth of the processing division, which processes yellow maize into animal feed and human consumable products like corn flakes. The demand for such products exponentially increases with the increasing population and the rowing of livestock farming enterprises in the country.

2.4. Importance of maize in South Africa

South Africa is known for its good quality maize production. This crop is of the utmost importance to both the commercial and subsistence or smallholder farming communities. This crop has many crucial uses. However, the two most important uses of this crop are: for the production of food for human consumption and for the production of animal feed (GrainSA, 2017). Furthermore, maize as a crop and other maize based products are consumed by the majority of South Africans. About a range of 67% to 83% of the population consumes maize in South Africa. On average, an estimated consumption of cooked maize per person ranges between 476 g to 690 g (GrainSA, 2017).

According to DoA (2002), maize production is carried out by applying a wide range of farming systems in South Africa. The production of maize is dominated by subsistent orientated small-scale, emerging and commercial farmers. The production of maize is generally characterised by low yields regardless of farm size which leads to low returns for farmers.

It is evident enough that maize is the most important and widely grown cereal crop and it is the major part of the diet for both rural and urban communities in South Africa (ARC, 2002). According to Ortmann (2006), maize serves as a source of income to all the commodity value chain agents, including but not limited to, farmers' household produce buyers, processors, exporters and transporters. Maize is therefore an important grain crop which is necessary for both food security and income generation.

Maize plays a vital role in food security for many poor households and is a critical food and cash crop with a per capita consumption of over 100kg per month. Both large and small-scale commercial farmers produce maize. The production of maize is unstable due to dependence on rainfall and other climatic conditions for its growth. Trends of lower rainfall in the drier areas of southern Africa suggest that these areas are becoming increasingly unsuitable for maize production in South Africa (DoA, 2005).

South Africa's maize production is crucial, particularly in small-scale farming, which contributes significantly to household food security (Geyling, 2019). According to Van Zyl Jy, 1998), the maize industry is pivotal in the South African economy with regard to revenue generation and employment. The share of the agriculture sector in employment is estimated at 7% of the South African labour workforce (Kabirije, 2015)

2.5. Status of the seed industry in South Africa

According to DAFF (2018), a competitive seed sector is key to ensuring timely availability of appropriate and high-quality seeds at affordable prices to farmers in South Africa. The seed industry in South Africa is comparatively advanced than in other African countries and primarily serves the needs of commercial farmers. The South African seed industry has evolved for over a century into a mature sector with some 107 seed companies that are members of the South African National Seed Organization (SANSOR). In 2010, agronomic crop seeds including but not limited to, Maize, Beans etc., accounted for about 73% of the total South African industry while horticultural crops and forage and pasture crop seeds accounted for 18.5% and 7.5%, respectively.

According to Cho (2016), seeds have a unique attribute among all agricultural inputs, whether commercial or subsistence. They are a source of life for their species and a means of delivering technology to farmers. Regardless of the scale of agriculture, seed quality, particularly its genetic attributes, determines the level of crop productivity in the presence of other crop production inputs (Seshatta, 2013). More importantly, quality seeds of any preferred variety are a basis for improved agricultural productivity since they respond to farmers' needs for both their increasing productivity and crop uses (Pelmer, 2005).

The poor performance of the African seed industry has been a major concern to policy makers over the years. Tripp and Rohrbach (2001) blame the failure of the commercial seed sector to develop the seed regulatory framework that favours parastatal enterprises as well as government and donor projects that provide seed to farmers for free or at subsidised prices. Recent efforts by African governments to deregulate the seed sector have witnessed the proliferation of private seed companies (Langyintuo, 2004). Even though the environment in South Africa is not always favourable for seed production, sufficient seed is produced for export purposes. During 2016/2017, maize (white and yellow) has commanded 77.50% of total seed market value, followed by barley and sunflower.

There are four companies dominating ownership of maize seed varieties, with 68% between them. These companies are Monsanto SA, Pioneer Hi-Bred, Pannar and Klein Karoo Seed. This is not the same as their market share, since some varieties have a greater share than others. Monsanto is taken to be the largest maize seed company in the country by sales (DAFF, 2011). The highest valued seed crop is maize (white and yellow) at 77.50% of the total market share in the agronomic industry.

2.6. Maize production trends in South Africa

According to the Trend Analysis Report (2017), maize is the most important grain crop in South Africa, serving as both the major feed grain and the staple food of the majority of the South African population. About 59% of maize produced in South Africa is white and the remaining 41% is yellow maize (Trend Analysis Report, 2017). White maize is primarily used for human consumption, while yellow maize is mostly used for animal feed production. Moreover, the ratio of areas planted is 62% white maize to 38% yellow maize. An estimated 7,5% of the area planted white maize is under irrigation and 92,5% is dryland, while the estimation of yellow maize is 14,0% which is under irrigation and 86,0% dry land.

According to Dlamini (2020), the size of the expected commercial maize crop has been set at 15,514 million tons, which is 0,48% or 75 600 tons less than the previous forecast of 15,589 million tons. The area estimate for maize is 2,611 million ha, while the expected yield is 5, 94 t/ha. The estimated maize crop is 38% bigger than the 2019 crop. The three main maize producing areas, namely; the Free State, Mpumalanga and North West provinces are expected to produce 84% of the 2020 crop. Moreover, the area estimate for white maize is 1,616 million ha and for yellow maize the area estimate is 994 500 ha. The production forecast of white maize remained unchanged at 9,075 million tons, with an expected yield of 5, 61 t/ha. In the case of yellow maize, the production forecast is 6,439 million tons, which is 1, 16% or 75 600 tons less than the 6,514 million tons of the previous forecast. The yield for yellow maize is 6, 47 t/ha (NCEC, 2020).

According to the report of statistics presented in the table below, the production of maize in South Africa has been consistent from 2013 to 2020, with 2016/17 being the greatest of production seasons with an average yield of 6.37 tonnes per hectare. This was the highest in these 9 seasons of maize production. The lowest reported yield per hectare was reported in production season of 2014/15 which was 3.75 tonnes/ha. According to Sihlobo (2020), South Africa began planting genetically-engineered maize seeds in the 2001/02 season. This process was supported by both the private sector and government, as a way of establishing public-private-sector partnerships in modernising and growing the South African agricultural sector. Before its introduction, average maize yields were around 2.4 tonnes per hectare, but has now increased to an average of 5.9 tonnes per hectare (2019/20 production season).

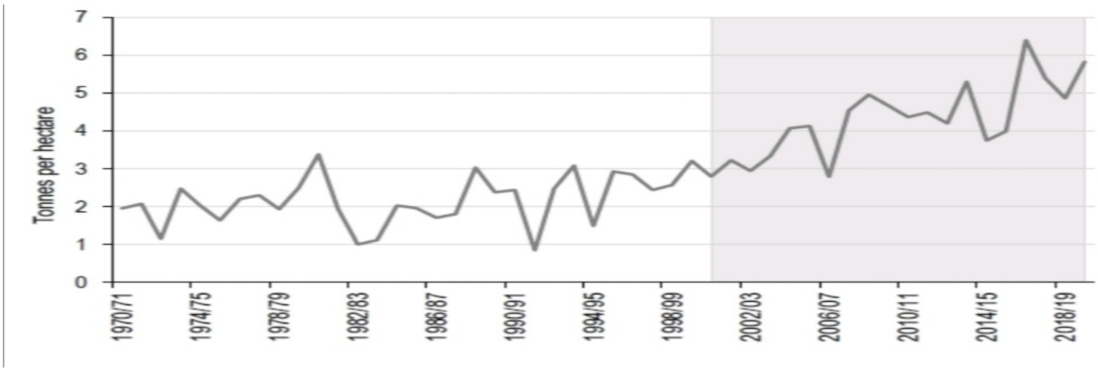
Table 2.1: Production trend for maize in South Africa for a period of 9 years from 2012 to 2020. (GSA,2020): Table:1 Maize production trend

Season	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20
Plantings (ha)	2781 200	2 688 200	2 652 850	1946750	2 628 600	2 318 900	2 300 500	2 610 800
Production (t)	11 810 600	14 250000	9 955 000	7775000	16 744 000	12 510 000	11 257 850	15 221 520
Yield (t/ha)	4,25	5,30	3,75	4,00	6,37	5,39	4,89	5,83

Source: GSA (2020)

The figure below shows the significant increase in maize yields in this period. However, the Sub Saharan Africa’s maize yields remained low with an average yield below 2.0 tonnes per hectare (Nigatu & Hansen, 2019).

Figure 2.3: South Africa’s maize yields (tons/ha), 1970/71 to 2019/20.



Source: South African Grain Information Services

Note: The shaded area represents the years where South Africa started growing GMO maize. By 2019/20 season, approximately 80% of South Africa's maize plantings were genetically modified.

The Bureau for Food and Agricultural Policy (BFAP) projects that domestic human consumption of white maize will remain relatively constant over the long term and any significant growth in white maize production will have to be absorbed by the export market, or alternatively, substitute yellow maize in the feed market at 38 a discounted price. Projected growth in white maize yields (to 5,66 ton/ha) and a relatively stable demand for white maize leads to the total area allocated to white maize being projected to decline by 27 per cent between 2014 and 2023. South Africa is still expected to remain a net exporter of white maize under normal weather conditions until 2023.

Regarding yellow maize, the increased demand for animal feed will be met by improved average yields in yellow maize in the short and medium term, assuming a constant area. In the longer term, yield increases (to 6 ton/ha) alone might not be enough to provide for the growing demand for feed and an increase in yellow maize plantings will be needed to ensure a net export position for yellow maize. Therefore, in the long run, the area where yellow maize is planted is expected to expand, reaching a level of 1.2 million hectares by 2023 (BFAP, 2014a; BFAP, 2015).

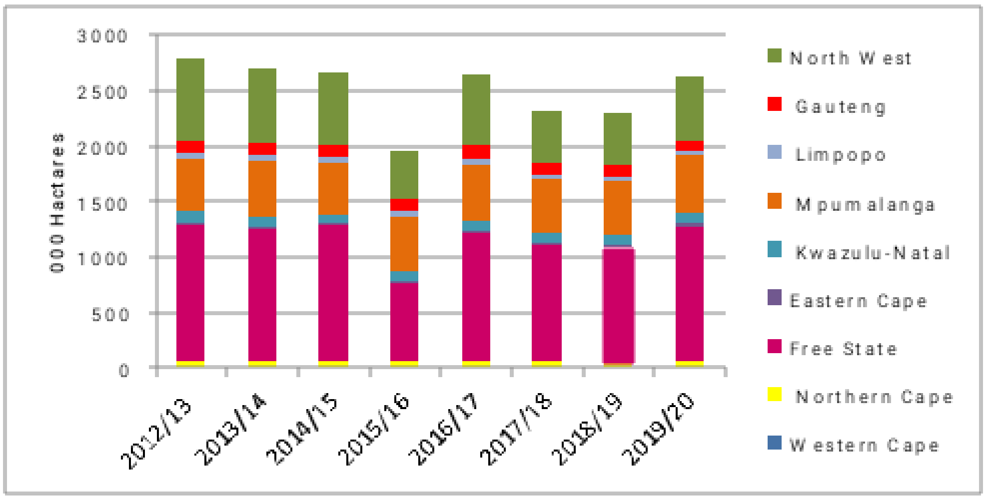
2.7. Distribution of maize crop amongst the provinces in South Africa

The two main white maize-growing provinces in South Africa, namely, the Free State and North West provinces, produced about 78% of the white maize harvest in 2017. Also, Free State and Mpumalanga produced about 67% of the yellow maize harvest. Improved weather conditions caused by a weak La Niña weather system, increased rainfall in South Africa and lower temperatures, encouraged farmers to plant more maize than the previous season.

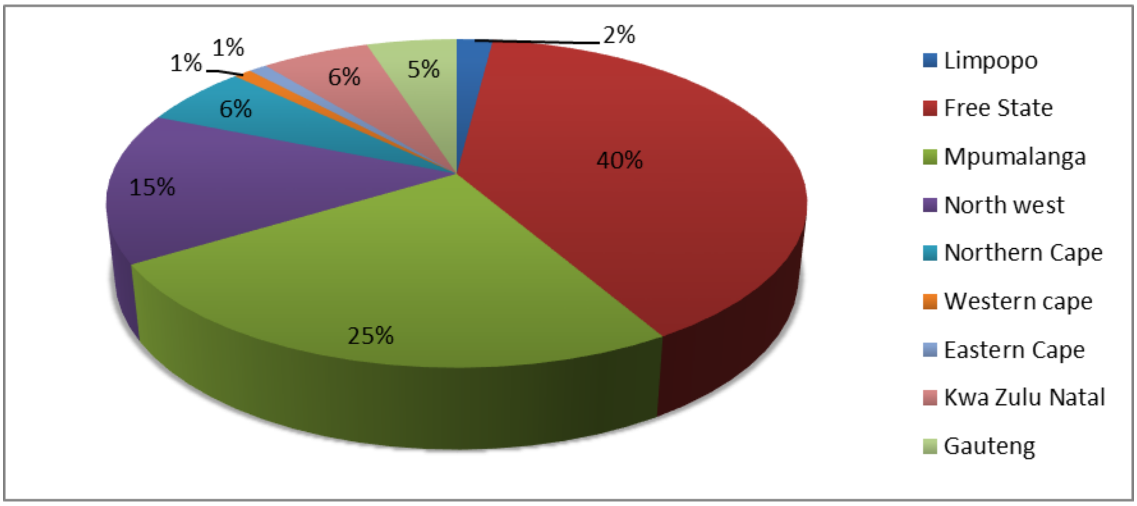
Maize is produced throughout South Africa, with the Free State, Mpumalanga and North West provinces being the largest producers (GSA, 2020a). The figure below reflects trends and the distribution of maize amongst provinces in South Africa over the past 8 years and also estimates of the 9th year being the 2020 planting season. According to the results reported by GrainSA (2020), areas where maize is planted differ from year to year. However, the recorded average throughout the 9 years is 2.9 million hectares of planted maize.

The Free State reported the highest maize planted area which makes up 48% of the total area planted in South Africa in the production season of 2018/19 followed by North West with 21% and Mpumalanga with 20.9%. The lowest maize producing province is Western Cape with an average of 3.65 hectares planted of maize.

Figure 2.4: Area where Maize is Planted per Province



Source: Grain SA (2020).



Source: Grain SAFigure 2.5: Shows maize production contribution per province

The above figure illustrates the data on maize production per province in South Africa. Western Cape and Easter Cape reported the lowest production statistics with 1 % contribution from each whereas Free State reported the highest maize production which accounted for 40% of maize production in the production season of 2018/19 followed by Mpumalanga which accounted for 25%.

2.8. Demand and supply of maize

The vast majority of maize produced in South Africa is consumed locally. As a result, the domestic market is of high importance to the industry. According to Tripp (2000), it is evident that smallholder farmers' desire for improved maize seeds is relatively weak despite efforts by research institutions to develop various maize varieties which have robust traits of productivity, drought and disease tolerance. Low demand levels of improved seeds have been constraints to farm inputs suppliers as they strive to distribute improved varieties.

According to the results of a study conducted by Tsedeke (2017), 32% of all the cultivars were hybrids, 23% were improved Open-Pollinated Varieties (OPVs), and 46% were local varieties (also known as landrace). The highest demand is therefore on local traditional varieties which are usually referred to as landrace varieties. It has been reported by previous studies that most farmers lack the knowledge regarding positive traits of improved seeds varieties. Hence, they stick to traditional varieties, which they seemingly prefer although such seeds are not economically efficient. Nonetheless, such traditional varieties have prominent aromatic and palatability characteristics that are preferred by a majority of smallholder farmers in most villages (RLDC, 2009).

According to Dhlamini (2020), the total supply of white maize is projected at 9 376 883 tons for the 2020/21 marketing season. This includes an opening stock level (at 1 May 2020) of 473 964 tons and local commercial deliveries of 8 896 160 tons. No whole white maize imports are estimated for the new season, only early deliveries of negative 1 241 tons and a surplus of 8 000 tons are projected. Total demand (domestic plus exports) for white maize is projected at 7 984 500 tons. The total domestic demand is projected at 6 814 500 tons. This includes 4 950 000 tons processed for human consumption, 1 810 000 tons processed for animal and industrial consumption, 10 500 tons for gristing, 20 000 tons withdrawn by producers, 20 000 tons released to end-consumers and a balancing figure of 4 000 tons (net receipts and net dispatches). A projected export quantity of 270 000 tons of processed products and 900 000 tons of white whole maize is estimated for exports for the 2020/21 marketing season. The projected closing stock level at 30 April 2021 is estimated to be 1 392 383 tons. There is an average processed quantity of 564 208 tons per month, which represents available stock levels for 2.5 months or 75 days (NAMC, 2020).

The total supply of yellow maize is projected at 6 574 096 tons for the 2020/21 marketing season. This includes an opening stock (at 1 May 2020) of 526 637 tons and local commercial deliveries of 6 038 950 tons. No yellow maize imports are estimated for the new season, only early deliveries of negative 11 491 tons and a surplus of 20 000 tons. The total demand (domestic plus exports) for yellow maize is projected at 5 956 500 tons. The total domestic demand is projected at 4 576 500 tons. This includes 585 000 tons processed for human consumption, 3 800 000 tons processed for animal and industrial consumption, 8 500 tons for gristing, 55 000 tons withdrawn by producers, 120 000 tons released to end-consumers and a balancing figure of 8 500 tons (net receipts and net dispatches). A projected export quantity of 130 000 tons of processed products and 1 250 000 tons of yellow whole maize is estimated for exports for the 2020/21 marketing season. The projected closing stock level at 30 April 2021 is estimated at 617 596 tons. At an average processed quantity of 366 083 tons per month, which represents available stock levels for 1.7 months or 51 days (NAMC, 2020).

2.9. Maize varieties grown by farmers in South Africa

Since the start of modern plant breeding (cross-breeding, F1-hybrid breeding, in vitro breeding, gene technology, smart breeding, and genomics), breeding efforts focus on the development of a few economically important plant species like maize. The intensive spread and wide use of improved, modern varieties has led to a genetic bottleneck, resulting in the loss of crop, variety and allele diversity (Peroni et.al., 2007). For example, 75% of the genetic diversity of farmers' crops has been lost since the 1900s in favour of genetically uniform, high-yielding varieties, and only

150–200 out of the 300,000 known edible plant species are used by humans (FAO, 2014). However, high-yielding crop varieties may cause crop failure under sub-optimal cultivation conditions on marginal locations and thus increase hunger and downgrade sovereign food production in countries of the global south (Salgotra, 2015).

Small-scale farmers in many developing countries still prefer local landrace varieties because they fill social and cultural niches that modern varieties are lacking (Zimmerer, 2014). Cooking characteristics are a classic example of these cultural services. The role of traditional farming practices, including traditional varieties like landraces as providers for cultural services, is becoming increasingly recognised globally. Therefore, it is concluded that the use of landraces is a potential way to achieve social-ecological resilience.

According to Mason et al. (2013), the widespread diffusion of maize improved modern varieties attests to the success of the many organisations that are engaged in crop improvement and technology delivery, including national maize breeding programmes, government agricultural extension services, and public and private seed companies. However, there is a reason to be encouraged by the fact that half of the developing world's non temperate maize area is devoted to modern varieties, concerns can justifiably be raised by the fact that the other half is still reserved for local varieties (also known as landraces) that have not benefited from formal plant breeding efforts. Moreover, it can be said that smallholder farmers use improved maize varieties for specific traits such as high yield and drought tolerance. However, the majority of smallholder farmers continue to exhibit a high demand for landrace varieties because of their taste, smell and many other assortments of traits that come with these varieties.

Production of maize in Sub Saharan Africa (SSA) is dominated by small-scale farmers who have land rights ranging from 0.5 to 3.0 ha (Byerlee & Heisey, 1997). Although improved varieties have been developed in most of the countries in SSA, including South Africa, the majority of smallholder farmers still rely on traditional (landrace), Open-Pollinated Varieties (OPVs) for their plantings (Aquino *et al.,* 2001; FAO & CIMMYT, 1997). South Africa's smallholder maize farmers are characterised by low maize productivity, despite the availability of many maize varieties on the market (Shiferaw *et al.,* 2011). Furthermore, smallholder farmers perceive little advantages in such improvement because improved varieties seeds are not designed for their needs (Reeves *et al.,* 2014). According to Banziger and Cooper (2001), breeders have often been accused of failing to consider the special preferences of farmers, especially the smallholder farmers.

This study conducted by Tsedeke Abate (2017) revealed that nearly 500 maize cultivars were grown in 13 African countries, South Africa included. In the 2013/2014 main crop season, 69% of the cultivars were planted and each occupied <1% of the total maize area; only two cultivars occupied >40% and four occupied >30% of the area. Approximately 32% of all the cultivars were hybrids, 23% were improved Open-Pollinated Varieties (OPVs), and 46% were local varieties (also known as landrace). Eastern Africa (EA) and Southern Africa (SA) accounted for about 43% and 38%, respectively, of all the cultivars reported, whereas West Africa's (WA) share was 19%. The average area planted to modern cultivars in the surveyed areas was estimated at 57% with EA, SA, and WA estimates of 82%, 55%, and 36%, respectively (Tsedeke, 2017)

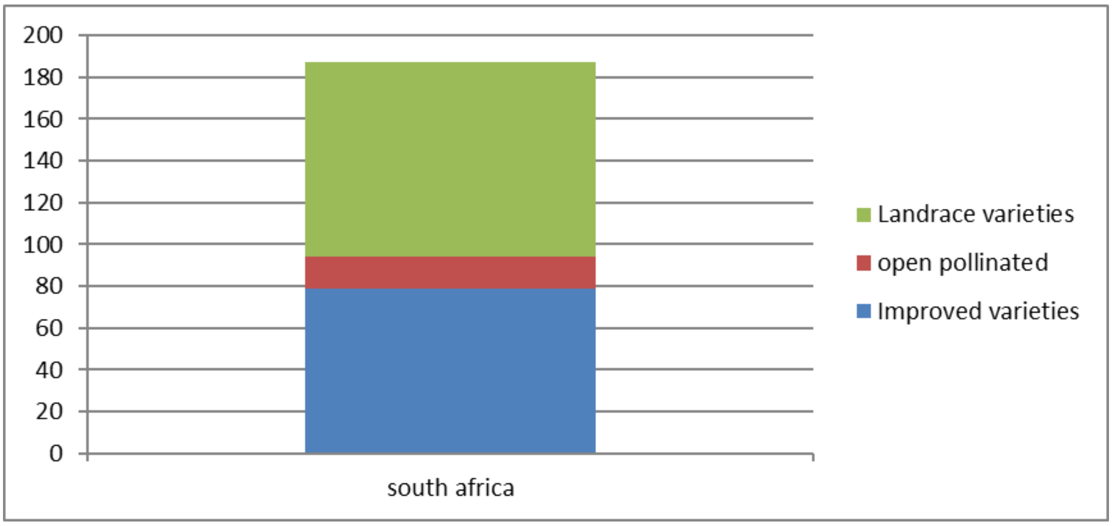
According to Mason et al. (2013), since the introduction of improved varieties into Africa in the sixteenth century, maize has been grown under a wide range of agro-ecologies and socioeconomic conditions. The status of maize as a strategic food security crop took prominence, especially following the devastating droughts of the early 1980s in Eastern and Southern Africa. Modern breeding and selection of maize in Africa have been going on since as early as the first decade of 1900s, but significant improved cultivar development efforts started in the 1950s.

Different classes of maize cultivars/Varieties grown during the 2013/2014 main crop season in South Africa

Table 2.2: Maize cultivars statistics

Country	Hybrid/Improved Varieties	Open Pollinated Varieties	Landrace/Traditional	Total
South Africa	79	15	93	187

Source: GSA, 2015



According to Sibiya (2013), farmers prefer growing the local landrace mainly for its taste, recycled seed, early maturity, tolerance to acid soils, drought tolerance, and satisfactory yields even during bad seasons. This is in agreement with the findings by Magorokosho (2006) on landraces collected from Malawi, Zambia and Zimbabwe, where farmers kept landraces because of the taste, tolerance to most abiotic and biotic stresses, early maturity and yield stability. The few farmers who grew hybrids preferred them mainly for yield, disease resistance, white mealie-meal, and shelling and grinding qualities. Most of these farmers grew the hybrids for sale and preferred them because they were also prolific, giving two to three cobs per plant. The improved OPVs were preferred mainly for the seed that could be recycled, yields that were higher than those of the local variety and their resistance to the main biotic stresses.

The cost of seed was the most important factor considered by farmers when choosing a variety, with most farmers desiring varieties with seed that could be recycled. Although the farmers preferred growing their local variety for the taste, they still preferred high yield and ranked it first. Taste was ranked second, although it was amongst the top perceived advantages of the local variety. Early maturity and low cost of inputs were also important characteristics and were ranked first and second. Pests/diseases and drought were second to high yield. All these attributes led to the changing trends of maize production among smallholder farming communities and commercial farmers (Sibiya, 2013).

2.10. Seed quality of maize varieties

According to a report by the SA Seed Sector Analysis Trend (2020), the South African seed market is segmented by the types of seeds, namely, the Conventional seeds, Hybrid seeds and genetically modified seeds and crop type. Maize is the country's most important crop followed by wheat. The consumption of maize and maize products continues to increase along with the increasing population. This increase necessitates the increase in productivity. Moreover, this validates that the seed industry in South Africa is quite mature and serves the commercial farmers with over 100 seed companies who are part of the SANSOR, which regulates seed certification in South Africa. Increasing export from the country is another factor that is driving the growth of the seed market.

Seed quality is the possession of seed with required genetic and physical purity that is accompanied by physiological soundness and health status. Seed quality can be characterised by physical, genetic purity, physiological and seed health. Therefore, a good quality seed should have high genetic purity, high pure seed percentage (physical purity), high germination and vigour. High seed quality is necessary to establish crops, therefore, cultivated seed should have vigour and related physiological characters (Farshadfar *et al.,* 2012). According to Sabetha (2014), maize seed quality during storage can decline to a level that may make the seed unacceptable for planting purposes.

According to Hampton and Hill (2002), seed quality can be described as a standard of greatness in specific characters or traits on which the performance of seeds grown depend. It is thus more concerned with the behaviour and rate of growth as an end product of plant growth, as a biological entity in itself, and as a determinant of future plant growth (Amarjit, 1995). Moreover, according to Hampton and Hill (2002), good quality seeds are distinguished based on genetic and/or physical purity, health, and high germination rate. The size and weight of seeds are important for plant vitality and yield upon planting.

Seed germination rate is another important attribute of seed quality. However, for field practice, the seed emergence rate is more important (Alm *et al.,* 1993). It has been indicated that minor deterioration in the seed germination rate can affect the germination vitality and the rate of emergence. The responses of all other inputs depend to a large extent upon the quality of seeds used (Jaffee *et al.,* 1994). Some of the direct benefits of quality seeds to farmers include enhanced productivity and higher harvest index. This is the weight of a harvested product as a percentage of the total plant weight of a crop. Quality seed also reduces risks from pests and other biotic factors; it also provides higher profits (Cromwell, 1996).

2.11. Accessibility and affordability of seeds by smallholder farmers

According to Opoku (2019), less than 10 percent of the world's smallholder farmers have access to the improved quality seeds that can halt hunger and tolerate the impact of climate change. The 2019 Report by the Access Seed Foundation revealed that only 47 million of the world's 500 million smallholder farmers were able to acquire improved seeds from the world's biggest global seed companies in 2017. This is affirmed by Tsekede (2017) who states that in the 2016/17 production season, 46% of the planted area was planted with local varieties (landrace). This indicates that a majority of the smallholder maize farmers still choose to grow traditional varieties as they are locally available and accessible to them.

Improved seeds are divided into open pollinated and or hybrid. Open pollinated seeds are produced from natural random pollination. In most cases, smallholder farmers save the best of these seeds from their harvest so they can use them from year to year without buying seeds each season. Hybrid seeds result from cross-breeding two parent plants that have desirable traits, and the resulting plants realize their potential in the first season, but lose their effectiveness in subsequent generations, a situation that forces farmers to buy new seeds each year (Mutanyagwa, 2017). Low availability of improved maize seeds has been a major constraint that limits smallholder farmers' maize production (Bett *et al.,* 2006). Low availability of improved seeds to farmers may be occasioned by local impediments such as poorly developed and inefficient distribution networks, long distances between distribution outlets and end users. All these make it costly for farmers to obtain the desired seeds and results in them resorting to the available landrace seeds. Limited availability of good quality seed is a key constraint repeatedly identified by farmers in rural areas in many countries (ASFG, 2011).

A number of initiatives that have addressed this problem through sustainable local seed production have resulted in improved access of appropriate, affordable and timely seeds (ASFG, 2011). Farmers everywhere need easy access to high-quality seed of well-adapted productive crops to allow them to produce good quality crops. Ongoing efforts to encourage the private sector to play a role in ensuring efficient production and distribution of seed in developing countries has led to increased yield (FAO, 2009).

2.12. Social and economic importance of maize

Maize is the main staple food for many citizens in South Africa and many other parts of the world. It is also a way of generating income as farmers consume a portion of their produce and sell the surplus. This crop is cultivated in almost all countries in the world. According to Oliviera et.al (2014), maize has nutritional benefits because it is rich in carbohydrates, mainly in the form of starch. This crop also has proteins, lipids, vitamins and minerals. These nutrients are essential in a diet. The maize industry is the important earner of foreign exchange for the country through exports of maize and maize products. South Africa exports maize mainly to Japan, Iran, Kenya and Venezuela. Other important markets are Zimbabwe, Zambia and Malaysia. Maize products are mainly imported to Mozambique, Angola and Zambia.

Agriculture remains an important economic sector in the Sub-Saharan Africa region (Goedde *et al.,* 2019). Within the sector, maize is one of the commodities that contribute to the GDP of the country. According to a report by Paul (2020), the contribution of the agricultural sector towards the GDP increased by a 27.8% quarter on quarter due to the higher production of animal products, horticulture and field crops. This is due to a great performance of the sector with the leading industry being the maize industry. The area where maize was planted increased and allowed farmers to plant 7% more hectares, with the area where maize was planted being 13% higher year on year at 2.61 million hectares. This led to an expectation of the total maize harvest hovering around 15.51 million tons which is 37.6% higher relative to the 2019 production season, according to the Crop Estimate Committee (CEC) June 2020 estimates. Furthermore, strong export demand boosted maize revenues in the first quarter of 2020 with a total of 512 800 tons which is 86% higher year on year (Paul, 2020)

International trade accounts for only 13 per cent of world maize production, maize represents almost 40 per cent of all cereal trade. Global trade in maize has increased significantly over the past two decades, from 71 million tonnes in 1995 to around 127 million tonnes in 2014, with the fastest expansion taking place in more recent years. Maize exports are driven by a handful of countries that have the domestic weather conditions to produce surpluses (BFAP, 2015). South Africa, being one of the top maize producers and one of the leading exporters of maize, has positively contributed to the foreign exchange earnings and ultimately impacted the economy positively. Japan, Mexico and Europe were the leading import markets during the 2013/14 season, each importing 15.5, 14.4 and 11.5 million tons, respectively. The figure below illustrates USDA forecasts on the expected growth in maize imports over the coming decade and how Chinese and Mexican imports are expected grow in the coming decades (ERS, 2015b).

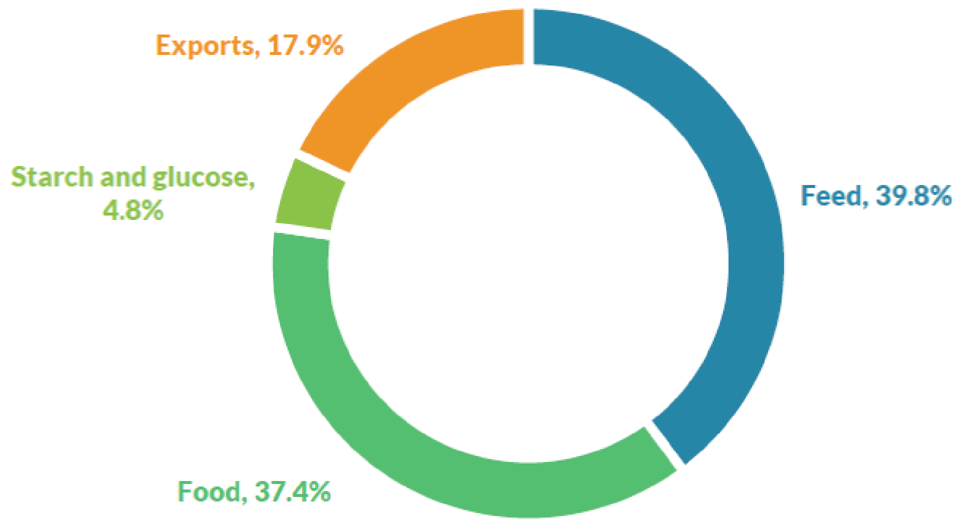
Source: ERS, 2015b

Figure 2.6: Forecasted maize imports, 2000/00–2023/24 (Million metric ton)

2.13. Consumption of maize in South Africa

South Africa utilises maize predominantly in the manufacturing of animal feed (39.8 per cent) and food (37.4 per cent) products. Exports account for 17.9 per cent of consumption, with the remaining 4.8 per cent being used in the production of starch and glucose. The remainder of stock is used to produce the following products: starch, glucose and dextrose (3.9%); high-fructose corn syrup (3.6 per cent); food and cereal products (2%); and alcohol for beverages and manufacturing (1%) (BFAP,2015).

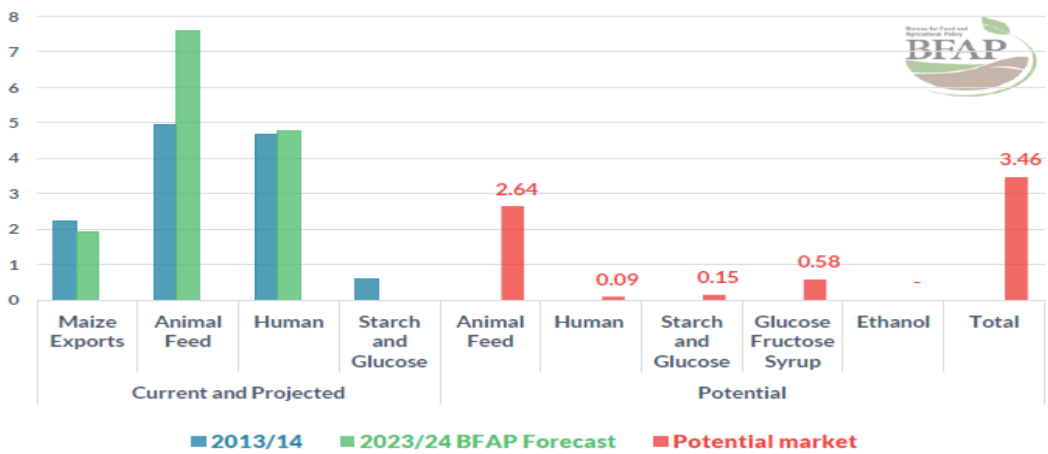
According to the BFAP report (2015), the main trend internationally is to employ ever greater shares of maize production in the manufacturing of animal feed. Feed demand accounted for 60 per cent of overall maize consumption in 2013/14. Projections made by the International Grains Council (IGC) indicate that feed demand will be the main driver behind maize consumption growth in the medium term, adding a further 60 million tons (or 11 per cent) between 2013/14 and 2019/20 (IGC, 2014). Projected gains are linked to income growth, rising populations, urbanisation and shifting dietary preferences (IGC, 2014). This same trend is observed in South Africa, with most future maize consumption gains occurring within the animal feed sector.



Source: SAGIS, 2015

Figure : 2.7 : Distribution of maize among different sectors

South Africa, with its potential of optimal maize production and its capability to export surplus, has been assessed and new ideas arose from analysis. According to a report on maize value addition by BFAP (2015), there could be a much greater potential for value addition of the current export maize surplus by expanding the processing and manufacturing units for food, animal feed, ethanol and glucose fructose production. Below is a figure depicting the projected consumption of maize in South Africa.



Source: BFAP (2015)

Figure 2.8: South African maize consumption potentials, 2013/14–2023/24 (Million

metric tonnes)

2.14. Maize as a source of employment

According to a report by the World Bank (2021), an employee is defined as a person of a working age who is engaged in an activity to produce goods, provide service for pay or profit, whether at work during the reference period or not at work due to temporary absence from a job or to working time arrangements. According to Saifaddin Galal (2020), in 2018 the employment rate in agriculture amounted to 850 000. This was an increase of 11.73% compared to 2013. The agricultural sector consists of activities in agriculture, hunting, forestry and fishing. Moreover, employment in the agricultural sector of South Africa was reported to be 4.989% of the total employment rate in 2020, according to the World Bank (2021).

Figure 2.9: Historic agricultural sector employment data

Source: World Bank (2021)

Maize is produced by approximately 9 000 commercial farmers and thousands of small scale farmers in the country. These farmers provide direct employment for an estimated workforce of more than 128 000. Moreover, work opportunities are provided in various industries relying on maize as a raw material for their production. These industries include, but are not limited to, maize milling, stock-feed, wet milling, poultry and dairy industries, which are directly dependent on maize for their production survival and employ thousands of workers (NDA, 2017).

CHAPTER THREE

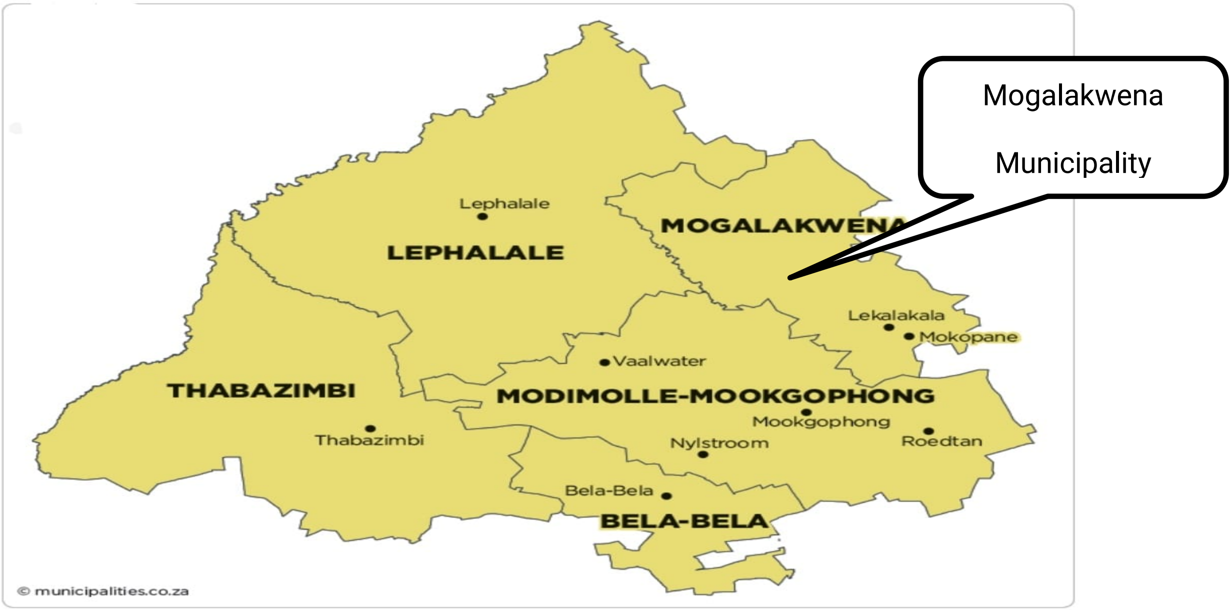
METHODOLOGY AND ANALYTICAL PROCEDURES

3.1. Study area

The study was conducted at Mogalakwena Local Municipality which is a category B municipality situated in the western quadrant of the Limpopo Province, within the western district of Waterberg. The area is 6156km^2. The area constitutes a total population of 307,682. In the total population, 96.1% is African, 0.1 %, Coloured, 0.5% Indian and 3.0% is White (Census, 2011). The temperature and rainfall are important climatological parameters in sustaining the physical environment and play a significant role in determining the biotic environment of a specific area.

The area falls within the summer rainfall region of Limpopo, with the rainy season lasting from November to March. Average rainfall is 600-650 mm. The rainfall period occurs from November to February. The highest rainfall occurs in January and December. Summer days are hot with temperatures varying between 28°-34° C in October to March.

The municipality's farming system is dominated by smallholder farmers and is characterised by a low use of production technology and small portions of land for farming per farmer. A majority of the farmers practice their farming on approximately 1.5 ha on average per farmer, which is sometimes less and sometimes more as this municipality is dominated by many villages where almost each household is allocated small portions of land for farming purposes. Figure 2 below is the Waterberg District Map.



Source: GPS maps

Figure 3.1: Limpopo Province Map

3.2 Study design and data type

The study employed the cross-sectional survey approach with a special focus on smallholder maize farmers from Mogalakwena Municipality. The study made use of a structured questionnaire to capture detailed knowledge on the socioeconomic characteristics and maize variety grown by smallholder farmers in Mogalakwena.

3.3 Sampling procedure and sample size

A random sampling method was employed to select the respondents from a population of smallholder maize farmers in Mogalakwena municipality. Data was collected from 5 villages under the umbrella of Mogalakwena Municipality which were purposively selected. The selected villages are: Lesodi, Mamatlakala, Makekeng, Marulaneng and Mapela. All the villages were dominated by Africans who speak Sepedi. According to the Department of Agriculture and Rural Development Mogalakwena Local Municipality, the total number of smallholder maize farmers is

713, out of which 83, 28, 48,15 and 32 participants were randomly selected from the villages, making up a total of 206. This total number is the 29% of the total number of maize farmers in the Mogalakwena Municipality, according to the statistics provided by the Department of Agriculture and Rural Development. Structured questionnaires were administered to respondents. One-on-one interviews and observation of reality were also applied in the collection of data. From the data that was collected, information on maize variety grown by the respondents was used to stratify the respondents into three mutually exclusive strata as follows:

Strata A: Improved maize users

Strata B: Landrace maize users

Strata C: Combination of the two

The data was organised and coded for analysis using the Statistical Package for Social Science (SPSS) computer programme. Data collected included information on socio-economic factors such as gender, source of income, type of education, household size, awareness of different maize varieties and other institutional factors that may have an influence on the farmer's choice of a maize variety.

3.4 Analytical Techniques

3.4.1. Descriptive statistics

Tools such as tables, frequency and frequency percentages were used to categorise respondents using demographic, socioeconomic and institutional variables.

3.4.2. Multinomial Logit

In order to determine factors that influence farmers' choice of the most preferred maize seed variety, the study employed the Multinomial Logit considering that smallholder maize farmers can decide to only use the landrace variety, only the Improved Maize Varieties or a combination of these two seed varieties on their farm plots. A Multinomial choice model is appropriate for identifying the factors influencing farm households' varietal choice.

In Multinomial Logit (MNL), the choice probability of K alternative for each farm household is computed as follows:

$$P(Y_i = K/X_i) = \frac{e^{Z_{ik}}}{\sum_{j=1}^{k} eZ_{ij}} = \frac{e\, X_i\, B_i}{\sum_{j=1}^{k} e\, X_{iB_j}}$$

Empirically, the model can be expressed as follows:

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

Where the dependent variable Yi is the choice of the alternatives (local only, IMV only and both local and IMV). X1……………X12 represents the independent variables, β' are parameters to be estimated and εi is an error term accounting for unobserved characteristics and measurement errors.

Table 3.1: Table describing variables

Yi	Farmer's choice of maize variety	0 if landrace 1 if improved varieties 2 if combination of landrace and improved varieties.	Categorical
X1	Gender of respondent	1 if female and 0 if male.	Dummy
X2	Age of respondent	Age of the respondent in number of years.	Years
X3	Household size	Number of members of the household dependent on the household head.	Continuous
X4	Occupation	1 if employed, 0 otherwise.	Dummy
X5	Farm size	Size of land under cultivation	Continuous
X6	Marital status		Categorical
X7	Educational qualification	1 if the farmers have formal education, 0 if otherwise.	Dummy
X8	Farmer's experience	The number of years respondents have been farming	Continuous
X9	Source of income	0 Salary/Wage 1 Social grant 2 Business or other	Categorical
X11	Awareness of the types of available maize seeds	1 if yes. 0, if otherwise	Dummy

X12	Extension contact	1 if the farmer has extension service, 0 otherwise.	Dummy
X13	Membership of association or NGO	1 if the farmer belongs to any association, 0 if otherwise.	Dummy

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4. Introduction

This chapter presents the findings of this study. The results are summarised from the descriptive statistical analysis using the Statistical Package for Social Sciences (SPSS). The discussions start with the descriptive statistics of the socioeconomic characteristics of the surveyed respondents aiming to address the objective, 'to describe and analyse the socio-economic characteristics of small-scale maize farmers in the Mogalakwena local municipality'. Demographic characteristics of the respondents considered include, but are not limited to, age, gender, level of education, household size and head, farming experience and the knowledge of maize varieties.

4.1. Socio-economic characteristics and Descriptive statistics

4.1.1. Age of respondents

According to findings of the study conducted by Mutanyagwa (2017), the age of the farmer positively influences the farmer's decision to choose certified improved maize seed varieties. Age is a human capital variable that reflects the ability of the respondent as a manager of the farm. Older farmers are expected to be more experienced in farming and therefore make better farming decisions, including the use of good quality seed. However, younger farmers may be more innovative and less risk averse which can make them to be more likely to use the improved varieties.

Results generated from collected data revealed that the average age of the respondents is 54 years. This indicates that most of the respondents are in the moderately economic active stage. According to findings of the study conducted by

Mutanyagwa (2017), the age of the farmer positively influences the farmer's decision to choose certified improved maize seed varieties. Age is a human capital variable that reflects the ability of the respondent as a manager of the farm. Older farmers are expected to be more experienced in farming and therefore make better farming decisions, including the use of good quality seed. However, younger farmers may be more innovative and less risk averse which can make them to be more likely to use the improved varieties.

Thus, they still qualify to work in the formal and non-formal sector and generate income. This income can help in subsidising the procurement of improved maize variety seed in order to realise greater produce as they are characterised by increased output level. Moreover, this also reflects the migration of young people and their non-participation in the agricultural activities. Moreover, future performance of the maize and the agricultural industry is doomed to collapse due to the low participation of the youth when the old generation fades away. This may worsen the situation of increased food insecurity, unemployment and increased poverty levels in the face of increasing population and limited fixed land and water resources and land size (Diko, 2020).

4.1.2. Household size

The average number of members living in the same household with the respondent was 4.75. The smallest household size was 1 with the highest household size of 13 dependents in a household. The number of members in a household tends to increase the level of using improved maize seed varieties as there is greater availability of labour force. According to Mutanyagwa (2017), for each additional family member in the household, there is an increase of 5 % who are more likely to use improved maize seed varieties, holding other variables constant. This suggests that a large family size provides more labour for farm operation and an increased incentive to produce more farm output while at the same time, cutting the cost of hiring labour from outside. Household size was used as a proxy for labour availability in the family and it may influence income earnings as well as expenditure. As Conteh et al. (2015) pointed out, farming in most rural areas of developing countries depends on human labour, hence household size influences diversification in farming activities as multiple activities within the household require more labour.

4.1.3. Education

The mean years of schooling in the study area is 8.77 years with 64% of formal education, 25% of primary education, 50.8% of secondary education and 24.2% of tertiary education. High levels of literacy are a good indication of human capital. Thus, farmers in the study area have the capacity to grasp information regarding maize farming through extension officers, by reading, attending trainings and any other form of specialised learning programme that can be organised. According to Mutanyagwa (2017), education is a factor in decision-making among farmers. The more years a famer invests in education, the greater the probability of using improved maize seed varieties.

Table 4.1: Summary statistics of continuous socioeconomic variables

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Age of respondent	200	20	81	53.89	14.109
Number of people in household	200	1	13	4.75	2.171
Number of years of formal education	130	2	16	8.77	4.072

Source: Survey data

4.1.4. Employment Status

It was noted that there is a high unemployment rate of 70.4%. Furthermore, 67.5% of the respondents depend on social grant as the primary income. This could be as a result of the low levels of formal education which also cause the majority of the respondents to be unemployed or unemployable as employment in this era requires tertiary qualification. Also, improved certified seeds have relatively high prices in the market, thus financially constrained farmers in this area avoid them.

4.1.5. Farming experience

The average number of years of farming experience among farmers in the area is 9.88, which is 10 years when rounded off to the nearest figure. The average number years of the respondents was above 50 years, which was an indication that age plays an important role in farming experience. Thus, a majority of farmers in this area have been exposed to maize farming long enough. However, age can also be a disadvantage particularly because older people tend to be resistant to change and stick to using improved seeds as they believe that they are experienced enough to change their production level without altering the inputs used.

Table 4.2: Descriptive results for Educational qualification

Education level					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Primary education	32	15.8	25.0	25.0
	Secondary education	65	32.0	50.8	75.8
	Tertiary education	31	15.3	24.2	100.0
	Total	128	63.1	100.0	

Source: survey, 2021

4.1.6. Distance to the maize seeds market

80% of the farmers in the area have no local market where they can access maize seeds. Moreover, an average distance of 42 kilometres has to be travelled by farmers to access the seed market. This inhibits farmers from using good quality seed due to high transport costs. Thus, distance to the market ultimately decreases the returns of maize production. Therefore, the farmers who stay far from the market are less likely to adopt the use of improved varieties. These findings are in line with a study conducted by Opoku (2019), who reported that less than 10 percent of the world’s smallholder farmers have access to the improved quality seeds that can halt hunger and tolerate the impact of climate change. Moreover, a study by Bett et al. (2006) revealed that the low availability of improved maize seeds has been a major constraint that limits smallholder farmers’ maize production and is, in most cases, occasioned by local impediments such as poorly developed and inefficient distribution networks, long distances between distribution outlets and end users. All these make it costly for farmers to obtain the desired seeds and results in them resorting to the available landrace seeds. Limited availability of good quality seed is a key constraint repeatedly identified by farmers in rural areas in many countries (ASFG, 2011).

4.1.7. Size of land planted of maize by farmers

The average size of land for planting in the area is 1.34ha. This shows that farmers in the area are farming on a small scale. It was reported by a majority of the farmers that their farming is primarily aimed for household consumption. Moreover, a majority of farmers in the area occupy 1 to 2 hectares of land because farming land has been provided to them by the tribal authority when they acquired land for settlement. The minimum size of land under cultivation for maize production is 0.5ha and the maximum is 6ha. This finding corresponds with the study conducted by High Level Panel (2017) who reported that most of South African smallholder farming communities are dominated by resource poor Black farmers who own less than 2ha farming on former homelands areas. A study by Mutanyagwa (2017) highlights land size as important in enhancing access to credit, capacity to bear risks and access to scarce inputs such as certified seeds. Land size measured in hectares is therefore hypothesized to positively influence the farmers to use improved maize seeds. In the study area, the average farm size is 1.3 ha which has the potential to make farmers in the area reluctant to adopt the use of improved maize seeds but rather invest more on growing landrace to satisfy their primary goal of household consumption.

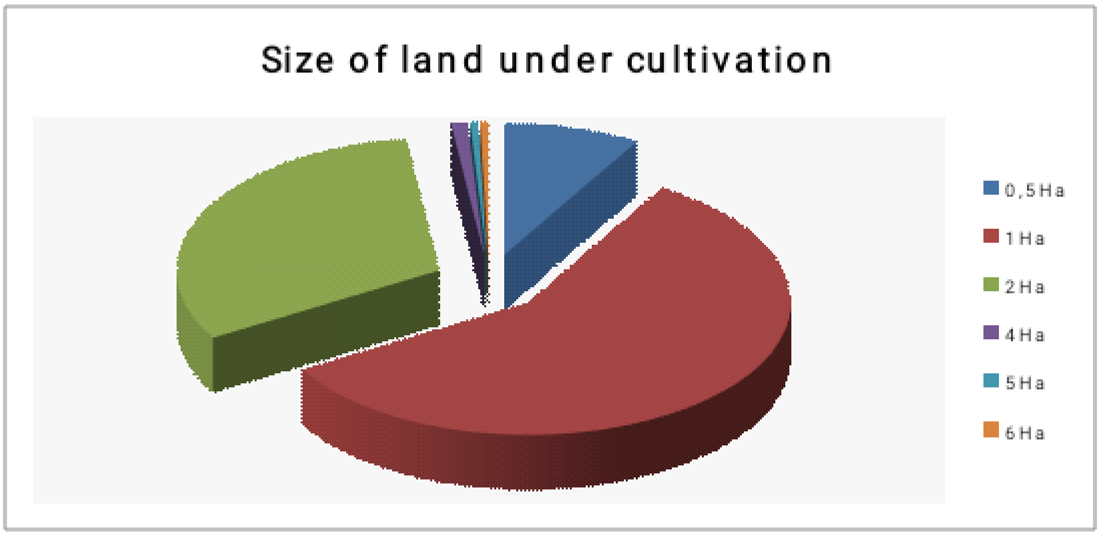


Figure 4.1: Size of land under maize cultivation

Source: Survey data

From the sampled population of 200 respondents, 59.5% grow landrace varieties, 27% grow improved varieties and 13.5% grow a combination of improved and landrace varieties. This affirms the finding of the study conducted by Aquino (2001) who highlighted that, although improved varieties have been developed in most of the countries in SSA, including South Africa, the majority of smallholder farmers still rely on traditional (landrace) and Open-Pollinated Varieties (OPVs) for their plantings (Aquino *et al.,* 2001; FAO & CIMMYT, 1997).

Results revealed that 51.8% of the sampled population are aware of the different maize varieties available in the market while 48.5% is not aware of the different available varieties except the local traditional maize seeds (landrace). Furthermore, 59.5% grows landrace, 27% improved varieties and 13.5% combined the two varieties. These results relate to those of the study conducted by Banziger et al. (2002) where 70% of smallholder farmers were found to use local and recycled maize varieties which were characterized by low yields. Reasons for the continuation of growing landrace varieties could be linked to the fact that only a few farmers have a local market while 67% of the farmers have to travel an average distance of 50km to access a market that can provide improved maize variety seeds. The other reason is due to lack of information, as results revealed that 75% of the sampled population does not have access to extension service. They also do not belong to any farmers' association or organisation and obviously lack information on agricultural practices in general.

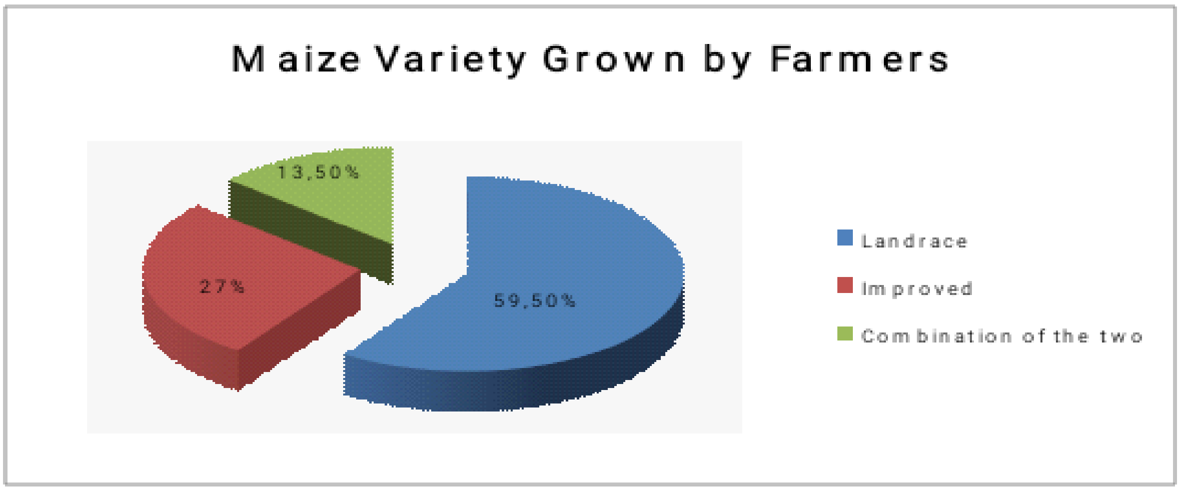


Figure 4.2: Source: Survey data

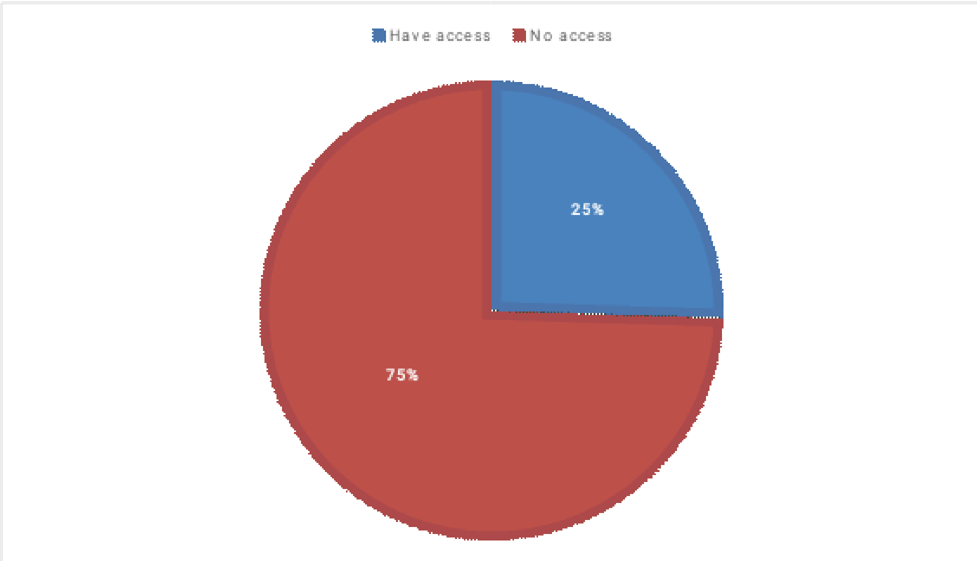
Figure : Depicts percentage of maize varieties grown by farmers in the study area

4.1.8. Access to farming credit

Results from the survey revealed that 25% of the sampled population had access to farming credit while a large percentage of 75% did not have the same privilege. The results confirmed that the South African smallholder farmers have limited access to credit as a result of low income, which hinders them from meeting the minimum farm credit requirements (Khapayi *et al.,* 2016). Moreover, access to farming credit was highly associated with the net-worth of farmers (income and assets). Results showed that a large percentage of the respondents were dependent on social grant which might be the most important factor that hindered the majority of farmers from meeting the minimum credit requirements. According to Baiyegunhi (2014), most financial institutions prefer giving credit to farmers within the economically active stage and subsequently have a reliable income stream. This justifies the low levels of adopting improved varieties and innovative technologies among smallholder farmers in the study area. A study conducted by Abiodum (2018) revealed that adequate access to credit is necessary to promote a sustainable agricultural development, use of advanced technologies and the livelihoods of rural farmers in Africa.

Table 4.4 : Depicts frequency and percentage of smallholder maize farmers having access to farm credit

	Frequency	Percentage (%)
Have access	51	25.5
No access	149	74.5



Source: Survey data

Figure 4.3: **Access to Farming Credit**

4.1.9. Extension contact

Survey data revealed that 75% of the sampled population in the study area do not have access to extension services. This further indicates that a greater percentage of farmers in the study area is denied access to adequate agricultural information, adoption of new technologies, assistance in developing their farms' technical and managerial skills, which consequently affect agricultural production. The results confirmed that smallholder farmers receive access to extension advisory on crop production through formal organisations and Department of Agriculture extension advisory (Kruger, 2014). Another study revealed that smallholder farmers face many challenges that prevent them from being highly productive, amongst the listed challenges, were inadequate support from research and extension services (FAO, 2013). Mutanyagwa (2017) asserted that smallholder farmers receive minimal to no extension visits, which leads to poor resource management for some farmers and uninformed decisions.

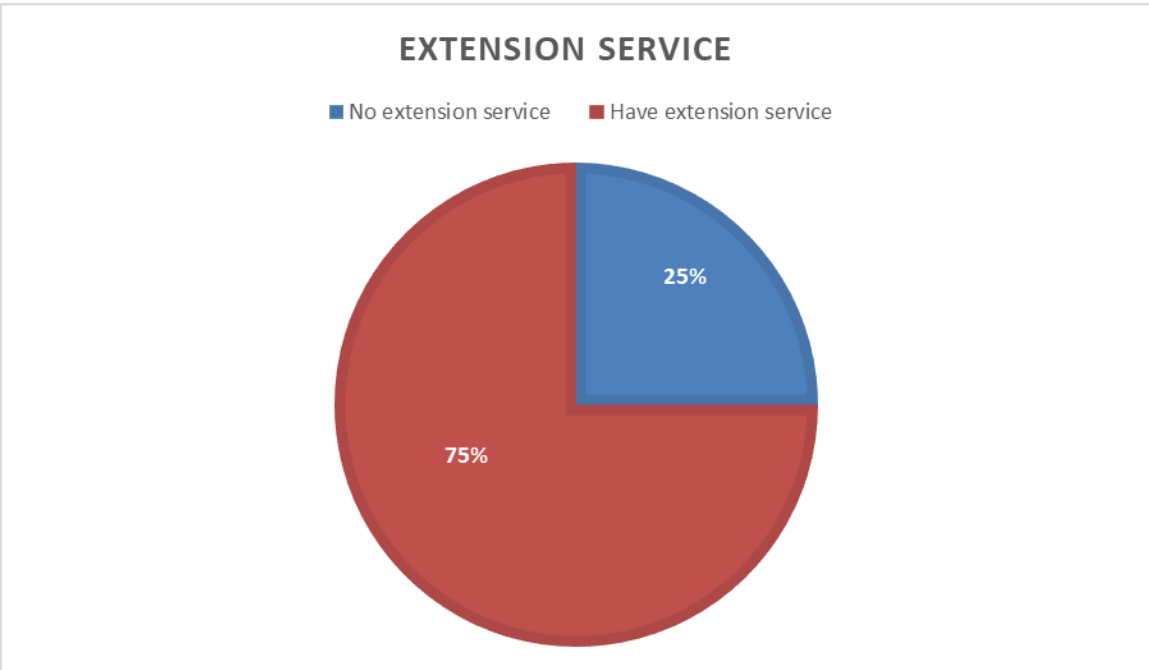


Figure 4.4: Depicts percentage of extension services received by farmers

Source: Survey data

4.2. Results from Multinomial Logistic Regression

The results from the MNL model which were used to determine and analyse factors influencing the farmer's varietal choice are presented in Table 5 below. The base category used is the choice of using landrace (traditional) maize varieties, meaning there is no adoption of improved maize varieties or the choice of using the combination of landrace and improved varieties. The results are compared. The likelihood ratio chi-square of 219.70 with a p-value of 0.000 shows that the model as a whole fit significantly better than an empty model.

Table 4.1: Multinomial Logistic Regression results

Maize Variety Grown by Farmers	Coef.	Std. Err.	P >I Z I
0 (Landrace) *Base Outcome* 1 Improved maize variety			
Age of respondent	-.0357	.0264072	0.176
Household size	.6481	.7572084	0.392
Educational level	-.1485	.3289147	0.652
Number of years of formal education	-.0486	.0798338	0.542
Knowledge of maize varieties	-2.1860***	.8129086	0.007
Kilometers travelled to market	.0011	.0351052	0.973
Extension contact	-2.4048***	.7400416	0.001
Access to farming credit	.3741	.8341413	0.654
Membership of agricultural association	-1.4789*	.8429389	0.079
	-1.4503**	.5762399	0.012
Size of farming land	.0025***	.0005749	0.000
Yield size	.0064	.038525	0.868
Farming experience			

Maize Variety Grown by Farmers	Coef .	Std. Err.	P >IZI
0 (Landrace) *Base Outcome* 2 Combination of the two			
Age of respondent	-.0113	.0396845	0.775
Household size	-1.2960	1.2654	0.306
Educational level	2.0732***	.7493592	0.006
Number of years of formal education	.2967*	.1564664	0.058
Knowledge of maize varieties	-16.1798	1618.654	0.992
Kilometers travelled to market	.0873	.0704673	0.215
Extension contact	-2.1341**	.9299296	0.022
Access to farming credit	-2.0130*	1.082106	0.063
Membership of agricultural association	-.5492	1.12584	0.626
	-.8743	.6336	0.168
Size of farming land	.0029***	.0006	0.000
Yield size	.06041	.0573	0.292
Farming experience			

Number of obs = 198

LR chi2(34) = 219.70

Prob > chi2 = 0.0000

Pseudo R2 = 0.5947

Log likelihood = -74.870984

***, ** and * represent coefficient significance at 1 %, 5% and 10 %, respectively.

The educational level coefficient is negative and significant. This means that, for every 1-unit increase in the educational level of a farmer, the likelihood of a farmer to grow improved variety only are likely to decrease by 0.148 units. Moreover, the educational level of a farmer with reference to a comparison between the combination of improved and landrace to the choice of landrace only has a positive coefficient of 2.073266. This means, for every 1-unit increase in the educational level of a farmer, the likelihood of a farmer growing a combination of landrace and improved variety is predicted to increase by 2.073 units and is significant with a p value of 0.006. As such, the more the farmer invests in education, the greater the chances of choosing a combination of both landrace variety and improved for different reasons and benefits. This supports the finding that smallholder farmers perceive little advantage from the improvement of maize seeds because such seeds are not designed for their needs (Reeves *et al.,* 2014).

Farmers see it fit to grow landrace varieties to satisfy their desired needs such as taste and other traits. They also grow improved varieties to benefit from increased yield and other beneficial traits such as time saving from weeding with hoes by growing maize varieties that can be controlled with chemicals. Farmer's decisions are therefore not only driven by yield and profit maximisation, but also by complex processes that are affected by several socio economic and psychological variables (Willock *et al.,* 2009). Therefore, farmers see it more viable to satisfy their needs by growing landrace variety for personal gains and grow improved variety for economic benefits.

The farmer's level of formal education on the choice of improved variety relative to landrace variety is significant and has a negative coefficient of (-.0486975) which denotes a negative relationship between this variable and the independent variable. According to the results, for every 1-year increase in the number of years of formal education, the log likelihood of a farmer to grow improved variety as compared to landrace is expected to fall by 0.0486 units. These results suggest that the lower the number of years that farmers spend in school, the greater the chances of choosing the landrace variety over improved variety. However, the number of years of formal education on the basis of a comparison of the combination of both varieties and landrace only has a positive relationship with the dependent variable which is the choice of the maize variety. The results suggest that for every 1-unit increase in the number of years of formal education, the likelihood of a farmer to grow a combination of both varieties rather than landrace is only anticipated to increase by 0.296 units. This makes economic sense because it indicates that farmers really want to balance their needs and generate profit while at the same time growing improved varieties as they are known for increased yields, compared to landrace.

Household size is positively related to the probability of adopting improved maize variety and inversely proportional to the choice of combining both improved and landrace varieties. The relative ratio of 0.648 shows that there is 0.648 times as much probability of adopting improved maize varieties among larger households than among smaller households. This means that as households increase by one person, there is a 0.648 relative probability of farmers growing improved maize variety. This could be because improved maize variety is characterised by increased productivity and will ultimately require more man power. Larger households tend to have a much stronger labour force than small households. This concurs with Sodjinou et al. (2015) who found that families with a greater number of persons adopt organic cotton than those with a smaller household size. However, when coming to the adoption of the combination of improved variety and landrace variety, distinctions are notable. The results revealed that there is a relative ratio of -1.296 times leasser probability of choosing to grow a combination of both improved and landrace simultaneously among larger households than in most relatively low households.

Distance travelled (in Kilometers) to access seed market showed a positive influence towards the choice of maize variety farmers grow. These results suggest that farmers who travel less distances to the market have a 0.011 times probability of adopting improved maize variety than those who travel relatively long distances. The latter have a 0.087 times probability of choosing to grow a combination of both landrace and improved variety.

Information is critical in farming and the most crucial source of relevant information is farmers' extension contact and membership to farming associations. Farmers get a lot of crucial and relevant information from extension officers as they receive regular trainings and workshops than farmers who do not participate in such workshops and trainings. These platforms create opportunities for farmer-to-farmer information sharing. The results show a negative relationship between extension contact, knowledge of maize varieties and membership to agricultural organisation and the maize variety grown by farmers. This contradicts the study conducted by Mmbando and Baiyegunhi (2016) whose results showed that both membership to an organisation and extension contacts have a positive relationship to the adoption of improved maize varieties.

Farm size is significant and negatively affects the probability of choosing improved maize variety, and a combination of both improved variety and landrace than just opting to grow landrace variety only. These results indicate that for every unit increase in farming size, there is a 1.450 much lesser probability of choosing improved maize variety and 0.874 less probability of choosing a combination of both improved and landrace variety. This suggests that with increasing size of land for cultivation, farmers would rather choose to grow landrace variety only. This could be because improved maize variety is considered to be more labour intensive and will therefore require more investment into labour. So, farmers deem it best to expand land and grow landrace only since a majority of small-scale farmers grow maize to ensure food security and eradicate hunger.

These results support a study conducted by Banziger et al. (2002) whose results revealed that 70% of smallholder farmers continue to use local and recycled maize varieties which are characterised by low yields. The challenge of low yield has been noted by most breeders of improved maize seed varieties. Moreover, much focus has been on raising yields, as well as addressing drought and disease tolerance. Smallholder farmers, however, perceive little advantages from such improvement because such seeds are not designed for their needs (Reeves *et al.,* 2014). Farmers' decisions are therefore not only driven by yield and profit maximisation, but also by complex processes that are affected by several socio economic and psychological variables (Willock *et al.,* 2009).

Farming experience positively affects farmers' choice of maize variety. Results revealed that for every 1-year increase in the farmers' experience, there is a 0.006 much more probability of farmers choosing to grow only improved variety and 0.060 probability of growing a combination of both improved and landrace variety. This could be because, those who have been in the field for longer have seen and learned the dynamics of farming and challenges that come with farming such as climatic conditions. As a result, farmers with more experience tend to choose improved variety while some prefer a combination of improved and landrace varieties because of their unique economic and socio-economic benefits. Improved varieties are known to contain certain traits that are improved over their parents, such as pest and disease resistant, drought resistant and their ability to overcome other possible stresses. Production using improved seed varieties has been identified as a precondition for achieving food security (Langyintuo *et al.,* 2000; Bernard *et al.,* 2010). Furthermore, experienced farmers also still choose to grow landrace varieties because they believe that traditional or landrace varieties have more other benefits such as climate adaptability and therefore give them the assurance of reproducing and saving them costs of seeds.

CHAPTER FIVE
SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1. INTRODUCTION

This chapter summaries the main findings of the study and concludes on the basis of the findings derived from the empirical results. This chapter also discusses the extent to which the objectives and research questions posed in Chapter One have been addressed in the analysis. The study analysed the factors that influence smallholder maize farmers' varietal choice in the Mogalakwena local municipality. Recommendations arising from the results of this study as well as the possible solutions and programmes which the government can implement to encourage informed decision-making on varietal choice are provided in this chapter.

5.2. SUMMARY

The study analysed the factors influencing smallholder maize farmers' varietal choice. This study was conducted in 5 villages within the Waterberg District. The objectives of this study were to: Identify and describe socioeconomic characteristics of smallholder maize farmers; analyse socioeconomic characteristics of smallholder maize farmers; identify different maize varieties grown by smallholder farmers, and to determine and analyse factors influencing farmers' choice of maize variety in the study area. A multi staged and simple random sampling methods were employed to collect data from a sample size of 200 respondents using a well-structured questionnaire. The research questions of this study were all well-addressed using the descriptive statistics and the Multinomial Logistic Regression.

The average age of the respondents was 54 years. This was an indication that most of the respondents are in their moderately active stage. More than 50% of the respondents have formal education, which is a good indication of human capital because a high literacy level indicates that the farmers in the study area have the capacity to grasp information regarding maize farming. Although there is high percentage of farmers who have formal education qualifications, there is a 75% of farmers who do not have access to extension contact or services. This leads to the farmers being deprived of their right to agricultural information and their capacity to gain new information regarding new innovations in the sector and maize varieties that can lead to increased farm production.

Among the socio-economic factors and other institutional factors, variables that were found to significantly influence small-scale maize farmers' varietal choice were knowledge of maize varieties, extension contact, membership to agricultural associations, size of farming land, yield size, educational level, number of years of formal education and access to farming credit. The study found that 59.6% of the farmers in the study area grew landrace varieties.

5.3. CONCLUSION

The general objective of this study was to analyse the factors that influence smallholder maize farmers' varietal choice in Mogalakwena using data collected from 200 maize farmers. In order to achieve the general aim of this study, several activities had to be performed and this included, identifying and describing socioeconomic characteristics of smallholder maize farmers; analysing the socioeconomic characteristics of smallholder maize farmers; identifying different maize varieties grown by smallholder farmers as well as determining and analysing factors influencing farmers' choice of maize variety. The conclusions derived from the results presented in chapter four are:

The selected farmers' households had an average of five members. This concurs with the study conducted by Sodjinou et.al (2015), who found that families with a greater number of persons adopt organic cotton than those with a smaller household size. The majority of farmers were old people with little access to extension service and an inadequate farming knowledge.

The results indicated that the choice of maize variety is influenced by factors such as age, household size, educational level, number of years of formal education, farmer's experience, and distance travelled to access seed market and yield size. Furthermore, factors that significantly influence the farmers' maize varietal choice were knowledge of maize varieties, extension contact, farm size under cultivation, taste, accessibility and educational level.

5.3. RECOMMENDATIONS

In light of the findings of this study, the researcher submits the following recommendations:

- There is a dire need for further studies to be conducted on the role and significance of extension services in enhancing the decision or choice of maize variety seeds. This study noted that many farmers in local villages are still growing landrace varieties because they lack information regarding the improved maize varieties. This may be as a result of poor extension service delivery. Hence, extension service can help address the challenge.

- Research on attributes that influence farmer's maize varietal choice should be conducted. For instance, there are many studies relating to varietal choice, however, such studies focus more on traits such as pests, disease tolerance and drought tolerance instead of the challenges faced by a majority of farmers in local villages who indicate that such seeds do not cater for their desires. Thus, further research should be conducted on the traits that are desired by such farmers, traits such as taste, palatability, and aroma as a majority of these farmers focus more on producing maize for household consumption only.

- The government should provide resources and develop existing infrastructure or make provision for new infrastructure to improve the quality of extension services. Furthermore, there is a dire need to encourage farmers' cooperatives which will make it easier for extension officers to reach out to farmers with a much wider dissemination of information to the study area.

6. SCIENTIFIC CONTRIBUTION

This study will make a great contribution to previous literature on the subject by providing new insight(s) on maize variety choices made by smallholder farmers in the Mogalakwena Municipality. The current government programme which provides production inputs is not adequately structured to accommodate such crops since they are considered to be cash crops rather than commercial ones. The results of this study will also assist programme planners to adequately structure their objectives and accommodate smallholder farmers and educate them on the importance of maize variety choice.

This study will elucidate the maize varieties that farmers are currently growing and further indicate the factors that influence the choice of maize variety. The results of this study will therefore contribute to the generation of guidelines that can help in formulating policies that aim to improve maize yields by providing subsidies on maize varieties that produce higher yields to meet the demands of the exponentially growing population and stabilise prices of end products of maize such as corn flakes and maize meal.

REFERENCES

Alexandratos, N. and Bruinsma, J., 2012. World agriculture towards 2030/2050: the 2012 revision.

Baloyi, R.T. 2011. *Technical efficiency in maize production by small-scale farmers in Ga-Mothiba, Limpopo Province, South Africa*. PhD thesis. Turfloop: University of Limpopo.pp. 5-13

Bernard, M., Hellin, J., Nyikal, R.A. and Mburu, J.G., 2010. Determinants for use of certified maize seed and the relative importance of transaction costs (No. 308-2016-5062, pp. 1-26).

BFAP. 2012. *BFAP Baseline: Agricultural outlook 2012-2021*. Pretoria: Bureau for Food and Agricultural Policy.

BFAP. 2014. *BFAP Baseline: Agricultural outlook 2014-2023*. Pretoria: Bureau for Food and Agricultural Policy.

BFAP. 2015. *Agri-Benchmark: Maize*. Pretoria: Bureau for Food and Agricultural Policy

Borooah, V.K. 2009. *Logit and probit ordered and multinomial models*. CA: Sage.

Borras, S.M (Jr.)., Franco, J.C., Isakson, S.R., Levidow, L. and Vervest, P. 2016. *The rise of flex crops and commodities: Implications for research.*

Cho, Y., Robalino, D. and Watson, S., 2016. Supporting self-employment and small-scale entrepreneurship: potential programs to improve livelihoods for vulnerable workers. *IZA Journal of Labor Policy*, *5*(1), pp.1-26.

Danso-Abbeam, G., Bosiako, J.A., Ehiakpor, D.S and Mabe, F.N., 2018. Adoption of improved maize variety among farm households in the northern region of Ghana.

Cogent Economics & Finance, 5(1): 1416896.

Dhlamini, S. 2020. Grain report July 2020, pp. 1-10, https://www.google.com/url?sa=t&source=web&rct=j&url=https://www.elsenburg.com/sites/default/files/Grain%2520Report_July%25202020.pdf&ved=2ahUKEwje-Lz14MbuAhUTShUIHbePCf4QFjAAegQIAxAC&usg=AOvVaw0J63trTgAe75bNFcObalDs

Fanadzo, M., Chiduza, C.A. and Mnkeni, P.N.S. 2009. *Comparative response direct seeded and transplanted maize (Zea mays L.) to nitrogen fertilization at Zanyokwe irrigation scheme, Eastern Cape, South Africa*.

FAO. 1999. *Women-users, preservers and managers of agrobiodiversity*. FAO, Rome: Italy, pp. 1-4.

Guris, S., Metin, N. and Caglayan, E., 2007. The brand choice model of wine consumers: a multinomial logit model. *Quality & Quantity*, 41(3): 447-460.

Greyling, J.C. 2019. *Policy, production and productivity: Spatial dynamics in the South African maize industry during the 20th Century.*

GSA. 2015a. *Area and production of white and yellow maize*. Pretoria: Grain South Africa.

GSA. 2015b. *Summer grain supply and demand tables*. Pretoria: Grain South Africa.

Hendriks, S. 2013. South Africa's national development plan and new growth path: Reflections on policy contradictions and implications for food security. *Agrekon*, 52(3):1-17

Hepelwa, A.S., Selejio, O and Mduma, J.K. 2013. *The voucher system and the agricultural production in Tanzania: is the model adopted effective? Evidence from the panel data analysis*. Environ. Dev. Initiat., Available from: http://www. efdinitiative. org/news/events/voucher-system-and-agricultural-productiontanzania-model-adopted-effective-evidence (accessed June 2014).

Jacobson, K., Myhr, A.I. 2013. GM crops and smallholders: Biosafety and local practice. *J Env. Dev.*, 22:104-124.

James, C. 2013. *Global status of commercialized biotech/GM crops*. Ithaca, NY:

ISAAA.

Japhether, W., De Groote, H., Lawrence, M., Danda, M.K. and Mohammed, L. 2006. *Recycling hybrid maize varieties: Is it backward practice or innovative response to adverse conditions in Kenya?*

Jayne, T.S., Chamberlin, J and Headey, D.D. 2014. Land pressures, the evolution of farming systems, and development strategies in Africa: A synthesis. *Food Policy*, 48: 1-17.

Kibirige, D and Obi A. 2015. Agricultural efficiency of smallholder farmers in Eastern Cape province of South Africa. *International Journal of Economics, Commerce and Management*, 3(9): 269-89.

Liebenberg, F and Pardey, P.G. 2010. *South African agricultural production and productivity patterns*. The shifting patterns of agricultural production and productivity worldwide, pp. 83-408.

Langyintuo, A.S. and Mekuria, M. 2008. Assessing the influence of neighborhood effects on the adoption of improved agricultural technologies in developing agriculture. *African Journal of Agricultural and Resource Economics*, 2:151-169.

Mabhaudhi, T. 2009. *Responses of maize (Zea mays L.) landraces to water stress compared with commercial hybrids*. PhD thesis.

Maize Trust. 2014. *Prospectus on the South African maize industry*. Pretoria: The Maize Trust.

McCann, J. 2001. *Maize and grace: History, corn, and Africa's new landscape, 1500-1999*. Boston: Boston University Press.

Mason, N.M and Ricker-Gilbert, J. 2012. Disrupting demand for commercial seed: input subsidies in Malawi and Zambia. *World Dev.*, 45:75-91.

Masters, W.A., Andersson, A., Haan, C. et al. 2013. Urbanization and farm size in Asia and Africa: implications for food security and agricultural research. *Global Food Security*, 2(3): 156-165.

Ngang, P.N. Farmers' adoption of improved maize varieties in the humid forest area of Cameroon.

Ortmann, G.F. and King, R.P., 2007. Agricultural cooperatives II: can they facilitate access of small-scale farmers in South Africa to input and product markets?. *Agrekon*, *46*(2), pp.219-244.

Peroni, N and Hanazaki, N. 2002. Current and lost diversity of cultivated varieties, especially cassava, under swidden cultivation systems in the Brazilian Atlantic Forest. *Agric. Ecosystem. Environ.*, 92:171-183.

Pienaar, L. and Partridge, A. 2014. *Trade into Africa: Perspective on South African horticultural trade with Africa (Part 2)*. Elsenburg: Western Cape Department of Agriculture.

SAGIS. 2015. *South African maize supply and demand*. Pretoria: South African Grain Information Services.

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

Sibiya, J., Tongoona, P., Derera, J and Makanda, I. 2013. Farmers' desired traits and selection criteria for maize varieties and their implications for maize breeding: A case study from KwaZulu-Natal Province, South Africa. *Journal of Agriculture and Rural Development in the Tropics and Subtropics (JARTS)*, 114(1): 39-49.

Swanepoel, C.M., Swanepoel, L.H. and Smith, H.J. 2018. A review of conservation agriculture research in South Africa. *South African Journal of Plant and Soil*, 35(4): 297-306.

"South Africa: Provinces and Major Urban Areas - Population Statistics in Maps and Charts". Citypopulation.de. Retrieved 29 August 2017.9 Census.

Salgotra, R.K and Gupta, B.B. 2015. Plant genetic resources and traditional knowledge for food security. Springer: Berlin, Germany.

Siziba, S., Mutsvangwa-Sammie, E.P.,and Manzungu, E. 2018. Key attributes of agricultural innovations in semi-arid smallholder farming systems in south-west Zimbabwe. *Physics and Chemistry of the Earth, Parts A/B/C*, *105*, pp.125-135.

Olson, M.B., Morris, K.S and Mendez, V.E. 2012. Cultivation of maize landraces by small-scale shade coffee farmers in western El Salvador. *Agric. Syst.*, 111: 63-74.

Sthapit, B. Rana, R. Eyzaguirre, P and Jarvis, D. 2008. The value of plant genetic diversity to resource-poor farmers in Nepal and Vietnam. *Int. J. Agric. Sustain*, 6: 148 -166.

StatsSA. 2014. *Gross domestic product*. Pretoria: Statistics South Africa.

StatsSA. 2015a. *Agricultural statistics*. Pretoria: Statistics South Africa.

StatsSA. 2015b. *Mid-year population estimates*. Pretoria: Statistics South Africa.

Tsegaye, B and Berg, T. 2007. Utilization of durum wheat landraces in East Shewa, central Ethiopia: Are home uses an incentive for on-farm conservation? *Agric. Hum. Values*, 24: 219–230.

Tshilambuli, R.B. 2011.*Technical efficiency in maize production by small-scale farmers in Ga-Mothiba, Limpopo Province, South Africa*. Sovenga: University of Limpopo.

Uyesi, I.O. 2003. *Comparative advantage of Turkey with regard to the EU*. Isparta: Suleyman Demirel University.

Unganai, L.S. and Kogan, F.N. 1998. Drought monitoring and corn yield estimation in Southern Africa from AVHRR data. *Remote Sensing of Environment*, 63(3): 219-232.

Van Zyl, J and Nel, H. 1988. The role of the maize industry in the South African economy. *Agrekon*, 27(2):10-6.

Van de Wouw, M., van Hintum, T., Kik, C., van Treuren, R and Visser, B. 2010. Genetic diversity trends in twentieth century crop cultivars: A meta-analysis. *Theor. Appl. Genet*, 120: 1241–1252.

Willock, J., Deary, I.J., Edwards-Jones, G., Gibson, G.J., McGregor, M.J., Sutherland, A., Dent, J.B., Morgan, O. and Grieve, R. 2009. The role of attitudes and objectives in farmer decision-making business and environmentally-oriented behaviour in Scotland. *Journal of Agricultural Economics*, 50(2): 286-303.

Zimmerer, K.S. 2014. Conserving agrobiodiversity amid global change, migration, and non-traditional livelihood networks: The dynamic uses of cultural landscape knowledge. *Ecol. Soc.*, 19.

DETERMINANTS OF SMALLHOLDER MAIZE FARMERS' VARIETAL CHOICE: A CASE STUDY OF MOGALAKWENA LOCAL MUNICIPALITY, LIMPOPO PROVINCE, SOUTH AFRICA

The aim of this study is to identify and analyse the factors influencing smallholder farmer's maize varietal choice in Mogalakwena Municipality.

Participation is voluntary and information provided by the respondent is confidential and will be used for the research purpose only. The study will not be harmful to humans and the environment.

Your honest and concise answer to the following questions will be highly appreciated

Name of enumerator……………………………………………………………………

Date of the interview……………………………………………………………………

Name of the respondent……………………………………………………………….

Questionnaire for the Survey on Determinants of smallholder maize farmers' varietal choice: A case study of Mogalakwena Local Municipality, Limpopo Province, South

Africa

NB: Tick the appropriate box when you answer the questions below.

DEMOGRAPHIC INFORMATION

Q.1 What is your age? [ ]

Q.2 What is your gender?

1. Male [ ]

2. Female [ ]

Q.3 Can I check some details of the adult and child members of your household? First, how many people are there in your household? [ ]

Q.4 Which of these statuses applies to you at present?

1.	Married	
2.	Widowed	
3.	Divorced	
4.	Living together (with partner)	
5.	Separated	
6.	Single (never married)	

Q.5. Who is the household head?

1.	Female head	
2.	Male head	

Q.6 . What is your educational qualification?

1.	Formal education	
2.	Non formal education	

Q.7. if formal education, what is your educational level?

1.	Primary education	
2.	Secondary education	
3.	Tertiary education	

Q.8 What are the number of years of formal education? [ ]

Q. 8. Are you employed?

1.	No	
2.	Yes	

Q.9.If yes, what type of work are you participating in?

1.	Formal employment	
2.	Non formal employment	

Q.10. where do you get your primary income?

1.	Salary/Wage	
2.	Social grant	
3.	Profit from business, etc.	

Q.11. Do you have any other source of income?

1.	Yes	
2.	No	

Q. 12.What is your monthly income? R

Q.13. How *many people in this household at present receives income?*

Q.14. Do you or any household member contribute to an occupational/private pension scheme or not?

1. Yes ☐

2. No ☐

Q.15. How much do you spend on the following items? (specify in rands)

ITEM	WEEKLY	MONTHLY	ANNUAL
Food			
Clothing			
Health			
Education			
Water			
Electricity			
Transport			
Communication			
Housing			
Agriculture production inputs			
Recreation			
Others			

Q. 16. Are you a fulltime farmer of seasonal farmer?

1.	Full time	
2.	Seasonal	

Q.17. Which maize varieties do you know?

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

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

Q.18. are you aware of the different maize varieties in the market?

1.	Yes	
2.	No	

Q. 19. Which variety of maize are you planting?

1.	Landrace	
2.	Improved	
3.	Combination of the two	

Q.20. What are your reasons for your choice of maize variety?

…………………………………………………………………….

…………………………………………………………………….

Q. 21. Is there a local market where you can buy maize seeds of your choice?

1.	Yes	
2.	No	

Q. 17. If NO, how many kilometres do you travel to access the market?.................

Q.22. Do you have extension contact?

1. Yes
2. No

Q.23. Do you have access to credit?

1. Yes
2. No

Q.24. Do you have membership of any association?

1. Yes	
2. No	

Please provide further information you consider relevant in the context of this survey, or indicate additional persons that you think should be contacted.

....
....
....
....
....
....