An analysis of the economical feasibility of alternative grain storage methods

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LIST OF ACRONYMS

GRAIN SOUTH AFRICA	GRAINSA
SOUTH AFRICAN FUTURES EXCHANGE	SAFEX
SOUTH AFRICAN RAILWAYS AND HARBOURS	SAR&H
GENETICALLY MODIFIED ORGANISM	GMO
NON-GENETICALLY MODIFIED ORGANISM	NON-GMO
SMALL ENTERPRISE DEVELOPMENT AGENCY	SEDA
GROSS DOMESTIC PRODUCT	GDP
DEPARTMENT OF AGRICULTURE, FORESTRY AND FISHERIES	DAFF
HUMAN APPROPRIATON OF NETT PRIMARY PRODUCTION	HANPP
PURDUE IMPROVED CROP STORGAE BAGS	PICS
NATIONAL AGRICULTURAL TECHNOLOGICAL INSTITUTE	INTA
INTERNATIONAL COOPERATIVE ALLIANCE	ICA

ABSTRACT

The mass storage of grain has portrayed a pivotal role in agricultural communities throughout the ages. The trading of grain for other goods was some of the earliest recorded trade transactions and played a pivotal role in the development of specialised crafts, socio-economic distinctions, establishment of urbanism and the formation of states.

In the first part of the study a literature study was conducted that consisted of a historical overview of the production and storage of grain. Emphasis was placed specifically on maize cultivation which are the largest cultivated grain seed in the world and plays a vital role in the protein requirements in diets to sustain food security.

The literature study continues by discussing the history of the production and storage of grain commodities in South Africa and how the increase in grain production in South Africa and deregulation finally paved the way for alternative and more cost-effective grain storage solutions.

The qualitative and quantitative study clearly indicated that producers and other role players in the market have a strong affiliation towards the use of alternative grain storage facilities. From the data analysis conducted as part of the empirical study participants clearly indicated that *service delivery, cost savings* and *more flexible marketing options* were the primary drivers that persuaded them to make use of alternative grain storage facilities.

The study concludes by making recommendations towards agri-businesses, producers and other role players in the grain value chain to make alternative grain storage facilities even more attractive and sustainable in the future.

Key terms: Agriculture; grain value supply chain; food security; grain crops; grain storage; feasibility; single channel; deregulation; alternative grain storage.

CHAPTER 1
NATURE ANDS SCOPE OF STUDY

1.1 INTRODUCTION

It was the great South African poet and publisher, Langenhoven, who noted on occasion that, if a person wants to look at the future, he first has to look back for an instance to see where he comes from.

The large-scale storage of grain in silos played an important role in agricultural communities throughout the ages. Harvested crops were kept until the next harvest resulting in surpluses which acted as commodities and were exchanged for other products.

The production and storage of grain commodities in South Africa also had a unique venture in history and were affected by the same circumstances and developments on a comparative basis, including mechanical and technological innovations; climate change; world trends; state, political and social happenings and other developments in South Africa.

After the deregulation of the South African grain market and the abolishment of the grain marketing committees in 1996 any person or institution was allowed to receive, store, buy and sell grain. This initiative paved the way for alternative grain storage solutions.

These alternative grain storage facilities are cost-effective and introduced new grain storage solutions to different role players and offer the producer a faster turnaround time to get their harvest off the land. Alternative grain storage solutions also offer better marketing opportunities not previously allowed.

The aim of this study is to determine the primary reasons to invest in alternative grain storage solutions. Further the study would evaluate the feasibility of alternative grain storage methods by collecting data through both quantitative and qualitative data collection instruments.

The study will be led by defining the problem statement and primary research objectives. The scope and outlay of the study will then be outlined followed by a primary theoretical and literature study. As part of the research methodology an empirical study will be conducted that will underline and give structure to the research undertaken.

The study will be concluded by making recommendations towards further studies that can accompany this study.

1.2 PROBLEM STATEMENT

The handling and storage of grain is still one of the biggest contributors in agricultural gross domestic product (GDP) today. Recent customer surveys that were conducted concluded that grain storage as a business unit attained the best customer satisfaction results from respondents. The results showed that the majority of respondents were grain farmers that had long affiliations with the agri-businesses. The reasoning behind this is because most cooperatives started as grain silo operators who primarily handled and stored the grain on behalf of grain control boards for the grain producers (Alsemgeest & Smit, 2012).

To sustain food security South Africa needs to ensure continuous growth through sustainability, effectiveness and innovation. Role players within the grain storage industry need to continuously add value to their shareholders. Alternative grain storage solutions can contribute to expanding market share and improve customer satisfaction. Alternative grain storage solutions can also form part of the long-term strategy of a business.

With the deregulation of the market in 1996 the agricultural division of the South African Futures Exchange (SAFEX) was established. Only white and yellow maize were initially registered as grain commodities to be traded on the South African Futures Exchange with other commodities being added as the years progressed. Grain commodities on SAFEX are traded using instruments such as derivatives. When grain commodities are traded on SAFEX there are spot prices for every delivery point. The spot price refers to the contract in the current month on SAFEX to which grain can be delivered. The delivery point refers to the grain storage facilities as registered with SAFEX.

For every delivery point there is a calculated transport differential to Randfontein which indicates the transport costs to Randfontein from the delivery point. Randfontein is used as reference point since it represents the biggest accumulation of grain producers in the surrounding areas when SAFEX was established. For very delivery point registered on SAFEX there is thus a different price at which producers can sell their commodities, in contrast to the regulated era of marketing boards when there was a single spot price for the whole country.

The deregulation of the grain market created a free market environment in which any individual can now store grain at locations as they prefer. Individuals can now store their grain at alternative grain storage facilities rather than in the traditional commercial silos (Roberts, 2009).

Alternative grain storage methods allow closer centralised locations to where grain can be transported, saving on transportation costs and ensuring better prices for grain. Role players within alternative grain storage domain can negotiate favourable storage rates directly with millers and other buyers and can receive a premium for delivering grain to such facilities. Alternative grain storage solutions would also be able to contribute to local communities and assist upcoming agricultural development.

To analyse the economic feasibility of alternative grain storage methods the following must be addressed:

- Identifying the best strategic location for the alternative grain storage facility.
- Analyse the capital outlay towards different alternative grain storage facilities.
- Analyse the economic feasibility of different alternative grain storage facilities;
- Identify the advantages and shortcomings of alternative grain storage facilities within the grain supply chain.
- Investigate value added services for alternative grain storage facilities.
- Investigate the effect alternative grain storage has on market share.

1.3 RESEARCH OBJECTIVES

1.3.1 Primary objective

The primary objective of this study is to determine if alternative grain storage methods is an economicly feasible and viable investment option. The outcome of this study would be able to assist roll players within the alternative grain storage domain to establish the strategic advantage alternative grain storage facilities can play in their quest to add value to their businesses.

Alternative grain storage facilities can contribute to expanding market share and improve customer satisfaction. The role alternative grain storage facilities can play in contributing towards food security and supporting local communities must also not be underestimated.

1.3.2 Secondary objectives

To answer the primary research question it would also be valuable to determine the following secondary objectives:

- The preferred method of alternative grain storage.
- Distinguish between different alternative grain storage facilities.
- Determine the correlation between variables such as geographical data and value added services.
- Determine the sustainability of alternative grain storage facilities within the grain supply and value chain.
- Determine the contribution alternative grain storage facilities has towards expanding market share.

1.4 RESEARCH METHODOLOGY

This research study will be conducted in two phases: a literature study followed by an empirical study to conclude the research methodology.

1.4.1 Literature review

The first part of the literature study gives an historical overview of the global production and storage of grain and how different grain storage techniques developed through time. The chapter also traces the origins of the maize plant specifically, since maize is the primary staple food crop produced in the world.

The chapter further delves into the development of agriculture which led to an increased need to store grain for prolonged periods of time. The increased demand for grain products to sustain food security for the global population growth led to an increased need for efficient mass grain handling facilities to ensure quality are maintained that adhere to world export standards.

The chapter concludes with a current market outlook on grain production and how grain storage also plays an important role to even out market fluctuations within the grain market supply chain.

The second chapter gives an historical overview of the production and storage of grain in South Africa. The chapter specifically focusses on maize cultivation since maize constitutes about 60% of cultivated land and 40% of calorie intake in South Africa.

The chapter delves into the history of mass grain handling facilities in South Africa which were initiated following the delegated Clark Committee investigation into grain storage techniques in Canada and the Unites States of America in the 1920's. Following the Clark committee investigation, the first mass grain handling facilities in South Africa were erected by South African Railways & Harbour.

The chapter further look at the pivotal role the Maize board played in the establishment of our grain silo complexes as we see it today. Agricultural cooperatives acted as agents for the Maize board and together with the appointed silo committees as supervisors, started to erect grain silos.

The third chapter starts with an oversight of the single-channel marketing system in South Africa that were initially regulated by the 1937 Marketing Act. During this period

the Maize board was the only appointed agents to trade maize. The Maize board was pivotal in the development of the maize industry in South Africa in the post war era.

The chapter further elaborates on how fixed pricing mechanisms adapted by the Maize board which led to cross subsidizing were not sustainable in the long run and led to the abolishment of the state controlled marketing boards in the mid 1990's.

This intervention paved the way into the de-regulated era which completely changed the grain marketing landscape in South Africa. The deregulation of the grain market in South Africa paved the way for the use of alternative grain storage methods.

The fourth chapter gives a brief outlook on the current grain production market in South Africa followed by the last two chapters which investigates different alternative grain storage methods and their feasibility.

1.4.2 **Empirical research**

1.4.2.1 Research design

The empirical study consists of both a qualitative and quantitative assessment. The qualitative study was conducted in the form of structured interviews where respondents were selected and asked a series of standard questions to determine what their general perception were towards alternative grain storage facilities.

Respondents were also asked to differentiate between traditional grain storage facilities, like silos, and alternative grain storage facilities. Respondents were then asked to indicate what their primary reasons would be to erect their own alternative grain storage facility in future.

To conclude the qualitative assessment respondents were given a list of ten primary drivers of which they had to choose five as the most important towards using or investing in alternative grain storage facilities.

1.4.2.2 Study population

The study population consisted of farmers and other role players within the grain value supply chain and included individuals of all ages, race & educational and cultural backgrounds. Individuals were specifically targeted based on their affiliation towards the use of alternative grain storage facilities

1.4.2.3 Research instruments

A qualitative study was conducted through structures interviews. The interviews aim was to establish what the primary drivers were when deciding on making use of alternative grain storage facilities.

A quantitative study was conducted through electronically distributed questionnaires. The questionnaires consisted of three parts.

The first part included demographical criteria where respondents had to select primary and secondary variables.

The second part of the questionnaire consisted of primary constructs which respondents had to evaluate in terms of the importance of the role these constructs play in alternative grain storage.

The last part of the questionnaire consisted of statements that were linked to the specific constructs in Part B of the questionnaire.

1.4.2.4 Data analysis

Data were statistically analysed in conjunction with the North-West University Statistical Consultation Services.

Demographic results were displayed using a statistical chart builder. The reliability of the constructs being tested were measured by using the Cronbach Alpha measuring instrument.

To test the strength of the relationship between the statements and the constructs correlation coefficients were calculated.

T-tests were also used to test the significance of the relationships between variables.

1.5 IMPORTANCE AND EXPECTED CONTRIBUTION OF THE STUDY

1.5.1 Importance of the study

After the deregulation of the grain market any individual or institution could buy and market grain directly to buyers in the market. Although this represented certain opportunities, it also increased competition. Alternative grain storage facilities could help a business to keep and expand its current market share. Alternative grain storage facilities would also help to increase customer satisfaction and add value to shareholders and local communities. The findings of this research could be beneficial to role players within the alternative grain storage domain.

1.5.2 Expected contributions of the study

By evaluating the constructs outlined in the research methodology this study would assess what factors contribute most to the economic feasibility of investing in alternative grain storage facilities.

By analysing the data obtained from the data collection instruments we can establish why certain alternative grain storage facilities perform better than others. This could be of strategic importance to invest in alternative grain storage facilities or ascertain what value added services could benefit the long term sustainability of these projects.

1.6 SCOPE OF THE STUDY

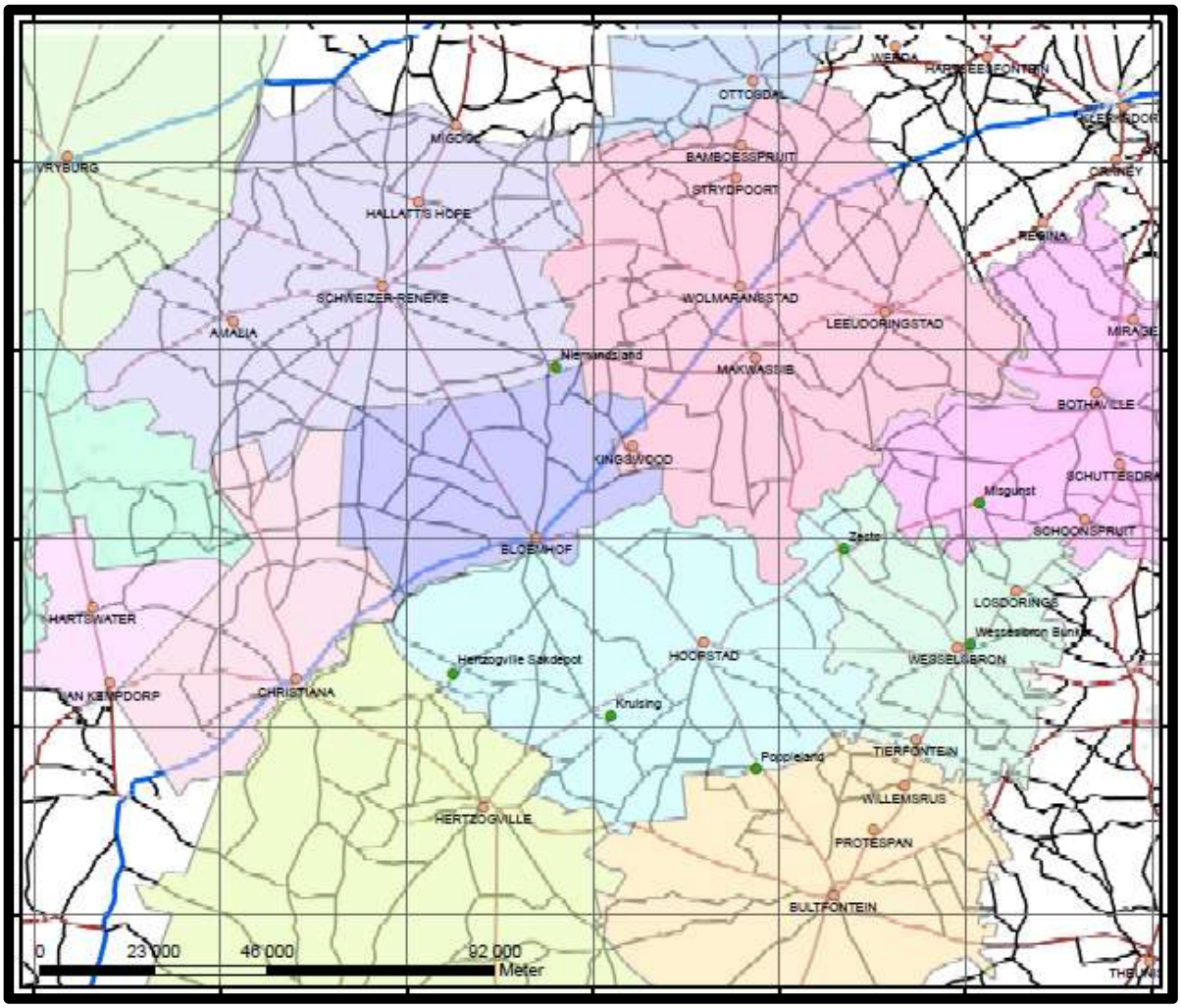
1.6.1 Field of study

The field of study falls within the operational and strategic management domain. The study aims to analyse the economic feasibility of alternative grain storage facilities.

1.6.2 Geographical demarcation

The study will be conducted within the North-West, Free State and Northern Cape provinces of South Africa. The reason behind this targeted geographical area is because of the concentration of alternative grain storage facilities in the production area.

Map 1.1 - Geographical demarcation



Source: Terratek, 2017

1.7 LIMITATONS OF THE STUDY

There is always the risk of a self-biased opinion from respondents when using research instruments such as questionnaires.

Although research has been done on the fragmentation of the grain supply chain after deregulation of the grain market, these studies mostly looked at on-farm storage from the producer's perspective.

Research on the economic viability of different alternative grain storage facilities is relatively scarce, making it difficult to obtain suitable and current literature.

There is uncertainty towards the application of the results for other role players within the alternative grain storage domain. The primary reason for this is because they

operate in specific geographical domains, and apply different strategic objectives and diversification strategies.

The study would only obtain information from an operational and strategic business perspective towards alternative grain storage facilities and not from the buyers of grain within the grain supply and demand chain.

1.8 CHAPTER OUTLAY

- **CHAPTER 1: NATURE AND SCOPE**

Chapter 1 starts with an introduction and background to the study after which the problem statement and research objectives and research methodology are defined. The chapter concludes with the scope, expected contributions and limitations of the study before ending with a brief synopsis of the chapter outlay.

- **CHAPTER 2: LITERATURE AND THEORETICAL REVIEW**

Chapter 2 consists of the literature and theoretical study. The study starts off with an overview of the history of grain production and the storage of grain; first from a global perspective and then from a South African context. The South African grain market is further analysed and discussed starting with the regulated grain market era through to the current deregulated era, which paved the way for alternative grain storage solutions.

The chapter concludes with an analysis of the different types of grain storage solutions with an outlook on the South African economy in terms of the current grain market environment.

- **CHAPTER 3: EMPIRICAL STUDY**

This chapter consists of the scientific study and the data analysis that has been done on the data collected through the data collection instruments distributed. The interviews and questionnaires tried to establish the viability of alternative grain storage solutions by identifying the primary reasons for using alternative grain storage facilities from producers' perspectives.

- **CHAPTER 4: CONCLUSIONS AND RECOMMENDATIONS**

The final chapter concludes with the findings of the study and makes subsequent recommendations. Suggestions towards further studies will also be made.

CHAPTER OUTLAY

CHAPTER 1: NATURE AND SCOPE
• Introduction to the study
• Problem statement
• Research objectives
• Research Methodology
• Importance and expected contributions of the study
• Scope of the study
• Limitations of study
• Chapter outlay
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• Overview of global grain production and storage
• History of grain production and storage in South Africa
• Overview of the regulated and deregulated grain market in South Africa
• Outlook on current South African grain market
• Reasoning behind alternative grain storage solutions
• Feasibility of alternative grain storage methods
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CHAPTER 3: EMPIRICAL STUDY
• Introduction.
• Research methodology
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• Research ethics
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CHAPTER 4: CONCLUSIONS AND RECOMMENDATIONS
• Introduction
• Conclusions.
• Recommendations
• Summary

CHAPTER 2
LITERATURE AND THEORETICAL STUDY

2.1 INTRODUCTION

This chapter begins with a historical overview of grain storage methods and the pivotal role the production and storage of grain portrayed in the development of modern economies and societies. The chapter continues to have a look at the current global grain production market and its outlook into the future.

The study then shifts focus to the South African grain market industry, starting at the regulated era and following through to the transition to the deregulated era in 1997. The study further elaborates on how deregulation paved the way for new, more cost-effective alternative grain storage methods within the grain value supply chain. The study concludes with a brief overview on the current outlook on the South African grain market industry and finalises by distinguishing between the different alternative grain storage solutions currently available.

The increase in grain production in South Africa from the early 1900s created an increased necessity for mass grain handling facilities. The government financed the building of silo complexes through the Landbank on condition that the grain committee that was established to oversee these projects certified them. All harvested grain had to be delivered to these silo complexes and the producers had no marketing rights over their grain commodities.

The deregulation of the grain market in 1996 paved the way for alternative and more cost-effective grain storage solutions. Alternative grain storage facilities also created more flexible marketing options, enabling producers and commodity traders to erect their own grain storage facilities from where they could market the grain (Grain SA, 2016).

With the significant increase in grain production in South Africa in the early 1920s there was an increasing demand for mass grain handling facilities with the ability to handle, store and grade the grain effectively and also adhere to export specifications.

The Grain Silo Committee, established in the early 1960s, gave momentum to the erection of grain silo complexes. These silo complexes were financed by the Landbank of South Africa on condition that these projects were certified by the Grain Silo Committee (Grain SA, 2016).

The grain industry in South Africa experienced a difficult and lengthy transition to the current deregulated era we are currently operating in. Although the transition was not without bumps, one thing that was as clear as daylight, was the way everyone adapted to the new circumstances.

The new environment was quickly defined and the necessary adjustments were made in the form of new regulating bodies that were created, including the South Africa Grain Information Service (SAGIS) and the South Africa Grain Laboratory (SAGL).

Although South Africa still faces many political challenges, we need to embrace our agricultural sector, which has the ability to produce quality food at competitive prices. It is a recognised fact that many communities in South Africa still do not have the financial means to afford sufficient food to attain a healthy lifestyle. It is an enormous challenge for us as South Africans to embrace this challenge by creating food security to all South Africans (Grain SA, 2016).

The basic definition of food security refers to an individual's ability to obtain sufficient food on a daily basis. The more specified definition refers to the ability of all people to access enough food at all times to sustain an active and healthy lifestyle (South Africa, 2011).

According to the Food Agricultural Organisation (FAO), the higher the self-sufficiency ratio of a country, the greater the ability of a country is to rely on its own production resources (Food Agricultural Organisation, 2016). The Department of Agriculture, Forestry and Fisheries indicates South Africa as being self-sufficient with a high self-sufficiency ratio for maize in particular (South Africa, 2011).

It is however still a concern that the most recent household survey conducted by Statistics South Africa concludes that 22.6 % of South African households have inadequate or severely inadequate access to food (Statistics South Africa, 2015).

2.2 AN OVERVIEW OF THE GLOBAL PRODUCTION AND STORAGE OF GRAIN.

2.2.1 Historical overview of the global production and storage of grain

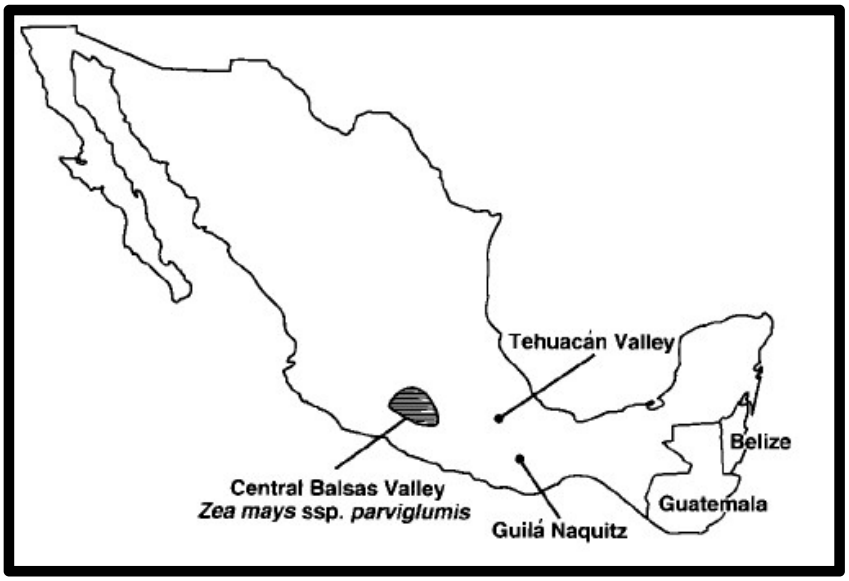
- **The origins of maize cultivation**

The importance of maize as the primary staple food crop of the world was already highlighted in the 1914 academic research publication titled *Maize: Its history, cultivation, handling and uses,* by Joseph Burtt-Davy. In the publication Burtt-Davy highlights the importance of the maize crop indicating that climatic conditions were the only limiting factor towards more widespread cultivation of maize.

At the time of the publication, which followed three to four years of research, the world already produced 108 million colonial tons of maize of which the United States had been producing 75 %. Maize is an easy crop to grow with relative low capital input and with a great variety of uses in different manufacturing processes. Research conducted on the geographical dissipation of maize clearly indicates its origins in the Americas where maize has been cultivated by native Indians since prehistoric times (Burtt-Davy, 1914).

Botanists accumulated considerable molecular data that traced the origins of maize as a descendent of teosinte (Figure 2.2), a native wild grass species that was cultivated in the Balsas River Valley (Figure 2.1) in Mexico (Piperno & Flannery, 2000).

Figure 2.1 – Origins of Maize, Balsas Valley (Mexico).



Source: Piperno and Flannery, 2000

Figure 2.2 – Teosinte plants, Balsas Valley (Mexico)

Source: Staller *et al.,* 2009

A simplistic paradigm describes the development of agriculture in simple terms as hunters who gathered seeds and started to experiment with the planting of the seeds.

These experimenters became dependent on the seeds they've grown and consequently became farmers. Crop seeds migrated over the landscape through farmer groups who saw the benefits in planting these seeds (Staller *et al.,* 2009).

❖ The development of grain storage

The storage of food crops has been synonym with food production since prehistoric times. Food storage guaranteed the provision of the foodstuff for long-term use beyond the time when the particular resource were available. Storage also allowed for a surplus to be created which was available for later use and formed a key element in social and economic complexity (Peña-Chocarro *et al*., 2015).

The durability and permanence storage value of cereal grains played a valuable role in the development of agriculture and hence the evolution of the modern civilisation by man. In the previous century there was a world shortage of cereals and consequently very little need for prolonged grain storage facilities (Oxley, 1948).

As agriculture developed through the ages the need to store grain crops in particular rose significantly. Crops needed to be stored for at least a year until the next harvest resumed. From the earliest indications shows remains of underground silos and collective granaries that were used to store the crops (Peña-Chocarro *et al*., 2015).

Underground grain silos (Figure 2.3) were some of the earliest bulk grain storage facilities and played an important role in agricultural communities. These silos were especially vital to keep grain surpluses until the next harvest. The production of grain surpluses were also some of the first indications of the accumulation of wealth by man (Garfinkel *et al.,* 2008).

Grain surpluses that were produced acted as commodities which could be traded for other products or services and played a pivotal role in the development of specialised crafts, socio-economic distinctions, establishment of urbanism and the formation of states (Garfinkel *et al.,* 2008).

Although there is very well preserved evidence concerning underground structures such as grain silos, these findings still rely on archaeology as the only source of information. Many archaeological findings show that these silos are only filled with earth and on very rare occasions do they still contain carbonised grain. It is therefore difficult to predict the precise use and purpose of these structures, but

fortunately newer modern archaeological methods are enabling archaeologists to derive much more information from the reserved evidence that was formerly thought possible (Shejbal, 1980).

Figure 2.3 – Ancient grain silos "*Kouloures"*, Crete (Greece).

Source: Privitera, 2014

As the agricultural system became more developed and structured in the Middle Ages, grain was starting to be stored above ground. For 150 years grain would primarily be stored on floors until grain lofts became semi-automated in the 19th century with the introduction of drop tube systems. The abundant supply of cheap labour was the main driver limiting engineering development of grain storage and consequently basic storage techniques were still the norm until the beginning of the 19th century.

It was only after transport started to become more developed that the need for more economic grain storage facilities arose. As societies developed, living standards kept rising and people moved away from storing grain only for direct consumption and saw new uses in grain as the production and trading in grain started to intensify (Boumans, 1984).

2.2.2 Current outlook on the global production and storage market for maize

Grain is the most important staple food for most countries and for that reason grain storage occupies a vital role in the economies of especially developing countries. The demand for grain is fairly stable from year to year since people's consumption does not vary significantly from one season to the next.

The market supply of grain can vary from season to season depending on climatic conditions. Grain storage fulfils an important function to even out these market fluctuations by taking surpluses that were stored from the previous season and releasing it back on the market in the lean seasons (Peña-Chocarro *et al.*, 2015).

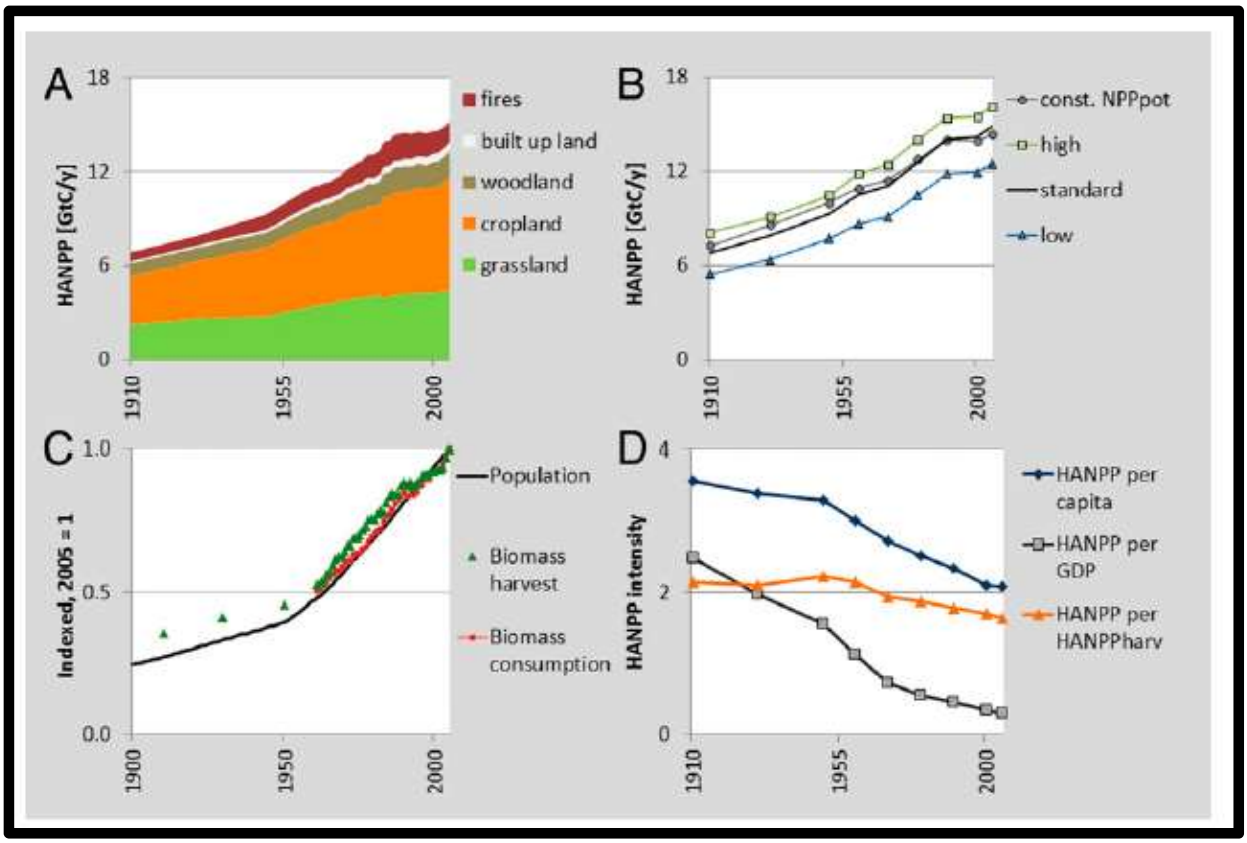
The seasonality of grain production, where in most instances there is only one harvest a year, necessitates good grain storage infrastructure to keep grain for longer storage periods to fulfil in the demand of a growing population. The demand for grain is inelastic, meaning that the fluctuation in grain prices has little effect on the amount of grain consumers' purchases. Grain storage plays an important role in economies to even out the fluctuations in the market supply of grain (Food Agricultural Organisation, 1994).

With the global population set to increase by over 2 billion people over the next decade, there is an expected increase of 110 % in global crop production and a subsequent increase in demand for natural resources and efficient ecosystems (Tilman *et al.*, 2011). Since 1910 the global population has grown fourfold while economic output has grown more than seventeen times, creating an increasing demand for more sustainable practices to ensure food security. (Tilman *et al.*, 2002).

One of biggest critical limiting resources is the available land capacity to produce from. The efficiency of production output can be analysed in terms of global population growth using the HANPP measurement indicator. The human appropriation of net primary production (HANPP) is a useful measure that helps to detect how humans interact with the biosphere (Krausmann *et al.*, 2013).

In terms of efficient land use for production the global average of HANPP reduced from 2.1 ton to 1.6 ton over a period of a century (Graph 2.1). The ratio of 2.1 indicates that for every ton of harvested plant production, the biomass increased with an additional ton. Over the last century this ratio declined to 1.6 which is a good indication of more efficient and sustainable agricultural practices.

Graph 2.1 – Global HANPP through the last century.



Source: Krausmann *et al.*, 2013

Sustainable practices like no-tillage and organic cropping systems, together with efficient mechanisation, play an ever increasing role to attain better yields from the arable agricultural land available. No-tillage studies conducted in the United States of America indicate that over a twenty eight year period a significant increase in organic elements in the soil with a better water retaining capacity was attained, compared to tillage systems (Teasdale *et al.*, 2007).

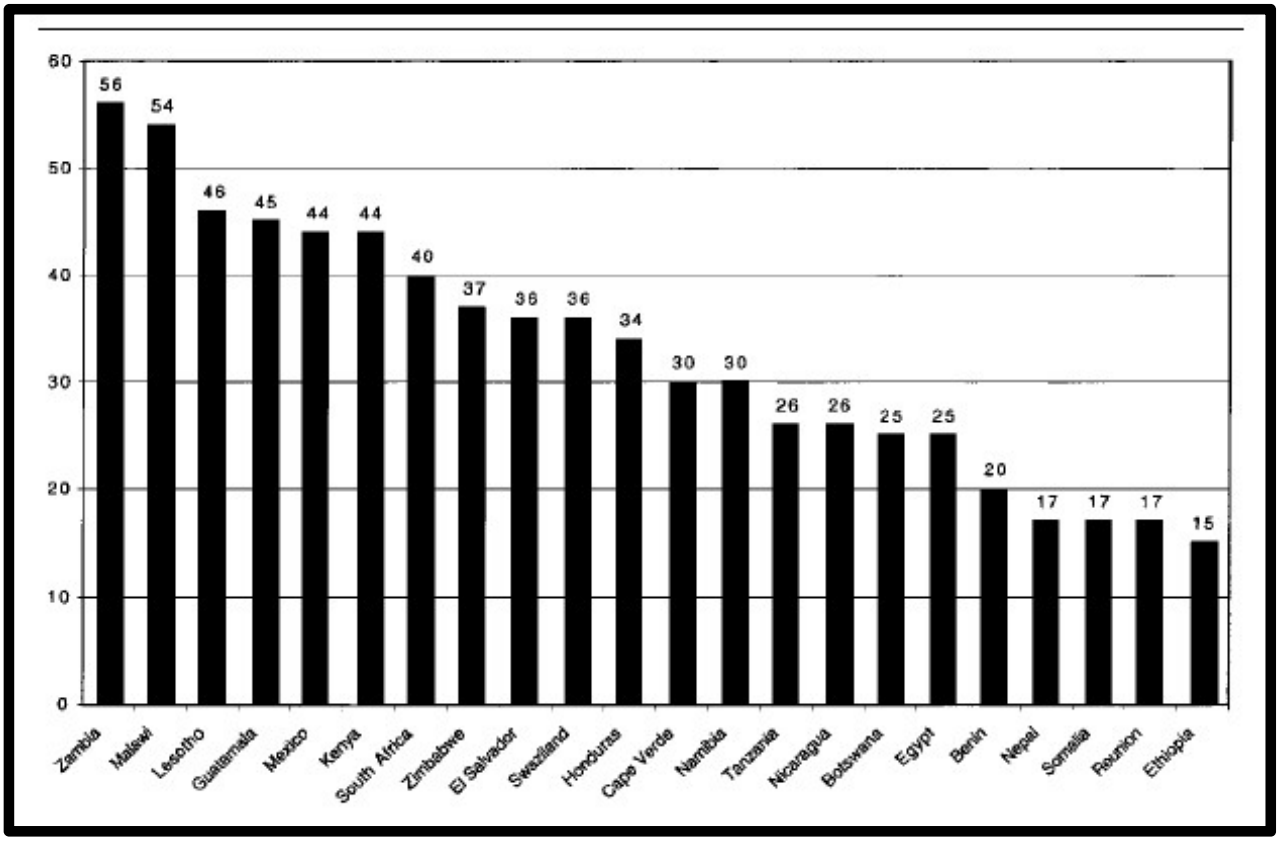
With the increased demand for grain produce to sustain food security for the global population growth the need for mass grain handling facilities became imperative to ensure that grain are stored and handled in the most efficient manner to ensure the necessary quality are achieved that adheres to world export standards.

2.3 THE HISTORY OF GRAIN PRODUCTION AND STORAGE IN SOUTH AFRICA.

2.3.1 The history of grain production in South Africa

As in the rest of the world, maize is also the primary crop being produced in South Africa. Maize provides the main source of carbohydrates for the South African region and is mainly produced in the central and eastern parts of South Africa displacing the largest area under cultivation than any other grain crop (Grain SA, 2016). Maize comprises about 60 % of cultivated land in South Africa and 40 % of calories consumed (Graph 2.2) (McCann, 2001).

Graph 2.2 – Maize calorie consumption as % of total diet.



Source: McCann, 2001.

Floury and flint maize variants were already produced by the indigenous people in South Africa before maize was starting to be commercially produced (McCann, 2001). The first accounts of commercial maize production in South Africa originated from the import of maize seed for commercial cultivation by Jan van Riebeeck in 1658. Maize cultivation was only starting to be established by the arrival of the Settlers in 1820 in

the Eastern Cape. As the Great Trek moved towards the north of the country in 1838, maize cultivation really started to gain momentum (Grain SA, 2016).

The revolution and industrialisation of the diamond and gold mining industries in the late nineteenth and early twentieth century transformed the maize industry, sparking a great demand for food supplies to sustain the vast mining labour sector. In 1885 the first railroad was built in Kimberley, opening up the regional market towards maize cultivation and export opportunities for maize. It was especially the Transvaal, Orange Free State and the colonial Basutoland where land was predominantly cultivated for production of maize crops. This region would later be known as the “maize triangle” and is still a cornerstone of maize production in South Africa and in the world today (McCann, 2001).

At the turn of the century South Africa’s maize production was even further stimulated by international trade and the opportunity to export maize. South Africa’s first recorded export transaction of maize was in 1893 by the firm King and sons to the United Kingdom. As production increased, maize exports also helped to stabilise the maize prices, since by 1908 South Africa’s production has already started to exceed the demand in South Africa, leading to surpluses in maize production (Grain SA, 2016).

Joseph Burtt-Davy, author of the comprehensive literature work *Maize – Its history, cultivation, handling and uses*, already noted in 1914 that maize cultivation was already rapidly becoming the most important crop in South Africa as the domestic market became increasingly large and more profitable. The cultivation season for maize in South Africa, compared to other maize producing countries, placed South Africa in a favourable position towards increased export opportunities.

The cultivation of maize would not have been viable in South Africa if it was not for export opportunities. Export opportunities stimulated the domestic maize market by offering a profitable outlet for surplus production and also regulating the price of maize and hindering an unnecessary accumulation of supplies. For a developing country like South Africa, the influx of capital was also dearly needed to develop agriculture (Burtt-Davy, 1914).

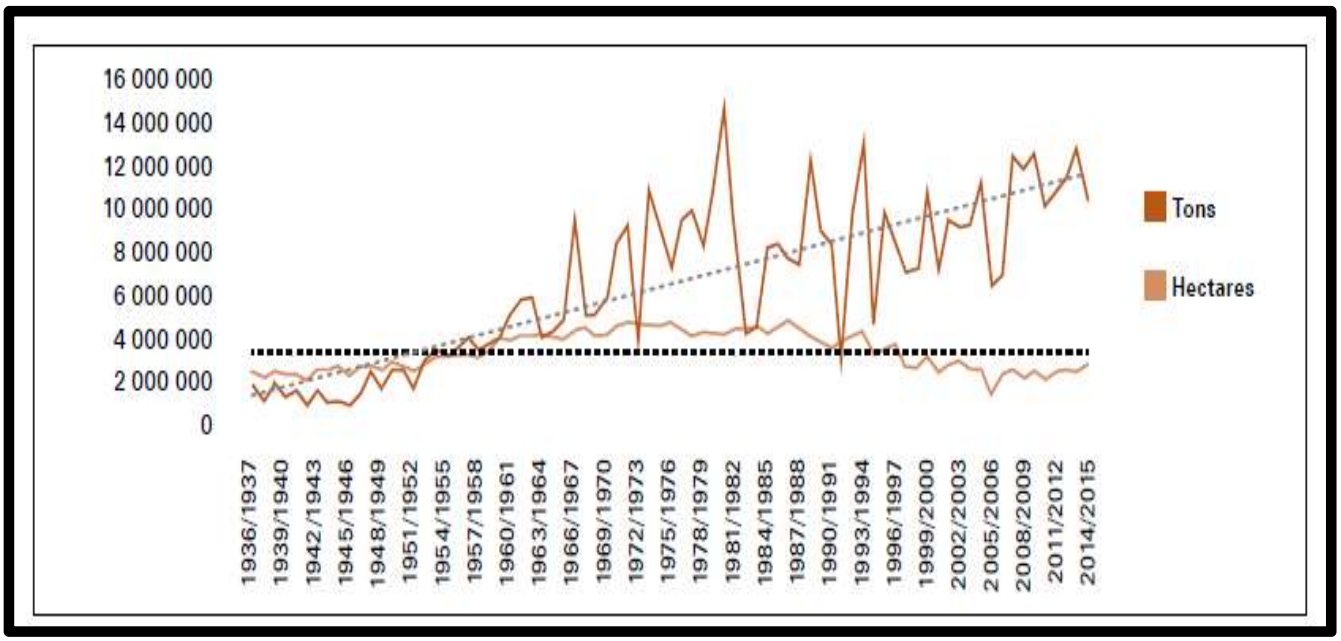
The production of maize only started to show a rising trend after 1930 due to more modern farming practices, mechanisation and the use of fertilizer. This led to an increase in maize consumption from 683 000 tons in 1913 to 1,4 million tons in 1940.

South Africa, however, experienced significant shortages during the outbreak of the Second World War. Although controlling measures were implemented through the marketing act to appeal to the London Food Council and the Combined Grain Board for larger grain allocations to South Africa, these appeals were unsuccessful since maize-producing countries first wanted to provide for their own needs.

The South African government was consequently forced to look at other initiatives and in 1945 the South African government entered into a successful exchange agreement with Argentina in which South African coal was exchanged for Argentinian maize. In 1973 the first long-term maize export contract was signed between South Africa and the Republic of China. This contract paved the way for future trade negotiations and export contracts with China (Grain SA, 2016).

Maize is mainly cultivated on dryland and that indicates why there is so much volatility in the production of maize over the years (Graph 2.3). Wheat is the second most produced crop followed by sorghum, sunflower and soybeans.

Graph 2.3 – Historical maize production figures of South Africa.



Source: Grain SA, 2016

Droughts have a significant influence on maize production in South Africa with cultivated land decreasing by around 40 % in the period from 1980 to 2013. The 1972 drought are still considered to be one of the worst in our history.

2.3.2 The history of grain storage in South Africa

Grain storage in South Africa has a long and proud history. By the 1920s grain production increased and international standards were on the rise, leading to specific standards concerning the weighing, cleaning, grading and storage of grain. This brought the problem of grain storage to the forefront and consequently South Africa summoned a delegation of dignitaries, the Clark Committee, to Canada and the United States of America to investigate the grain storage facilities which they already operated.

Following the investigation of the delegation, the South African Railways & Harbours (SAR&H), which was part of the state department administration, erected two harbour silo complexes with a 72 000 ton capacity. The SAR&H also constructed silos adjacent to railway tracks (Table 2.1) leading to a total capacity of 101 850 tons in 1924.There were however problems with the safe and efficient storage of maize and in 1949 the maize board sent a delegation to Australia to further investigate mass handling and storage methods (Grain SA, 2016).

Table 2.1 – SAR&H silos constructed

Station	Capacity (tons)	Station	Capacity (tons)
Frankfort	5 800	Ficksburg	2 600
Heilbron	5 800	Middelburg	2 600
Klerksdorp	5 800	Makokskraal	2 600
Reitz	5 800	Moorreesburg	2 600
Bethal	4 800	Potchefstroom	2 600
Bethlehem	4 800	Leslie	2 600
Kroonstad	4 800	Pienaarsrivier	2 200
Bothaville	4 800	Ventersburg	1 800
Kinross	4 800	Kaallaagte	1 800
Senekal	4 800	Koster	1 800
Rendezvous	4 800	Leeudoringstad	1 800
Lindley	4 800	Makwassie	1 800
Balfour	3 000	Val	1 800
Clocolan	3 000	Westminster	1 800
Ventersdorp	3 000	Davel	1 800
Vermaas	3 000	Standerton	1 800
Vrede	3 000	Settlers	1 750
Coligny	2 600		

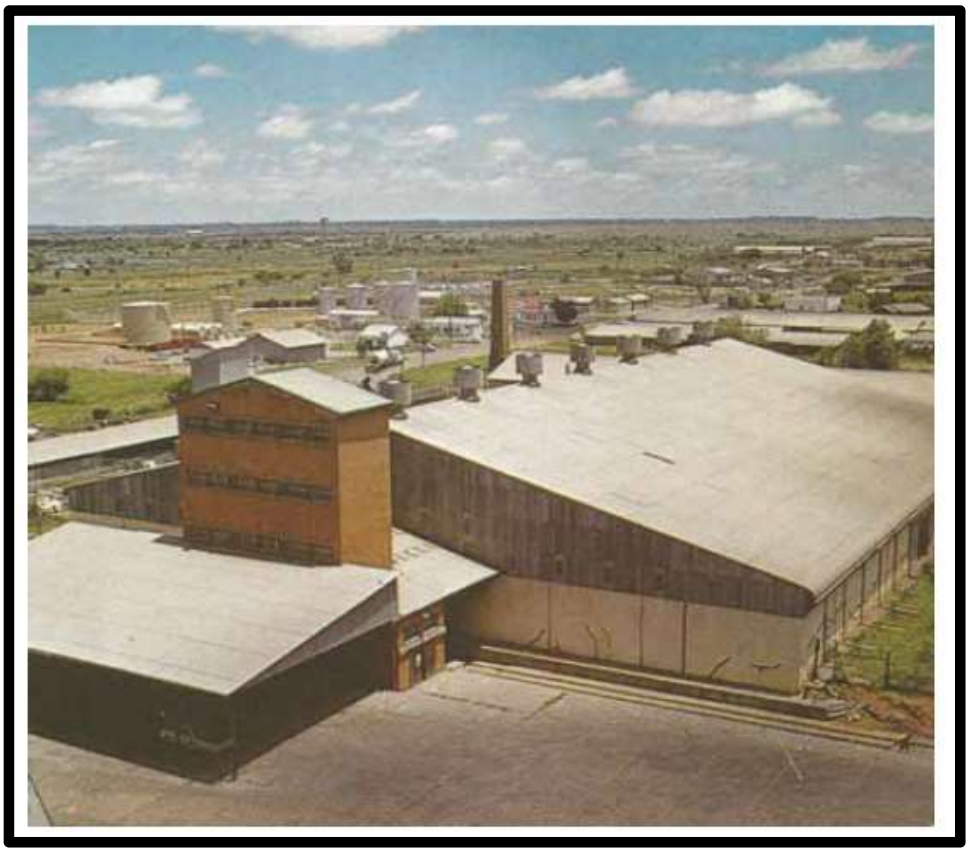
Source: Grain SA, 2016

Although grain were primarily delivered to these silos in bags, there was some grain delivered in bulk. The efficient manner in which the silos were managed held distinct advantages like guaranteeing the mass and grade of the grain. Grain silos also allowed for the efficient dispatch of grain in which there were minimal losses.

Effective storage was however always a concern for the Maize Board from the earliest days and in 1945 the Maize Board constituted the need to send another delegation to Australia to investigate mass grain handling facilities. The investigation resulted in the Maize Board's decision in 1951 to make funds available to build the first mass grain storage facility in Lichtenburg (Figure 2.4). This facility is still considered the pioneer of mass handling facilities in South Africa.

The success of this facility led to the minister of Agriculture's decision in 1952 to make long-term funding available towards the building of concrete grain silos (Figure 2.5). The erection of these silos only gained momentum in 1960 when cooperatives, acting as control board agents, started to erect grain silos under the supervision of the grain silo committee.

Figure 2.4 - Mass grain handling facility – Lichtenburg, North-West



Source: Grain SA, 2016

Figure 2.5 - Concrete grain silos – Vaalwater, Limpopo

Source: www.wikipedia.org, 2017

A cooperative can be defined as “an autonomous association of individuals who share common economic, cultural and social needs and aspirations through a jointly owned democratic enterprise” (International Cooperative Alliance (ICA, 2017). Producers form an integral part of agricultural cooperatives in South Africa with large shareholding. South African agricultural cooperatives play a significant role in the production and distribution of food and also play an important long-term role in poverty reduction (SEDA, 2013).

The grain silo committees consisted of members of the grain boards and representatives from the Department of Agricultural Economics, which had the final say on where silos were to be constructed. Vertical silos allowed for much faster intake and offloading of grain and more efficient fumigation practices.

In total agricultural cooperatives erected 266 silo complexes with a capacity of 15,4 million tons of maize. The northern regions of South Africa had 220 depots and the southern regions 46 depots. In 1984 the silo building programme was decommissioned and the grain silo committee was dissolved (Grain SA, 2016).

Agricultural cooperatives played an important role in establishing the grain industry as we know it today. Agricultural cooperatives served the commercial agricultural industry through the following functions:

- Input suppliers to the farmers;
- Marketing agents on behalf of grain and transport control boards; and
- Providing services such as storage and transport of the grain commodities.

One of the diminishing factors concerning the agricultural cooperatives was that they did not cater for small-scale farmers. With the democratic election in 1994 the government eliminated government support to commercial famers and the agricultural cooperatives who acted as their agents. As a result of the decision to eliminate government support, agricultural cooperatives lost a considerable amount of business and consequently many cooperatives converted into investor-orientated firms (IOFs) to become more efficient and diversified.

Government puts increased pressure on cooperatives as organisations to support small-scale agricultural producers and their local communities. This led to the implementation and signing of the new Cooperatives Act (14 of 2005) in August 2005 (Ortmann & King, 2007).

The agricultural cooperatives who were the silo owners earned good income in the form of guaranteed capacity-based remuneration as well as a handling fee based on the amount of grain the silo received. After the deregulation of the grain market in 1996 this guaranteed compensation to the silo owners was abolished. The deregulation of the grain market also opened the industry to more cost-effective alternative grain storage solutions allowing many role players within the grain value supply chain to erect their own storage facilities.

Alternative grain storage solutions have the following distinct advantages for producers in the market:

- Faster turnaround time;
- Shortened harvest;
- More cost effective;
- Flexible marketing options.

2.4 AN OVERVIEW OF THE REGULATED AND DEREGULATED ERA OF THE GRAIN MARKET IN SOUTH AFRICA

2.4.1 The single-channel marketing system

The single channel marketing system was introduced in 1944 and regulated through the 1937 Marketing Act, which later consolidated into the 1968 Marketing Act, and lasted until 1995. The Maize Board was the only licensed agent appointed by the Ministry of Agriculture to trade maize and consequently determine buying and selling prices. The Maize Board was represented by twenty one producers nominated by the South African Agricultural Union (SAAU). After 1981 the NAMPO ascendancy nominated producer representatives to serve on the board.

In the post-war period mining and manufacturing industries have grown rapidly, generating an increased demand for maize and maize products. Although there was a period stretching from the mid-1940s until the mid-1950s when exports declined, maize production attained unprecedented growth in the decade thereafter. New modern farming practices, mechanisation and the use of fertilizer and hybrid seeds were the main contributors to the increase in maize cultivation. The Maize Board played an integral part in this growth phase, especially towards the importation of hybrid maize seeds that attained much better yields.

Grain storage infrastructure was consequently also being expanded and modernised. Grain elevators, which were the first grain storage facilities erected by the South African Railways in the 1920s to facilitate towards maize exports, were being modernised and new concrete grain silos were also built. Storage capacity grew from two million tons in 1964 to approximately fifteen million tons in 1985. Once again the Maize Board was instrumental in this process of modernising the grading and storage facilities pertaining to the quality of maize and the economic regulation of the maize industry (Bernstein, 2004).

The pan-seasonal and pan-territorial fixed pricing mechanisms used by the regulated single channel market regime consequently cross-subsidised producer maize prices. Producers closer to the market had lower transport costs and in effect cross-subsidised those producers who had higher transport components being further away from the market. This cross-subsiding was encapsulated into the fixed maize price determined by the Maize Board (Vink & Van Rooyen, 2009).

The single price mechanisms also didn't distinguish between different grades of grain and consequently there was no real industrial development in the food value supply chain, because the quality of the grain that was produced was not sufficient to fulfil in the needs of baking bread or for making pasta, for example (Vink & Van Rooyen, 2009).

2.4.2 The deregulation of the grain market

According to Groenewald (2000:1) the end of the 19th century saw increased interference from governments and politicians into the economy as a necessary measure to improve people's lives. This intervention ended an almost one hundred year rule in which the *laissez faire* economic system was dominant (Groenewald, 2000). The Merriam-Webster dictionary defines *laissez faire* as "a doctrine opposing governmental interference in economic affairs beyond the minimum necessary for the maintenance of peace and property rights" (www.merriam-webster.com, 2018) The movement of state intervention into the economy was strengthened in the aftermath of the First World War and two post-war depressions which saw a great decline in agricultural product prices (Groenewald, 2000).

Prior to 1996, when the marketing of the Agricultural Products Act of 1996 was passed, agricultural cooperatives in South Africa were financial intermediaries who were managed by the marketing control boards establishing effective demographic monopolies.

In the regulated era commercial farmers were subsidised in various forms by storing their grain in the permanent grain silos that were erected by the agricultural cooperatives. This practice was however not sustainable, and consequently marketing boards and state control of agricultural commodities were abandoned with the passing of the Agricultural Products Act of 1996 (Ortmann & King, 2007).

These major policy reforms had a significant influence on agricultural cooperatives since they were no longer agents of the various marketing control boards and consequently no longer had the right to distribute government subsidies. De-regulation completely changed the grain marketing landscape in South Africa and caused many shifts in the grain supply chain. Suddenly commodity prices were determined by free-market forces instead of being regulated by the control boards (Grain SA, 2016).

With the deregulation of the grain market the grain industry became more differentiated allowing other role players better access to the market and enabling them to participate in the market with greater certainty at lower costs. The deregulation also provided more opportunities for rural communities to get involved in the process and distribution of maize (Vink & Van Rooyen, 2009).

After the deregulation of the grain market the production of grain in marginal located areas became obsolete causing many silo complexes and railway infrastructure to become either totally unused or partially unutilised. The cost of building new silo complexes was simply not feasible anymore after the decommissioning of the silo building program (Grain SA, 2016).

As farming practices became more modernised and mechanised, which resulted in higher yields, a bigger concentration of storage opportunities in other strategic areas was being created. Alternative grain storage solutions, like silo bags and bunkers, opened up a new market for grain traders, since silo owners were suddenly not the dominant and sole provider of grain storage in South Africa (Grain SA, 2016).

After deregulation and the demolishment of the Maize Board the guaranteed fixed income the silo owners received fell away, allowing for any person or institution to receive, store, buy and sell grain. This paved the way for more cost-effective alternative grain storage facilities. Alternative grain storage facilities held distinct advantages, especially for the producers who were able to erect their own storage facilities on their farms.

Producers could decrease their harvest time considerably with a much quicker turnaround time and also save on the wear and tear of their vehicles. The flexibility of alternative grain storage solutions also allowed producers to market their grain directly from the land and save on the storage, transport and wear and tear costs they had to pay when they delivered to traditional grain silos.

Commodity traders who were not previously allowed to erect their own storage facilities now also had the option to invest in their own alternative grain storage facilities. This allowed private grain traders to place these facilities close to the millers who are the biggest buyers of grain in the market (Grain SA, 2016).

- **Legislation**

The gradual deregulation of the grain market commenced through history with different legislation acts that were implemented. Below is a summary of the highlights of these legislation and their core purposes:

- **Maize Control Act (1930 to 1935)**
  - Buying stations for maize were erected in Europe without parallel investment in Southern African farming areas.
  - The two-tiered pricing mechanism offered better prices to Settler farmers than native Africans.
  - Restrictions were imposed on grain movement within Southern Africa (Smale & Jayne, 2003).

- **The Agricultural Marketing Act (1935)**
  - One-channel marketing system in which maize control boards were the only legal entities allowed to buy, sell and store the grain.
  - Fixing of grain prices and transport tariffs.
  - Marketing quotas were being enforced (Grain SA, 2016).

The deregulation of the grain market fully commenced with the implementation of the *Marketing of Agricultural Products Act, 1996.* The purposes of the 1996 act were:

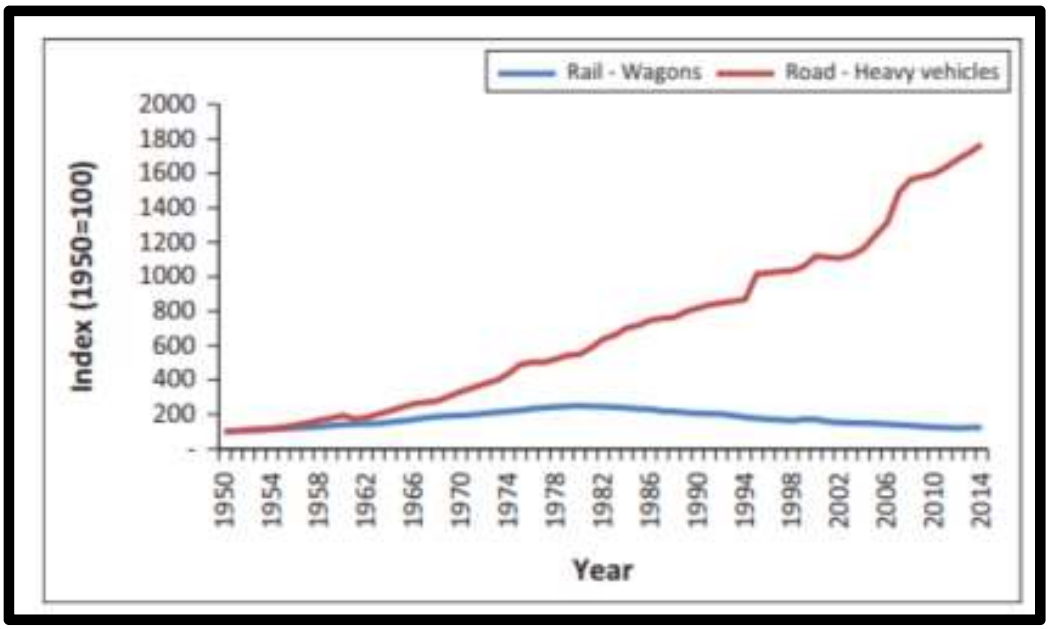
- Increased market access to all role players in the grain value and supply chain.
- Encourage effective marketing of agricultural products.
- Optimisation of earnings on exports of agricultural products.
- Enhancing the viability of the agricultural sector.

The deregulation of the grain market also led to the establishment of SAFEX (South African Futures Exchange), where grain commodities can be traded. SAFEX allows for the trading of grain commodities through futures and other contracts through registered traders. Grain traded on SAFEX also has to be stored at registered SAFEX grain storage facilities.

In the regulated era the control boards were in essence the only entities that transported grain in bulk quantities throughout South Africa. Grain was predominantly transported by railways. Deregulation however completely changed the playing field

of the grain industry. International role players now also had access to the market which resulted in a shift in focus and coordinated operations in the past. Logistics especially presented unique challenges to grain storage operators. This is evident with the rapid incline of grain transported by road after the deregulation of the grain market (Graph 2.4) (Grain SA, 2016).

Graph 2.4 - Comparative figures – railway vs road freight



Source: Havenga *et al,* 2016

After the deregulation of the grain market the production of grain in marginal located areas became obsolete causing many silo complexes and railway infrastructure to become unused. The cost of building new silo complexes were simply not feasible anymore after the decommissioning of the silo building programme. Changed farming practices producing higher yields created a bigger concentration of storage opportunities in other strategic areas. (Grain SA, 2016).

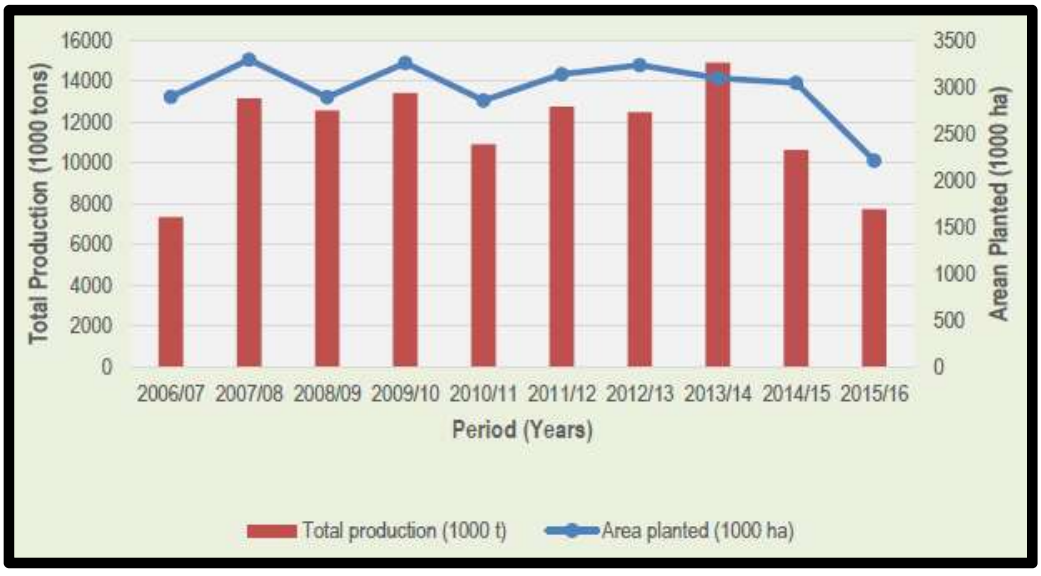
2.5 OUTLOOK ON THE CURRENT GRAIN PRODUCTION MARKET IN SOUTH AFRICA

Maize is the most important grain commodity in South Africa acting as a staple food for the majority of the South African population. White maize is primarily used for human consumption while yellow maize is used for animal feed. The maize industry does not only play a pivotal role in its ability to earn foreign income, but also as an avid employer (South Africa, 2017).

The multiplier value of maize lies in the raw material generated from maize production which can be used in the manufacturing processes of many products, including paper, paint, textiles and medicines. Currently South Africa has about nine thousand commercial maize producers, producing an average of around 10 million tons in a normal season over the last 10 years.

From 2006 until 2008 and in the 2015/2016 production season South Africa has however encountered unprecedented droughts in some regions, bringing production down to around 7 million tons (Graph 2.5) (South Africa, 2017).

Graph 2.5 - 10 years of maize production in South Africa



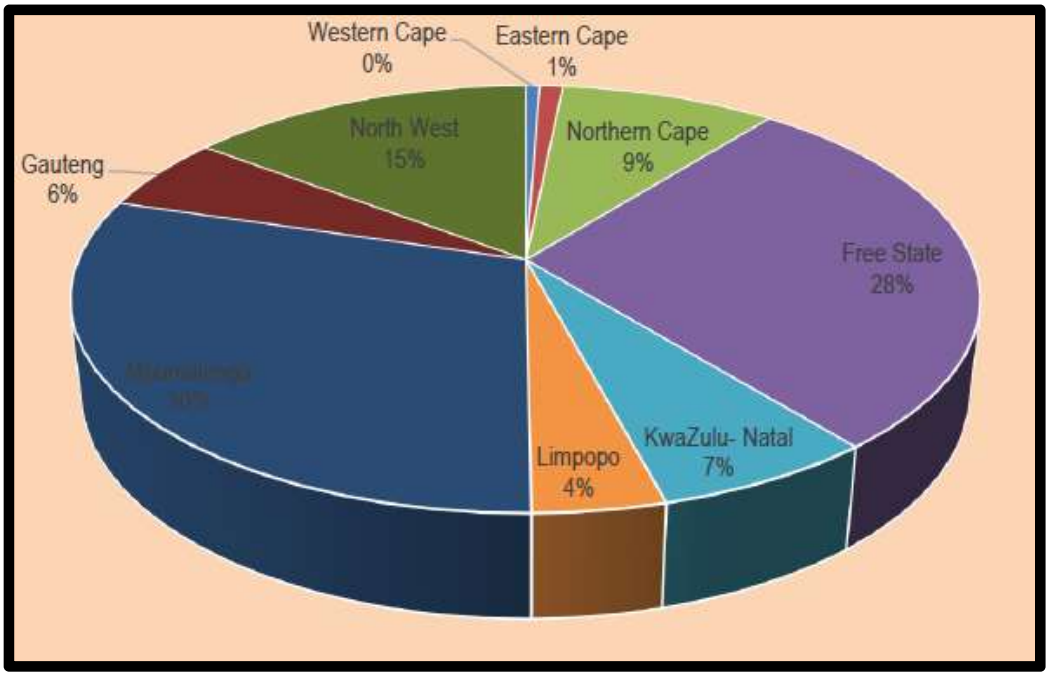
Source: Department of Agriculture, Forestry and Fisheries (South Africa, 2017)

The maize industry is a very volatile industry, especially due to the fact that most of the land being cultivated for maize production is on dry land and consequently very dependent on the weather patterns. Maize is primarily being cultivated in the Free State which is very well suited for dry-land maize production due to its deep sandy

soils. The Free State is also the most volatile in terms of maize production due to the droughts experienced over the last couple of years.

Due to better rainfall patterns Mpumalanga were the biggest maize producer for a couple of seasons, but the Free state remains the biggest maize producer on average when normal rainfall patterns are present. The North-west province are traditionally the third biggest producer of maize. (Graph 2.6).

Graph 2.6 - Maize cultivation by province in South Africa



Source: Department of Agriculture, Forestry and Fisheries (South Africa, 2017)

The most recent crop estimates compiled by the Crop Estimate Committee projects that South Africa will produce around 15.2 million tons of grain of which 12.8 million tons constitutes maize production (Table 2.2) (South Africa, 2018).

Table 2.2 – Crop estimate and forecasts

Crop	Area planted 2018	Third forecast 2018	Area planted 2017	Final crop 2017	Change – tons 2018 vs 2017
	ha	tons	ha	tons	%
White maize	1 268 100	6 629 660	1 643 100	9 916 000	-33,1
Yellow maize	1 050 750	6 197 150	985 500	6 904 000	-10,2
Total maize	2 318 850	12 826 810	2 628 600	16 820 000	-23,7
Sunflower seed	601 500	792 255	635 750	874 000	-9,4
Soya beans	787 200	1 430 300	573 950	1 316 000	+8,7
Groundnuts	56 300	80 600	56 000	92 050	-12,4
Sorghum	28 800	84 750	42 350	152 000	-44,2
Dry beans	53 360	65 610	45 050	68 525	-4,3

Source: Department of Agriculture, Forestry and Fisheries (South Africa, 2017)

Rain-fed agriculture would continue to play a vital role in sustaining food security in sub-Saharan Africa. It is unfortunately true that the poor and vulnerable are most susceptible to climatic changes, impacting maize production.

The exact impact of climate change on changing weather patterns is uncertain, but what is evident is that investors and other role players within agricultural development would need to adapt to these changes by looking at new strategies, decisional and operational support structures.

It is estimated that rain-fed agriculture provides in the region of 60 % of the world's food production, while in sub-Saharan Africa it is as much as 90 %. An increased emphasis must be placed on maximising productivity with using as little resources as possible. (Cooper *et al.,* 2008).

2.6 REASONING BEHIND ALTERNATIVE GRAIN STORAGE SOLUTIONS

- **Circumstances leading to alternative grain storage methods**

According to Dr LC Wentzel from North-West Cooperative in Lichtenburg there was increased encouragement in the period from 1940 until the early 1950s from different role players within the grain value supply chain towards the government to erect the first mass grain handling facilities in South Africa. The handling of grain in bags

simply became too expensive and the need arose for bulk handling of such products. This led to the commissioning of the silo building programme which was announced in parliament on 12 February 1952 (Agbiz, 2017).

The Grain Silo Committee was brought into life to oversee the building of these silos and were constituted from members of the grain control boards and the Department of Agricultural Economics. The erection of these silos were financed by the state and constructed by the agricultural cooperatives after certification was given by the Grain Silo Committee (Grain SA, 2016).

The Grain Control Boards consequently managed each stage of setting the price of grain within the single-channel marketing system. By the late 1980s agricultural cooperatives consolidated to such an extent that the six biggest agricultural cooperatives in South Africa controlled all the bulk grain handling facilities in the country.
The single-channel marketing era created oligopolies discouraging any possible entry into the market by competitors (Lulama *et al.,* 2007). Small-scale farmers also did not have access to grain storage and transport services offered by the cooperatives and were restricted to subsistence maize cultivation in their former homelands (Ortmann & King, 2007).

The silo building programme was suspended in 1984 and finally abandoned in 1990 when Dr. Kraai van Niekerk, Minister of Agriculture, abolished the Grain Silo Committee as well as state financing towards the construction of silos. Agricultural cooperatives, who acted as agents on behalf of the control boards, played a very important role in the grain industry up to 1996 when the market was deregulated. Grain producers conducted all of their business through the cooperatives, since they managed and owned the cooperatives, who were legally obliged to market all of their grain through the control boards.

After the deregulation of the grain market the production of grain in marginal located areas became obsolete, causing many silo complexes and railway infrastructure to become unused. This event created a bigger concentration of storage opportunities in other areas. Alternative grain storage solutions established a new market for grain traders and producers in South Africa since they were much more-cost effective and offered better direct marketing options for producers and agri-businesses (Grain SA, 2016).

- **New marketing tools**

According to Vink and Van Rooyen (2009:18) the deregulation of the grain market led to the establishment of different institutions and strategic marketing tools which became available to producers giving them greater confidence and certainty to participate in the market and consequently lowering their transactional costs.

One such an institution that was established after deregulation was the South African Futures Exchange (SAFEX). SAFEX allowed producers to manage their liquidity better by hedging themselves against price risk, which in turn enabled producers to lower their costs of doing business (Vink & Van Rooyen, 2009).

Location differentials became the preferred tool for trading future contracts on SAFEX. The location differential represents the transport costs for moving grain from a registered SAFEX silo or grain storage depot to Randfontein. Randfontein is used as reference point due to its central location and the large quantities of grain that has been processed there.

According to Grain SA (2016:132) the location differential was originally calculated with reference to railway transport, which is a much more cost-effective means of transport. South Africa's railway infrastructure deteriorated rapidly after the deregulation of the grain market and consequently more and more volumes of grain were transported by road, creating a bloated location differential.

A higher location differential gives the producer a lower selling price on his grain. The grain producer also have to cope with higher maintenance costs due to road infrastructure deteriorating. Alternative storage solutions can be strategically placed creating a much faster delivery turnover time for farmers. Alternative grain storage facilities also offer the lowest cost per ton compared to conventional silo structures (Grain SA, 2016).

2.7 FEASIBILITY OF ALTERNATIVE GRAIN STORAGE METHODS

2.7.1 Hermetic grain storage systems

Hermetic grain storage refers to a sealed storage system generating a modified atmosphere low in oxygen and high in carbon dioxide with a constant moisture environment. The low oxygen generated in these systems normally results in 100 % insect mortality preserving the quality of the grain. Hermetic storage systems also prevent build-up of mycotoxins which have been linked to causing cancer (Villiers *et al.,* 2006).

Studies conducted on hermetic storage of dry grain, with a humidity below 67 %, showed no quality or weight loss after a storage period of six months. Constant monitoring of carbon dioxide levels and airtightness are however key factors in ensuring that the quality of the grain is maintained in these storage systems (Bartosik, 2012).

Hermetic storage systems normally consist of special-developed plastic enclosures. These plastic enclosures are flexible and can come in a variety of applications like purdue improved crop storage bags (PICS) bags and silo bags. These type of storage methods are primarily used in Africa, Asia and South and Central America.

Different types of hermetic storage bags meet different post-harvest storage and transportation needs. Organic hermetic storage (Figure 2.6) is the most commonly used hermetic storage and can use conventional grain bags with an ability to store grain between five and three hundred tons. Super grain bags (Figure 2.7) were developed specifically to adhere to easier transportation and are constructed of flexible food grade PVC (Villiers *et al.,* 2007).

Hermetic storage were pioneered by Calederon and Navarro in 1980. Argentina were the first country to adopt silo bag storage for dry grains in the mid-1990s (Bartosik, 2012).

Grain bag storage systems have become more prominent as the cultivation of especially maize grew worldwide. During above-average crops grain bags provided flexible storage capacity and have reached an acceptable level of emergency storage for cooperatives and other agri-businesses operating within the grain value chain (Ward, 2012).

Figure 2.6 – Organic hermetic storage bags

Source: Villiers *et al.*, 2006

Figure 2.7 – Super grain bags

Source: Villiers *et al.*, 2006

Hermetic storage technology has proven to be very feasible, especially in developing countries like where maize production is not on the commercial scale as in South Africa and the Americas. Hermetic storage still plays an important role in bumper crop production years to safely store grain when traditional bulk handling facilities are inefficient to store all of the grain.

2.7.2 Alternative grain storage methods

- **Silo bags**

Silo bags are a hermetic storage method that basically entails a sealed storage system that contains a modified atmosphere. These storage bags were pioneered in the mid-1990s in Argentina. Silo bags have since gained rapid adoption within the agricultural and industrial sectors to such an extent that silo bags have been adopted in over forty countries worldwide. Silo bags play a vital role in especially developing countries where there is no available mass grain handling infrastructures (Bartosik, 2012),

According to Bartosik (2012:2) hermetic storage methods allow for the storage of grain at higher moisture content than grade standard conditions. This creates a big advantage to the producer because it enables him to get a much faster turnaround when crops are harvested.

Silo bags are constructed using two sealed polyethylene bags that are placed within a third outer bag. The outer bag is made of woven nylon or polypropylene for strength. A silo bag is approximately 60 meters long and 2,74 meters wide. One silo bag can store approximately 200 tons of grain (Bartosik, 2012).

Silo bag systems have the following distinct advantages:

- Very low cost per ton storage.
- Allow storing of grain at higher moisture levels than generally accepted.
- Allow for better traceability and classification in terms of genetically modified and non-genetically modified grains.
- Assist with bumper crops by creating flexible surplus storage solutions.
- Higher operational efficiency during harvest.
- Easy sampling of grain.
- Grain quality are maintained.

Silo bag systems provide a low cost per ton grain silage solution. One silo bag costs around R7 500, making it very cost-efficient, although the silo bags would need to be replaced every season. Silo bag machinery are expensive, but with a much longer life expectancy. This modern machinery makes the bagging and de-bagging of the grain into the silo bags very efficient (Figure 2.8 & 2.9) (Silobag, 2017)

Studies conducted by the National Agricultural Technology Institute (2012) indicate that grain with a humidity below 67 % can be safely stored in silo bags for up to six months with no loss of quality. The maintaining of the airtightness in the silo bag is crucial (Bartosik, 2012).

Figure 2.8 – Silo bag loading system.

Source: Bartosik, 2012

Figure 2.9 – Silo bag unloading system

Source: Bartosik, 2012

- **Grain storage bunkers**

Grain storage bunkers (Figure 2.10) originated in Australia where it has been effectively deployed for over 25 years. A grain storage bunker consists of a corrugated iron wall build to the specific storage requirements. The bunker is then sealed with a tarpaulin to protect the grain from weather (www.news24.com, 2003).

The grain storage bunker provides a low-cost bulk storage solution which can be built in as little as four weeks. Although the grain storage bunker has a higher capital outlay than silo bag systems it does have a longer life expectancy. One grain storage bunker can easily store 12 000 tons of grain. Modern grain handling equipment is also very efficient to handle the grain in a storage bunker. Because of the size of a bunker, it does need higher capital outlay towards machinery than in the case of silo bag systems.

The first grain bunker silo were built in the Western Cape by Afgri (Pty) Ltd following a global search to low-cost alternative grain storage solutions. Bunker silos are not only financially viable, but also efficient to store grain for up to 12 months as required for production purposes by millers throughout the year (www.news24.com, 2003).

Figure 2.10 – Unloading of maize into a grain storage bunker

Source: Bessemer systems, 2018

- **Grain tent silo**

Although this is a new alternative grain storage method (Figure 2.11) in South Africa it is a viable alternative since it has the functionality of a conventional silo and is more permanent than grain storage bunkers. Tent silos can accommodate approximately 18 500 tons of grain and boasts less grain losses than other alternative storage methods.

By lowering the silo into the ground, extreme temperatures can be handled, which also save on costs to reinforce the sidewalls. The silo operates like a conventional silo (Farmers Weekly, 2014).

Figure 2.11 – Tent silo complex

Source: Farmers Weekly, 2014

- **Metal Silo**

The metal silo (Figure 2.12) we're predominantly populated in Northern America but has since been promoted in other grain producing countries as well, including Africa. The metal silo presents a hermetically sealed storage option that kills harmful pests through oxygen deprivation.

Metal silos can play a significant role to decrease postharvest losses, which can vary between 5 – 30% in developing countries. Metal silos presents a long-term storage option where grain can be safely stored for up to two years enabling producers to sell their maize at higher prices.

Metals silos require a high capital outlay compared to the other storage methods and consequently dampens the demand and widespread adoption by producers. (Gitonga *et al.,* 2013)

Figure 2.12 – Metal Silo

Source: Agriexpo.online, 2019**.**

- **Grain dams**

Grain dams has a storage capacity of about 150 tons of grain, which is much less than other alternative grain storage methods discussed here.

Grain dams are typically used as carry through facilities on the farm although they are sometimes used by agri-businesses for storage of smaller quantities of grain commodities, like sunflower. Grain dams are ideal to keep different grades of grain separate in years when there are quality problems with the harvest.

Grain dams has a low capital outlay and typically constructed from galvanised mesh walls (Figure 2.13) with a PVC plastic liner. Grain dams can also be constructed from zinc (Figure 2.14) which is a longer lasting and more cost effective alternative

Figure 2.13 – Grain dam – Galvanised mesh with PVC liner

Source : Rsaseed, 2019.

Figure 2.14 – Grain dam - Zinc

 .

Source: Proagri, 2019

2.8 SUMMARY

It is evident from the literature study that alternative grain storage is a feasible and economicly viable link within the grain supply value chain. Grain storage portrays a critical role in developing agriculture, especially towards food security in developing countries.

Grain storage in South Africa was regulated until 1996 when the market deregulated and alternative grain storage became a viable alternative. Producers, agri-businesses and other role players within the grain value chain made use of this opportunity to invest in their own storage facilities. Alternative grain storage presented many advantages for producers and agri-businesses to invest in.

In the empirical study the researcher will make use of qualitative and quantitative data capturing techniques to ascertain what the primary drivers are that persuade these respondents to make use of and invest in alternative grain storage facilities.

CHAPTER 3
EMPIRICAL STUDY

3.1 INTRODUCTION

The previous chapter consisted of a detailed theoretical study which started with a brief historical overview of the history of grain production and storage practices. The study continued with an overview of the regulated grain market in South Africa which later transcended into the deregulated era paving the way for alternative grain storage methods. The study concludes by distinguishing between different alternative grain storage methods and their economic feasibility.

The empirical study consisted of both a qualitative and quantitative assessment. During the qualitative assessment at least ten responses were attained from respondents in the form of structured questionnaires. Respondents consisted of different role players (producers, buyers, agri-businesses) within the grain supply value chain. (Appendix A) Respondents were asked the following questions:

- What are your general perceptions concerning alternative grain storage facilities?
- Would you choose alternative grain storage facilities above traditional grain storage methods, like grain silos?
- Would you consider erecting your own storage facility in future and what would be the primary reason constituting such a decision?
- What in your opinion differentiates alternative grain storage facilities from traditional grain storage facilities, like silos?
- If possible, what value-added services would you say there are a need for in terms of alternative grain storage facilities?

To conclude respondents were given a list of ten primary drivers of which they had to indicate the five drivers they see as most important towards using / investing in alternative grain storage facilities. (Appendix A)

The quantitative assessment involved a questionnaire that has been electronically distributed. The questionnaire consisted of three parts:

- Section A – Biographical information
- Section B – Primary constructs / drivers
- Section C – Questionnaire

The questions asked in Section C were linked to the construct drivers in Section B to test for correlation. (Appendix A)

3.2 RESEARCH METHODOLOGY

The research methodology followed during the study and data collection process was as follows:

- Conduct a qualitative study through distributing ten structured questionnaires to respondents who make use of alternative grain storage methods.
- Conduct a quantitative study through electronically distributed questionnaires within the geographical demarcation.
- Gather, inspect and sort the data attained.
- Determine the reliability of the data through descriptive statistics attained from the North-West University statistics department.
- Analyse, discuss and compare the results obtained before making final conclusions and recommendations.

3.3 RESEARCH DESIGN

Research design can be seen as the plan on how to obtain research subjects and collect information from them. In the research design process the methods of how information are collected are discussed, and research conclusions concerning the research problem are drawn (Welman *et al.*, 2010).

The research design employed in this study can be explained as follows:

- Qualitative data were gathered in the form of structured questionnaires distributed to a pre-selected group of individuals within the geographical

demarcation. These individuals were specifically selected according to their affiliation with alternative grain storage facilities.

- Quantitative data were gathered in the form of electronically distributed questionnaires to respondents within the geographical demarcation who are affiliated with the grain value supply chain.

- The data captured through the questionnaires were tested for validity by the statistical division of the North-West University using the Cronbach Alpha reliability coefficient and other statistical indicators. The correlations between the primary constructs and the questions were also tested.

- The analysed data were compared to the constructs as determined in the research instruments. Analysed data were further discussed and compared to the hypotheses.

3.4 RESEARCH INSTRUMENTS

3.4.1 Qualitative instruments

A few respondents were selected by using the non-probability sampling method to be interviewed. The aim of the interviews is just to establish the primary drivers that will be used in the research design and further statistical analysis. The primary drivers relate to the use of alternative grain storage facilities by the role players identified.

Data would be collected in the form of structured questionnaires. These questionnaires would mostly be distributed through experienced individuals working in the alternative grain storage industry within the identified geographical domain. These individuals are experienced grain handling and storage operatives and are in close contact with the producers and other role players within in the target areas that are making use of alternative grain storage solutions.

3.4.2 Quantitative instruments

Questionnaires were electronically distributed within the geographical demarcation to constitute a fair representation of the target population in that specific area. In total 51 responses were attained.

The questionnaires were structured as follows:

3.4.2.1 Section A (demographic and operational criteria)

Demographic information would be obtained from primary and secondary variables.

The demographic criteria consisted of the following primary variables:

- Age
- Highest qualification
- Sex
- Ethnicity

The demographic criteria consisted of the following secondary (operational) variables:

- Type of alternative grain storage.
- Considering erecting your own grain storage facility in future.
- Primary reason for grain production.
- Total quantity of hectares cultivated.
- Quantity of hectares cultivated towards grain production.
- Quantity of grain delivered to alternative grain storage facilities.
- Quantity of hectares rented.

3.4.2.2 Section B (Primary constructs)

Section B consisted of two parts:

Part A

Respondent were asked to indicate the importance of alternative grain storage facilities within the grain value supply chain by portraying their responses on a Lickert scale as follows:

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

Part B

Respondents were given five primary constructs which had to be sequenced in order of importance. Responses were coded from 1 to 5 on a Lickert scale which could be portrayed as follows:

- 1 = Extremely important
- 2 = Moderately important
- 3 = Important
- 4 = Less important
- 5 = Least important

3.4.2.3 Section C (Statements)

Formulated statements in regard to each construct would be evaluated. These statements would be analysed in context with how they correlate with the primary constructs identified in Section B of the questionnaire.

Section C consists of 30 statements on which respondents had to indicate their level of agreeableness. The 30 statements were presented on a Lickert scale where responses were portrayed as follows:

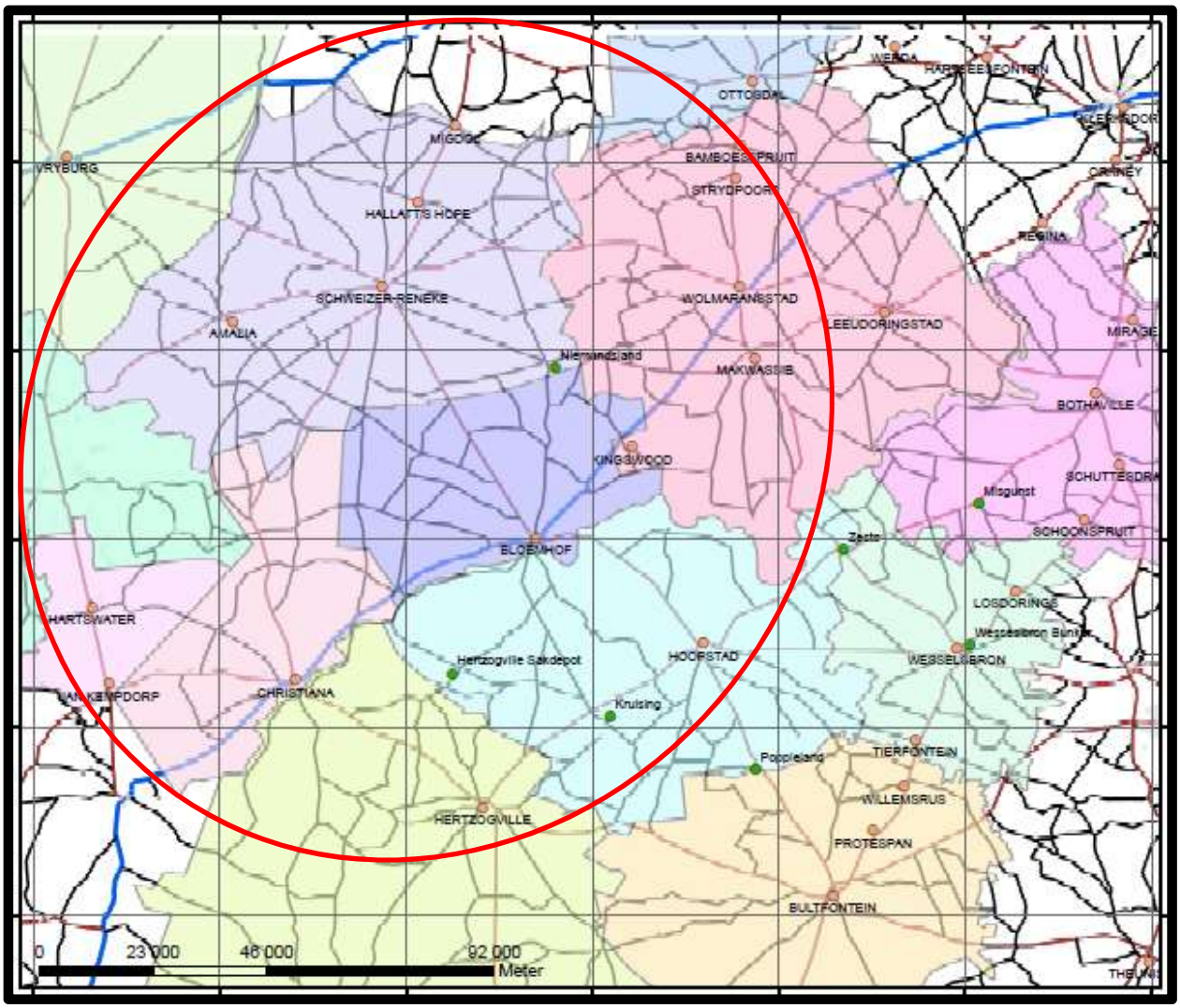
- Option 1 = Strongly agree
- Option 2 = Agree
- Option 3 = Uncertain
- Option 4 = Disagree
- Option5 = Completely disagree
- Option 6 = Uncertain

3.5 RESEARCH TARGET GROUP

3.5.1 Geographical demarcation

The research population consisted of role players within the grain value supply chain who make use of alternative grain storage facilities. The geographical demarcation stretched over the Free State, North-West and Northern Cape provinces of South Africa (Map 3.1). Respondents were selected based on their affiliation and experience in the use of alternative grain storage facilities. Fifty one responses were collected in the geographical area.

Map 3.1 – Geographical demarcation (outlined in red)



Source: Terratek, 2017

3.5.2 Population size

In total, 51 responses were gathered from the target group identified. The target group consisted of a fair presentation of producers and other role players within the grain value supply chain that make use of alternative grain storage facilities. As part of the study 15 structured interviews were also conducted with respondents within the target group.

3.6 DATA CAPTURING AND ANALYSIS

Demographic information would be statistically analysed using the Statistical Package for Social Science (SPSS). The statistical analysis would be conducted with assistance of the Statistical Consultation Services of the North-West University. Demographical results would also be displayed using a statistical chart builder.

The reliability of the different constructs being analysed would be measured using the Cronbach Alpha measuring instrument.

In the statistical analysis the Spearman's rank order correlation test would be used to test the strength of relationships between the variables. A *p*-value (Sig. 2-tailed) less than 0.05 indicates a 95 % probability of finding similar results in the population. A *p*-value of less than or equal to 0.05 will be considered a statistical significant relationship (Ellis & Steyn, 2003).

A further indication of the strength of the relationships will be found in the correlation coefficient (*r*-value). In the case where the *r*-value is greater than 0.3, but less than 0.5, it would indicate a medium strength relationship. In the case where the *r*-value is greater than 0.5, it would be an indication of a strong relationship between variables. The correlation coefficient gives us an indication of practical significance (Ellis & Steyn, 2003).

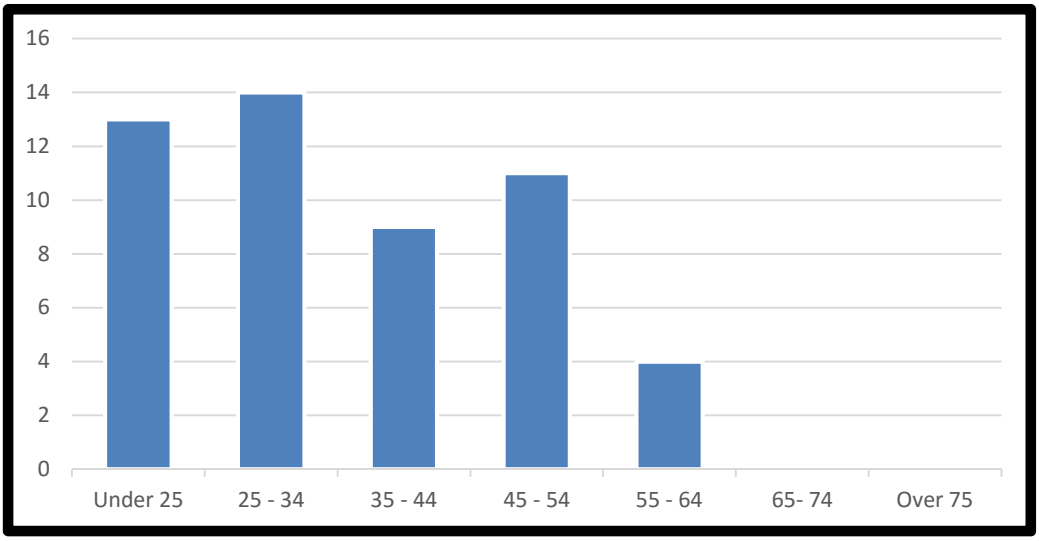
The *t*-test that is represented by the *p*-value criterion were used to test the significance of the relationship between variables. It could also be affected by sample size (Field, 2009). In instances where $p \leq 0.05$ the results would be statistically significant.

3.6.1 Demographic information

3.6.1.1 Primary variables

- **Age of participants**

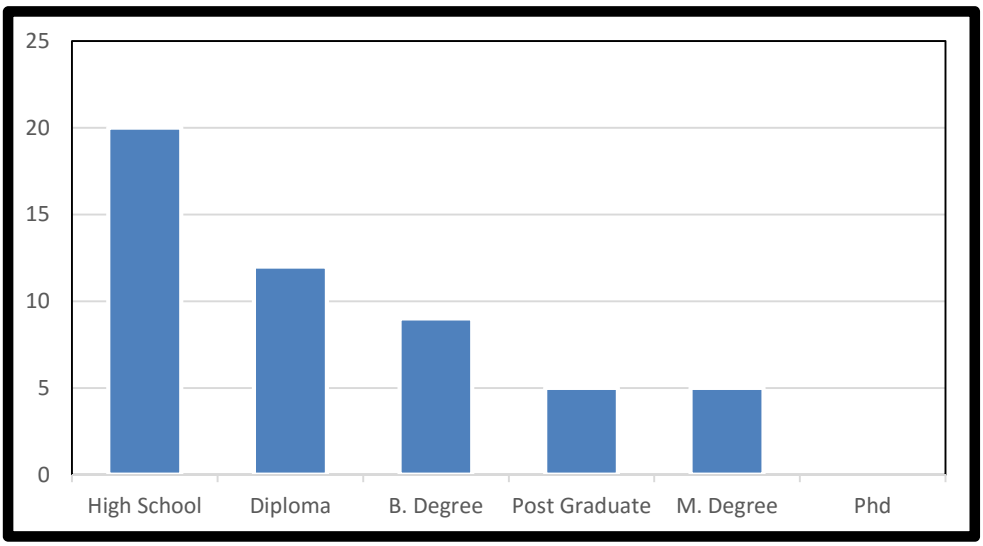
Graph 3.1 – Age groups of participants.



From the target group 27 % of respondents fell between the ages of 25 and 34, the highest in the population. 47 % of respondents fell between the ages of 35 and 65 which were distributed over three age brackets. The rest of the respondents were between 20 and 25 years of age.

- **Education of participants**

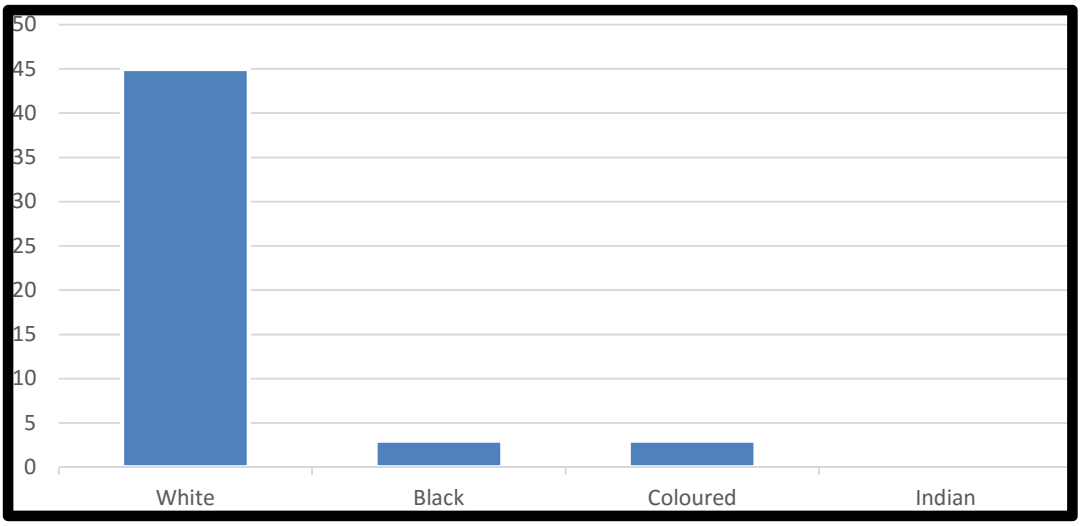
Graph 3.2 – Education of the participants



From the target group 61 % of the participants had a diploma or higher qualification with 39 % only having a matric.

- **Ethnical group**

  Graph 3.3 – Ethnical composition of the participants

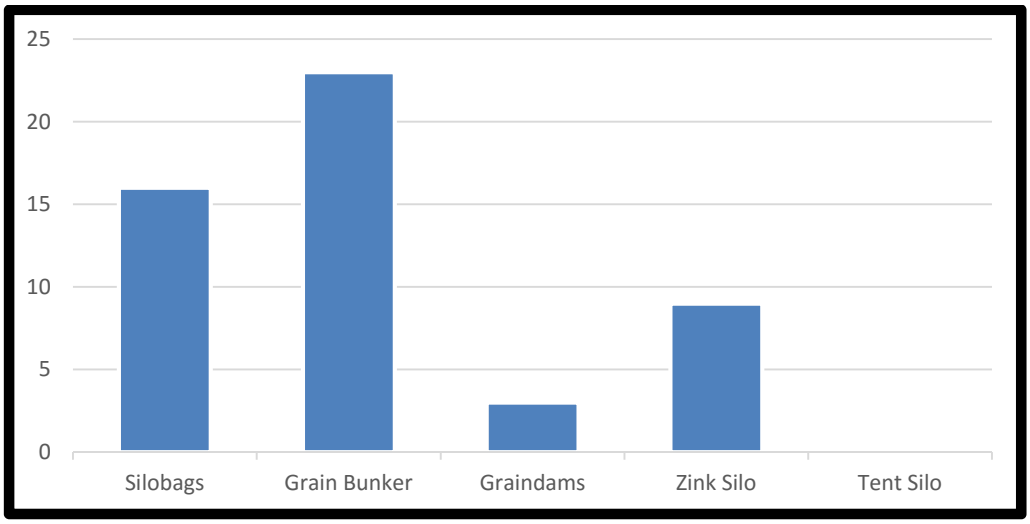


The ethnic composition of the target group consisted of 45 white participants with an even distribution between black and coloured participants of 4 each.

3.6.1.2 Secondary variables

- **Type of alternative grain storage method delivering to**

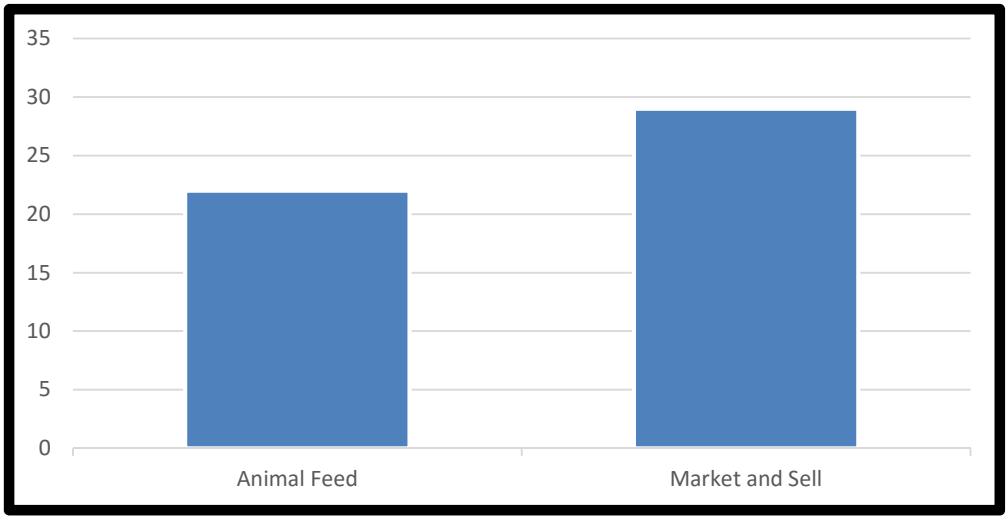
  Graph 3.4 – Type of alternative grain storage facility



The most popular alternative grain storage facilities the participants made use of were grain storage bunkers with 45 % of participants making use of these facilities. Silo bags were second mostly used with 31 % followed by zinc silos and grain dams.

- **Primary reason for cultivating grain**

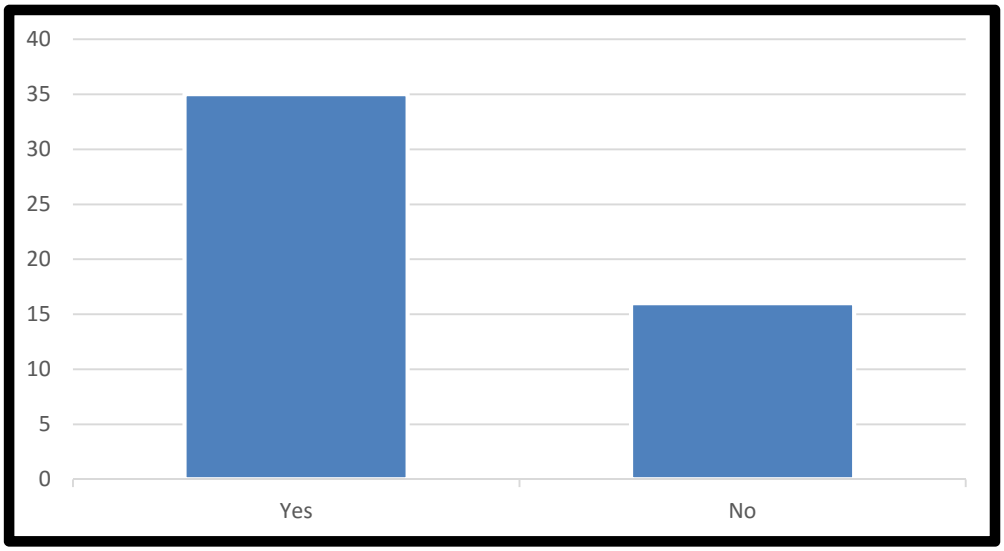
  Graph 3.5 – Primary reason for producing grain



From the target group 57 % of participants indicated that they cultivate grain primarily for market and selling purposes. The remaining participants cultivated grain for animal feed purposes.

- **Consider own alternative grain storage facility**

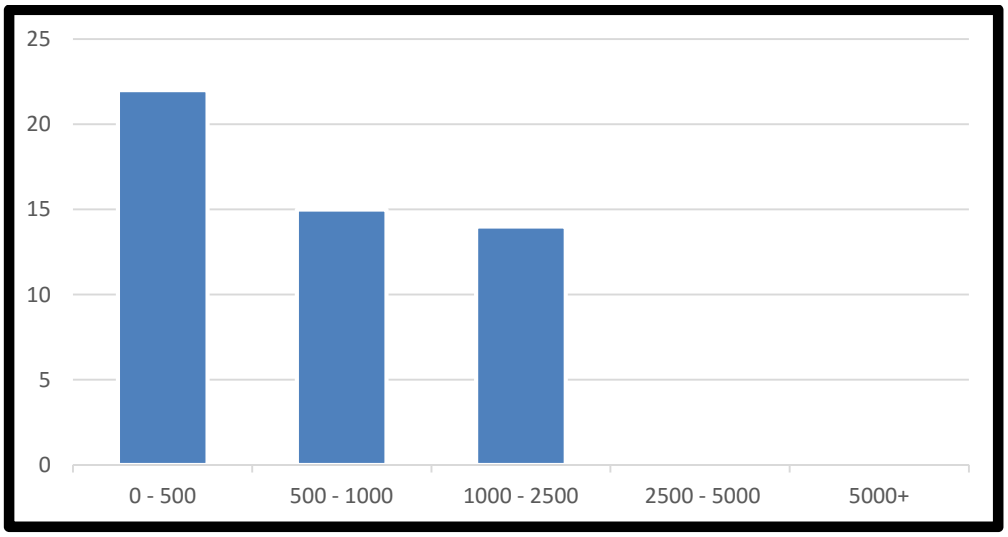
  Graph 3.6 – Consider own grain storage facility



From the target group 69 % of respondents indicated that they would consider erecting their own alternative grain storage facilities in future.

- **Hectares cultivated towards grain production**

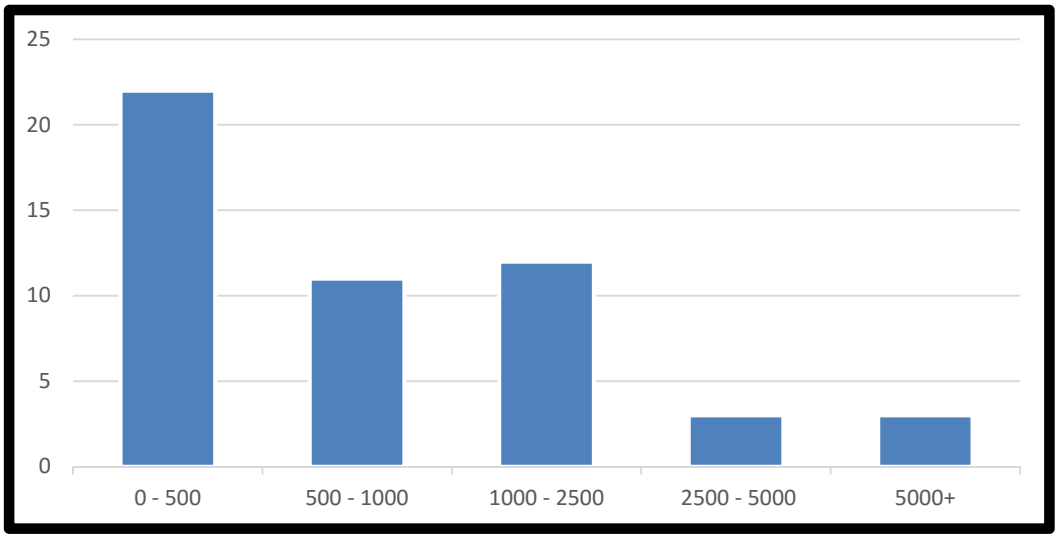
  Graph 3.7 – Hectares cultivated towards grain production



From the target group 43 % of participants indicated that they cultivated between 0 and 500 hectares towards grain production. The rest of the participants were almost evenly spread between 500 – 1 000 hectares (29 %) and between 1000 – 2500 hectares (28 %).

- **Quantity of grain delivered to alternative grain storage facilities**

  Graph 3.8 – Quantity of grain delivered to alternative grains storage facilities



From the target group 43 % of participants indicated that they deliver between 0 – 500 tons of grain to alternative grain storage facilities. From the rest of the target group 45 % of participants delivered between 500 and 2 500 tons, with the remaining 12 % of participants delivering more than 2 500 tons of grain.

3.6.2 Ranking of constructs

Section B of the data collection process consisted of 5 primary drivers (constructs) that participants had to rank in order of importance. The table below indicates the results as follows:

Frequency - The frequency with which respondents awarded any of the five available ranking towards a driver adds up to the total number of respondents who participated in the study, which were 51.

- **Service delivery**

  Table 3.1 – Service delivery construct – frequency of responses

Service delivery		Frequency	Valid percent	Cumulative percent	Mean	Std. deviation
Valid	1	37	72,55	72,55		
	2	3	5,88	78,43		
	3	3	5,88	84,31		
	4	5	9,80	94,12		
	5	3	5,88	100,00		
	Total	**51**	**100,00**		**1,71**	**1,29**

Respondents ranked the service delivery construct as number 1 (frequency 37) with 73 % of respondents indicating it as the most important driver when making use of alternative grain storage facilities.

- **Handling and storage fees**

  Table 3.2 – Handling and storage fees construct – frequency of responses

Handling and storage fees		Frequency	Valid percent	Cumulative Percent	Mean	Std. Deviation
Valid	1	10	19,61	19,61		
	2	23	45,10	64,71		
	3					
	4	9	17,65	82,35		
	5	9	17,65	100,00		
	Total	**51**	**100,00**		**2,69**	**1,44**

Respondents ranked *handling and storage fees* as number 2 (frequency 23) with 45 % of participants indicating this driver as very important when making use of alternative grain storage facilities.

- **Flexible marketing options**

  Table 3.3 – Flexible marketing options construct – frequency of responses

Flexible marketing options		Frequency	Valid percent	Cumulative percent	Mean	Std. deviation
Valid	1	4	7,84	7,84		
	2	17	33,33	41,18		
	3	26	50,98	92,16		
	4	3	5,88	98,04		
	5	1	1,96	100,00		
	Total	**51**	**100,00**		**2,61**	**0,80**

Respondents ranked *flexible marketing options* as number 3 (frequency 26) with 51 % of participants indicating this driver as important when making use of alternative grain storage facilities.

- **Cost management**

Table 3.4 – Cost management construct – frequency of responses

Cost management		Frequency	Valid percent	Cumulative percent	Mean	Std. deviation
Valid	1					
	2	8	15,69	15,69		
	3	13	25,49	41,18		
	4	28	54,90	96,08		
	5	2	3,92	100,00		
	Total	**51**	**100,00**		**3,47**	**0,81**

Respondents ranked *cost management* as number 4 (frequency 28) with 55 % of participants indicating this driver as less important when making use of alternative grain storage facilities.

- **Wear and tear**

Table 3.5 – Wear and tear construct – frequency of responses

Wear and tear		Frequency	Valid percent	Cumulative percent	Mean	Std. deviation
Valid	1					
	2					
	3	9	17,65	17,65		
	4	6	11,76	29,41		
	5	36	70,59	100,00		
	Total	**51**	**100,00**		**4,53**	**0,78**

Respondents ranked *wear and tear* the lowest (frequency 36) with 71 % of respondents indicating this driver as least important when making use of alternative grain storage facilities.

3.6.3 Measuring reliability of constructs

Reliability refers to the consistency in which a measure (statement) reflects the constructs that it is measuring (Field, 2009).

To determine the reliability of the constructs we would use the Cronbach Alpha measuring instrument. Cronbach's Alpha is perhaps the most well-known measuring instrument of internal consistency. Alpha measures how the responses within a survey correlate with each other by determining the proportion of the variance that is consistent in the responses gathered from the survey (Vaske *et al.,* 2017).

Although there have been many debates amongst statisticians as to what constitutes an acceptable Cronbach Alpha, it is generally accepted that an Alpha between 0.65 and 0.80 are adequate to determine the reliability of responses within human dimension research (Vaske *et al.,* 2017).

Alpha can be substantially influenced by the number of items relating to a specific construct as well as the diversity of the constructs being measured (Field, 2009).

Section C of the questionnaire consisted of 30 statements that correlates with the constructs that were ranked in Section B of the questionnaire. Respondents were given a scale from 1 to 6 (table on which they had to indicate to what extent they agree with the particular statement.

Table 3.6 – Example of scale – Section C (Questionnaire)

SECTION C							
QUESTIONS							
No	**Question**	**Strongly Agree**	**Agree**	**Uncertain**	**Disagree**	**Completely Disagree**	**Not Applicable**
C1	I am satisfied with the service I receive from alternative grain storage facilities.						

The table below (Table 3.7) indicates the reliability of the correlation between the statements depicted in Section C towards the specific construct those statements are linked to. Due to the diversity of the constructs being measured in this study we would accept an Alpha of 0.6 and higher as being reliable.

Table 3.7 – Construct reliability table

Construct reliability statistics			
Construct A	**Cronbach Alpha**	**Mean**	**Std. Deviation**
Service delivery	0,809	1,706	1,285
Flexible marketing options	0,802	2,608	0,802
Wear and tear	0,776	4,529	0,784
Cost management	0,771	3,471	0,809
Handling and storage fees	0,765	2,686	1,435

In this study the Cronbach Alpha coefficient were above 0.6 for all constructs indicating that there is definite consistency in the results indicating that the statements do reflect the construct they are measuring.

3.6.4 Measuring correlation

Correlation refers to the relationship between two or more variables. Variables could either be *positively related; not related* or *negatively related.*

To express these relationships between variables there are two measurement tools we can use: *covariance* and the *correlation coefficient. Covariance* are however not a standardised measure since it is dependent on the scale of the measurement. Being dependent on the scale measurement presents problems since *covariances* cannot be compared in an objective way.

To test the significance of the relationship between the variables we would use the non-directional hypothesis known as the two-tailed test (Field, 2009). For any randomly sampled population we would use the *t*-test to test for statistical significance. The *p*-value is a criterion for the *t*-test where a value smaller than 0.05 is considered

to be sufficient evidence that the results obtained are statistically significant (Ellis & Steyn, 2003).

The problem of dependency on the measurement scale can be overcome by using a standardised measurement tool known as the *correlation coefficient*. If we have the same unit of measurement results can be easily compared and analysed.

The *Pearson Correlation Coefficient (r-value)* standardises the *covariances* so that we attain a value between -1 and +1. The closer the results are to +1, the better the indication that the two variables are positively correlated. A positive correlation suggests that an increase in one variable increases another variable in a proportionate quantity.

A *r*-value between 0.30 and 0.50 depicts a medium strength relationship between the variables. A *r*-value larger than 0.50 depicts a strong relationship between variables (Field, 2009).

In the table below (Table 3.8) we would indicate the correlation between the constructs as well as the correlation between the statements linked to that specific construct.

3.6.4.1 Correlation between constructs and statements

Table 3.8 – Correlation between constructs and statements

Correlations						
Construct	**Correlation**	**Service delivery**	**Flexible marketing options**	**Wear and tear**	**Cost management**	**Handling and storage fees**
Service delivery	Correlation Coefficient	-0,195	-0,061	-0,127	-0,299	-0,182
	Sig. (2-tailed)	0,169	0,668	0,375	0,033	0,201
	N	51	51	51	51	51
Flexible marketing options	Correlation Coefficient	-0,153	-0,085	-0,027	-0,031	-0,152
	Sig. (2-tailed)	0,283	0,555	0,849	0,827	0,286
	N	51	51	51	51	51
Wear and tear	Correlation Coefficient	0,004	0,163	0,084	0,029	-0,071
	Sig. (2-tailed)	0,977	0,254	0,556	0,841	0,618
	N	51	51	51	51	51
Cost management	Correlation Coefficient	0,118	-0,087	0,059	0,081	0,033
	Sig. (2-tailed)	0,410	0,544	0,683	0,572	0,816
	N	51	51	51	51	51
Handling and storage Fees	Correlation Coefficient	0,220	0,072	0,105	0,244	0,271
	Sig. (2-tailed)	0,120	0,618	0,464	0,085	0,054
	N	51	51	51	51	51

Overall there were strong correlations between the statements and the constructs they were linked to. The only slightly negative correlation was between the 1st and the 4th construct where a *r*-value of -0.299 was attained (Table 3.8).

3.6.4.2 Correlation between constructs

Table 3.9 – Correlation between construct

Correlations						
Construct	**Correlation**	**Service delivery**	**Flexible marketing options**	**Wear and tear**	**Cost management**	**Handling and storage fees**
Service delivery	Correlation Coefficient	1,000	0,005	-0,158	-0,444	-0,627
	Sig. (2-tailed)		0,974	0,268	0,001	0,001
	N	51	51	51	51	51
Flexible marketing options	Correlation Coefficient	0,005	1,000	0,474	-0,045	-0,617
	Sig. (2-tailed)	0,974		0,000	0,756	0,001
	N	51	51	51	51	51
Wear and tear	Correlation Coefficient	-0,158	0,474	1,000	-0,057	-0,497
	Sig. (2-tailed)	0,268	0,000		0,690	0,000
	N	51	51	51	51	51
Cost management	Correlation Coefficient	-0,444	-0,045	-0,057	1,000	0,116
	Sig. (2-tailed)	0,001	0,756	0,690		0,419
	N	51	51	51	51	51
Handling and storage fees	Correlation Coefficient	-0,627	-0,617	-0,497	0,116	1,000
	Sig. (2-tailed)	0,001	0,001	0,000	0,419	
	N	51	51	51	51	51

The following strong negative correlations were attained between the constructs:

- A *r*-value of -0.627 and a *p*-value of 0.001 indicate a strong negative correlation between the 1st and 5th constructs.
- A *r*-value of -0.617 and a *p*-value of 0.001 indicate a strong negative correlation between the 2nd and 5th constructs.

3.6.4.3 Correlation between statements

Table 3.10 – Correlation between statements – service delivery construct

Inter-item correlation matrix - service delivery construct						
	Q1	Q7	Q9	Q13	Q23	Q27
Q1	1,000	0,662	0,433	0,161	0,246	0,339
Q7	0,662	1,000	0,664	0,370	0,285	0,464
Q9	0,433	0,664	1,000	0,599	0,178	0,393
Q13	0,161	0,370	0,599	1,000	0,452	0,588
Q23	0,246	0,285	0,178	0,452	1,000	0,579
Q27	0,339	0,464	0,393	0,588	0,579	1,000

The following strong positive correlations were attained within the statements linked to the service delivery construct:

- *R*-value of 0.662 between Q7 and Q1. Respondents who were very positive with alternative grain storage facilities also felt that these facilities were more than adequate to handle their harvest.

- *R*-value of 0.664 between Q7 and Q9. Respondents who felt strongly about the ability of alternative grain storage facilities to handle their harvest also felt strongly that being able to retract grain quickly for own use is a primary consideration when deciding where they want to deliver their grain.

- *R*-value of 0.599 between Q9 and Q13. Respondents who felt strongly that being able to retract grain quickly for own use is a primary consideration when deciding where they want to deliver their grain also felt strongly that value added services, like drying and sifting of grain, is a primary consideration when they decide where to deliver their grain.

Table 3.11 – Correlation between statements – flexible marketing options construct

Inter-item correlation matrix - flexible marketing options						
	Q3	Q5	Q8	Q15	Q20	Q25
Q3	1,000	0,448	0,524	0,544	0,319	0,056
Q5	0,448	1,000	0,499	0,480	0,689	0,281
Q8	0,524	0,499	1,000	0,314	0,397	0,334
Q15	0,544	0,480	0,314	1,000	0,649	0,295
Q20	0,319	0,689	0,397	0,649	1,000	0,493
Q25	0,056	0,281	0,334	0,295	0,493	1,000

The following strong positive correlations were attained within the statements linked to the flexible marketing options construct:

- *R*-value of 0.524 between Q8 and Q3. Respondents who considered having flexible pricing and marketing options as a primary consideration when they decide where to deliver their grain also considered the SAFEX differential as an important consideration when they decide where to deliver their grain.
- *R*-value of 0.544 between Q15 and Q3. Respondents who considered the SAFEX differential as an important consideration when they decide where to deliver their grain also indicated that receiving a premium for their grain as an important consideration as to where they deliver their grain.
- *R*-value of 0.689 between Q20 and Q5. Respondents who indicated that buyers offer better premiums by transporting their grain directly from the land also indicated that they considered it an important consideration to market their grain within a specified time period after harvesting is complete when they decide where to deliver their grain.
- *R*-value of 0.689 between Q20 and Q15. Respondents who indicated that receiving a premium for their grain as an important consideration also indicated that buyers offer better premiums by transporting their grain directly from the land.

Table 3.12 – Correlation between statements – wear and tear construct

Inter-item correlation matrix - wear and tear						
	Q4	Q6	Q10	Q12	Q18	Q30
Q4	1,000	0,754	0,361	0,460	0,315	0,335
Q6	0,754	1,000	0,415	0,405	0,440	0,316
Q10	0,361	0,415	1,000	0,417	0,629	0,065
Q12	0,460	0,405	0,417	1,000	0,336	0,394
Q18	0,315	0,440	0,629	0,336	1,000	0,325
Q30	0,335	0,316	0,065	0,394	0,325	1,000

The following strong positive correlations were attained within the statements linked to the wear and tear construct:

- *R*-value of 0.754 between Q6 and Q4. Respondents who indicated that the turnaround time as an important consideration when they decide where to deliver their grain also indicated the condition of the road infrastructure as a primary consideration when they decide where to deliver their grain.
- *R*-value of 0.629 between Q18 and Q10. Respondents who indicated that the distance they need to travel to deliver their grain as a primary consideration also indicated that the risk associated with using their tractors and trailers on public roads as a primary consideration when they decide where to deliver their grain.

Table 3.13 – Correlation between statements – cost management construct

Inter-item correlation matrix - cost management						
	Q2	Q14	Q16	Q19	Q21	Q28
Q2	1,000	0,529	-0,088	0,007	0,516	0,050
Q14	0,529	1,000	0,232	0,320	0,885	0,300
Q16	-0,088	0,232	1,000	0,708	0,315	0,480
Q19	0,007	0,320	0,708	1,000	0,332	0,604
Q21	0,516	0,885	0,315	0,332	1,000	0,274
Q28	0,050	0,300	0,480	0,604	0,274	1,000

The following strong positive correlations were attained within the statements linked to the cost management construct:

- *R*-value of 0.529 between Q14 and Q2. Respondents who indicated that they enjoy the fact that the quality of their grain is guaranteed when they deliver to alternative grain storage facilities also indicated that they think it is viable to invest in on-farm alternative grain storage facilities when they produce primarily for animal feed purposes.
- *R*-value of 0.516 between Q21 and Q2. Respondents who indicated that they think it is viable to invest in on-farm alternative grain storage facilities when producing primarily for animal feed purposes also indicated that it is not cost-effective to deliver grain to alternative grain storage facilities when producing primarily for animal feed purposes.
- *R*-value of 0.885 between Q21 and Q14. Respondents who indicated that it is not cost-effective to deliver grain to alternative grain storage facilities when producing primarily for animal feed purposes also indicated that they enjoy the fact that the quality of their grain is guaranteed once screened and delivered at the alternative grain storage facility.
- *R*-value of 0.708 between Q19 and Q16. Respondents who indicated that the ability to upgrade their grain with an on-farm storage facility does not provide enough reasoning to invest in on-farm storage facilities also indicated that by

delivering their grain to alternative grain storage facilities they can manage their time more efficiently in other divisions of their farming operations.

- *R*-value of 0.604 between Q28 and Q19. Respondents who indicated that the ability to upgrade their grain with an on-farm storage facility does not provide enough reasoning to invest in on-farm storage facilities also indicated that the collection of their grain from the land and delivering it to an alternative grain storage facility as a cost-effective option.

Table 3.14 – Correlation between statements – handling and storage costs construct

Inter-item correlation matrix - handling and storage costs						
	Q11	Q17	Q22	Q24	Q26	Q29
Q11	1,000	0,308	0,385	0,090	0,143	0,059
Q17	0,308	1,000	0,360	0,400	0,121	0,561
Q22	0,385	0,360	1,000	0,625	0,289	0,524
Q24	0,090	0,400	0,625	1,000	0,290	0,570
Q26	0,143	0,121	0,289	0,290	1,000	0,443
Q29	0,059	0,561	0,524	0,570	0,443	1,000

The following strong positive correlations were attained within the statements linked to the handling and storage costs construct:

- *R*-value of 0.561 between Q29 and Q17. Respondents who indicated that the handling and storage costs they pay at alternative grain storage facilities are in line with the costs at traditional grain storage facilities also indicated that they would consider delivering more grain to alternative grain storage facilities by getting a quality premium for the grain they produce.
- *R*-value of 0.625 between Q22 and Q24. Respondents who indicated that alternative grain storage facilities enable them to store their grain at competitive rates also indicated that getting a quantity discount for their grain they would consider delivering more grain to alternative grain storage facilities.

- *R*-value of 0.524 between Q22 and Q29. Respondents who indicated that alternative grain storage facilities enable them to store their grain at competitive rates also indicated that the handling and storage costs they pay at alternative grain storage facilities is in line with the costs at traditional grain storage facilities.
- *R*-value of 0.570 between Q24 and Q29. Respondents who indicated the handling and storage costs they pay at alternative grain storage facilities are in line with the costs at traditional grain storage facilities also indicated that by getting a quantity discount for their grain they would consider delivering more grain to alternative grain storage facilities.

3.7 APPROACH AND QUALITY OF RESEARCH DESIGN

In this study a mixed methodology research approach will be used consisting of both qualitative and quantitative data capturing instruments.

For this reason triangulated research methodology will be used by combining both quantitative and qualitative research instruments to attain data. Triangulation refers to using different methods to assess the construct validity. By using the triangulation theory we can get a better understanding of the theory being researched (Turner *et al*, 2017).

3.8 RESEARCH ETHICS

Research ethics are concerned with underlying issues such as honesty and respect for the individuals when we undertake a research study (Welman *et al.,* 2010).

The respondents who were identified to take part in this study were thoroughly informed regarding the purpose of this research study. Respondents were further assured as to their right of privacy and anonymity with the acknowledgement of a consent form before they took part in the study.

Further to this consent indemnity against any physical or emotional harm emanating from participation in this research study was ensured to respondents.

3.9 SUMMARY

In this chapter the research methodology and other considerations were discussed that were used to gather the data. Frequency tables were used to indicate significant correlations between constructs and between statements relating to those constructs. The strength of the relationship was also tested for the variables under scrutiny.

From the data gathered 92 % of respondents indicated that alternative grain storage facilities portray a very important role within the grain value supply chain.

Chapter 3 consisted of the statistical analysis that was obtained with the empirical study. In Chapter 4 conclusions and recommendations will be made based on the results obtained from Chapter 3.

CHAPTER 4
CONCLUSIONS AND RECOMMENDATIONS

4.1 INTRODUCTION

Chapter 4 brings this study to a close with conclusions, recommendations, achieving the research objectives, suggestions towards possible further areas of research and a summary.

Conclusions are made based on the empirical study conducted in Chapter 4 from which certain recommendations are made towards the feasibility of alternative grain storage methods.

Results would also be evaluated to determine if the primary and secondary research objectives have been met.

Suggestions would also be made towards possible further studies.

4.2 CONCLUSIONS

4.2.1 Quantitative study

As part of the quantitative study a list of five primary constructs were given to participants which they had to rank in order of importance to determine the feasibility of alternative grain storage solutions. Participants were then given a questionnaire with 30 statements that correlate with the constructs they ranked in Section B of the questionnaire.

From the results obtained in the questionnaires *service delivery, flexible marketing options* and *handling and storage costs* were the constructs that ranked the highest.

Below we discuss the results of these constructs in more detail:

- **Service delivery construct**

At the start of this research study the researcher identified that grain storage as a business unit attained very good customer satisfaction rankings from respondents. The satisfaction that respondents showed towards grain storage business units is spawned from a long affiliation that these grain producers had with agricultural cooperatives in the regulated grain market era.

After deregulation when the controlling boards were abandoned and cooperatives transcended into modern diversified agri-businesses the traditional grain storage industry faced enormous challenges with the posing fragmentation of the grain market.

Even though profound changes took place in the landscape of the grain storage industry it is still evident from this study that producers continued their support towards these agri-businesses, especially towards alternative grain storage facilities.

In C1 respondents were asked to indicate their level of satisfaction with the service they receive from alternative grain storage facilities. Frequency analysis indicated that 80,39 % (frequency 41) of respondents are satisfied with the service they receive from alternative grain storage facilities. Respondents also ranked *service delivery* the highest out of the five constructs that were given.

- **Flexible marketing options construct**

In the problem statement the researcher identified that one of the consequences of the deregulation of the grain market was the establishment of the South African Futures Exchange (SAFEX) where grain commodities can be traded using different marketing instruments.

The deregulated market created a free market environment in which any individual can store grain at their preferred locations. Deregulation also presented opportunities for large grain producers and other role players in the grain market to erect their own on-site grain storage facilities.

Flexible marketing options were the construct ranked the second highest by respondents when making use of alternative grain storage facilities. Flexibility in the market were a direct consequence of the deregulation of the market, and the results

from the study also indicate that respondents placed a very high emphasis on this factor.

In the statements presented to participants the following strong correlations were attained between the statements linked to the *flexible marketing* construct: In C20 results indicated that 74.51 % (frequency 38) of respondents agreed that the ability to market their grain within a specific time period after harvesting is a primary consideration when they deliver their grain to alternative grain storage facilities. This response were closely correlated to C5 which also indicated a 74.51 % (frequency 38) positive result in which respondents agreed that buyers offer better premiums when grain were directly transported from the farms.

Alternative grain storage facilities can facilitate a faster turnaround time for producers and consequently lower their costs. Producers can immediately market their grain after delivery. They can either sell their grain directly to the agri-business or request a silo certificate which they can sell at their own time and convenience by means of SAFEX. The silo certificate can only be attained by delivering the grain to a registered SAFEX grain storage facility. It would therefore only make sense to erect an on-site grain storage facility when primarily producing for animal feed purposes or by selling the grain directly to a buyer in the market. Most grain millers in the market therefore erected their own storage facilities for this reason, saving a lot on costs in the long run.

- **Handling and storage costs construct**

In the problem statement the researcher mentioned that the strategic centralised locations of alternative grain storage facilities allow producers to save on costs and in the end they realise a better price for the grain they have produced.

Handling and storage costs were the construct that were ranked third highest and it is evident that producers are cost sensitive in terms of where they deliver their grain to. Producers can negotiate favourable storage rates and even get a premium for their grain when they deliver to alternative grain storage facilities.

All these factors contribute to the producer receiving a better price for his product compared to delivering to traditional grain silos which are further away.

In the questionnaire the correlation between statement C24 and C22 were the highest. Statement C22 indicated a 70.59 % (frequency 36) positive response in which

respondents agreed that alternative grain storage facilities enable them to store their grain at competitive rates. With statement C24 62.74 % (frequency 32) of respondents agreed that receiving a quantity discount for their grain would motivate them to deliver more grain to alternative grain storage facilities.

For producers who primarily produce their grain to market and sell, alternative grain storage still presents a very feasible solution to lower their cost and consequently receive a better price for their grain.

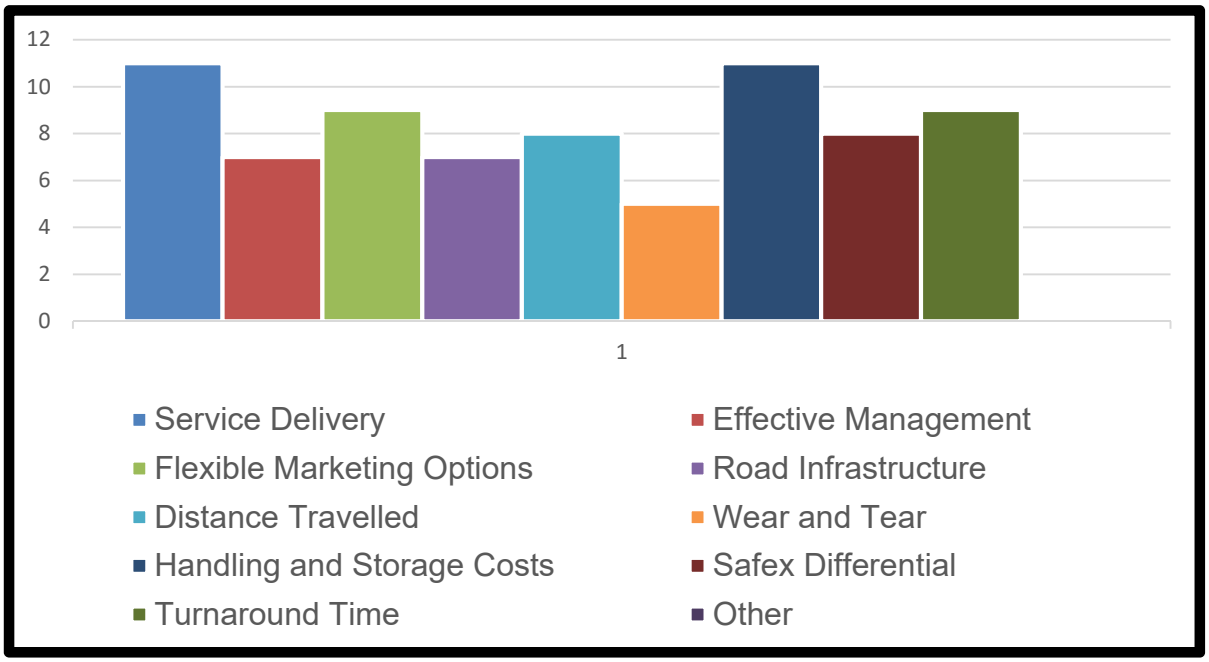
4.2.2 Qualitative study

As part of the qualitative study structured interviews were conducted. Fifteen positive responses were attained from the interviews conducted. The structured interviews consisted of two sections. Section A consisted of six questions concerning the feasibility of alternative grain storage facilities that respondents had to answer.

Section B of the interview consisted of a list of ten primary drivers applicable to measuring the feasibility of alternative grain storage facilities. From the list of ten drivers participants had to choose five drivers which they considered the most important. It is important to distinguish that no ranking were requested here and that participants only had to choose five out of the ten drivers they consider most relevant and important towards alternative grain storage facilities.

The results that were obtained from the interviews were as follows:

Graph 4.1 – Structured interview – primary drivers



We can see from the results obtained that the following drivers were considered the most important concerning the feasibility of alternative grain storage facilities: *service delivery, handling and storage costs* and *flexible marketing options.*

This results correlated with the results obtained in the questionnaires above where *service delivery, handling and storage costs* and *flexible marketing options* also ranked highest in terms of importance when making use of alternative grain storage facilities.

4.2.3 Meeting the research objectives

4.2.3.1 Primary objective

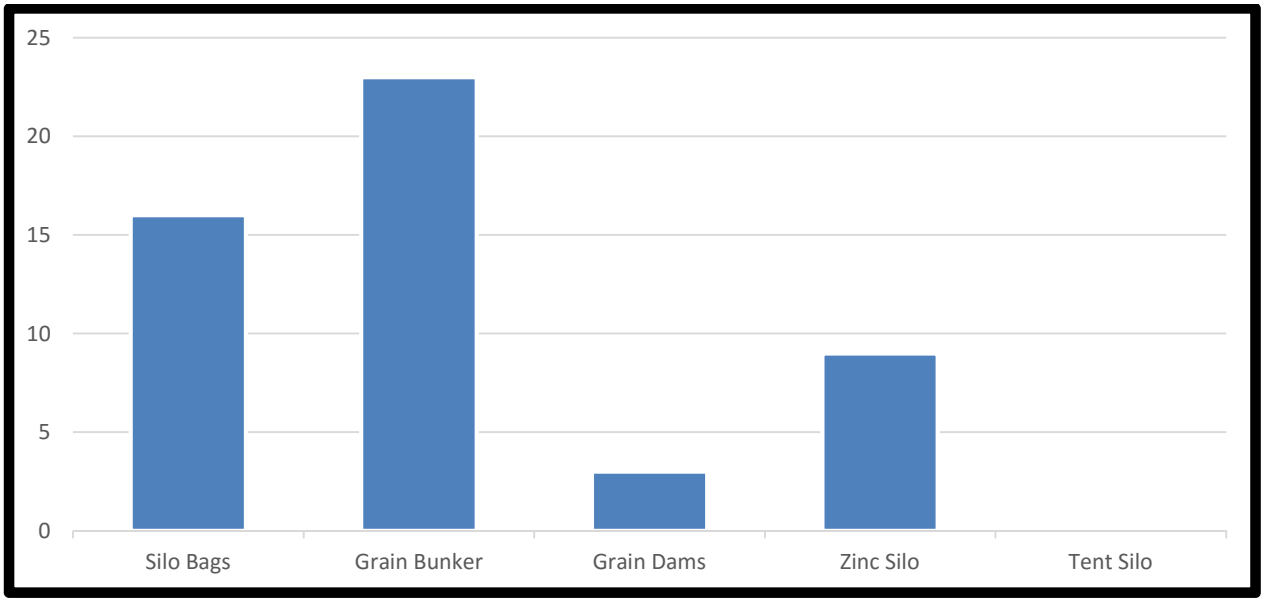
The primary objective of the study was to determine if alternative grain storage facilities are an economicly feasible and viable investment option. From both the qualitative and the quantitative analyses it was evident to the researcher that producers and other role players preferred alternative grain storage facilities above traditional grain silos. Primary drivers like experiencing excellent *service delivery*, *affordable handling and storage fees* and *flexible marketing options* that were received at alternative grain storage facilities were ranked as the primary drivers towards the use of such facilities.

4.2.3.2 Secondary objectives

1. Distinguishing between alternative grain storage facilities

As indicated below the methods mostly used by respondents were grain bunkers and grain silo bags. Zinc silos were primarily used for on-farm storage facilities while grain dams are used only to compliment bunkers when their might be a shortage due to capacity problems.

Graph 4.2 – Alternative grain storage facilities used



2. Distinguish the correlation between the variables

The correlation between the variables were discussed in 3.5, 4.2.1 and 4.2.2 above.

3. Determine the sustainability of alternative grain storage facilities

The sustainability of alternative grain storage facilities lies in the strong affiliation respondents showed towards using these facilities. This objective were supported with the strong correlations and reliability of the variables as analysed in 3.5.

4. Determine the contribution alternative grain storage facilities have towards expanding market share

Although it was difficult to determine the role alternative grain storage portrays towards expanding market share it was evident that alternative grain storage facilities do play a vital role to protect current market share.

Producers who delivered to traditional grain silos in the past now make use of alternative grain storage facilities due to their good strategic location and cost-effectiveness.

The variables and drivers that contributed to the sustainability were analysed in 3.5 above.

4.2.4 Final remarks

The researcher will now make final conclusions by comparing the answers received from the interviews that were conducted with the responses received from the questionnaires that were analysed above.

Respondents were asked if they would consider erecting their own grain storage facilities in the future. Thirteen of the fifteen interviewees responded that they would consider erecting their own grain storage facilities in future. Three of the respondents also indicated that they already have their own grain storage facilities with one participant also having his own mill facility on the farm. The primary reason for investing in own storage facilities were – *cost saving, animal feed purposes* and *better time management.*

Respondents were also asked if they prefer alternative grain storage facilities above traditional grain storage facilities. 67 % of respondents indicated that they do prefer alternative grain storage above traditional grain storage facilities. The main reasons presented as to why they prefer alternative grain storage facilities above normal grain silos were that alternative grain storage facilities had a faster turnaround time due to their closer strategic locations and were also more cost-effective in comparison to when delivering grain to silos.

4.3 RECOMMENDATIONS

The deregulation of the grain market paved the way for alternative grain storage solutions which were not only more cost-effective but also offered more flexible marketing options.

It was evident from the study that there was a shift from delivering grain to traditional silos to delivering grain to alternative grain storage facilities. Alternative grain storage facilities enable the producer to manage his time more effectively by having a faster turnaround time when delivering to alternative grain storage facilities.

It was also evident that producers and other role players within the grain value supply chain were still strongly affiliated with the agri-businesses. Respondents were very satisfied with the service they received from alternative grain storage facilities and also ranked *service delivery* as the most important driver when choosing where to deliver their grain.

Based on the responses received from the questionnaires and interviews conducted, the following recommendations are made:

1 Agri-businesses should develop attractive value adding products and services to make alternative grain storage facilities even more feasible to producers and other role players within the grain value supply chain. Suggestions include offering quality premiums and quantity discounts to grain producers to deliver their grain to alternative grain storage facilities.

2 The grain storage business is built on relationships and agri-businesses should find a niche in the market to be a successful link in the supply chain. Through establishing long-term agreements with producers and other role players in the grain supply chain, agri-businesses can ensure that they utilise their alternative grain storage assets to full potential and lift their market power.

3 The deteriorating road infrastructure is a big concern and if agri-businesses could invest in more attractive and innovative transport solutions it would certainly attract more clients delivering at these facilities. Suggestions include collecting maize directly from the farm and offering a transport premium for producers to deliver their grain to alternative grain storage facilities.

4 Agri-businesses should collaborate with grain producers and other role players within the grain supply chain when erecting new alternative grain storage facilities.

5 Alternative grain storage facilities are very effective if they can be erected next to a major railway line. Our deteriorating railway infrastructure is however a reason for concern and agri-businesses should collaborate with producers and other role players to formulate new initiatives towards an action plan to upgrade railway infrastructure.

4.4 SUMMARY

From the study results it can be concluded that alternative grain storage facilities have a positive and strong affiliation with producers and other role players within the grain supply value chain. Producers, and other role players within the grain supply chain, are especially drawn to the excellent service offering, cost effectiveness and flexible marketing options being presented by alternative grain storage facilities.

Alternative grain storage facilities would continue to be a viable, sustainable and economicly feasible alternative in the developing agricultural domain. The data analysis conducted on the quantitative study corresponded with the qualitative results obtained from the interview held with participants. There were strong correlations between the constructs that indicated the primary drivers for making use of alternative grain storage facilities. The statements that supported the primary drivers have also shown strong correlation and were discussed in the data analysis of Chapter 3.

Although there were certain limiting factors presented in the short time frame available to conduct the study and the limited geographical demarcation, it is conclusive that the research objectives outlined in the beginning of this chapter have been fairly met.

Although this study mainly focused on areas where agriculture is reasonably well developed, it would be feasible to look at further studies where joint ventures in informal agricultural settlements can be supported by alternative grain storage facilities in the process of alleviating poverty and sustaining food security for all people.

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APPENDICES

Appendix A – Data Collection Instruments

INTERVIEW

1. What is your general experience of alternative grain storage facilities?

2. Out of the following what would you consider the primary drivers for making use of alternative grain storage facilities?

    - Service delivery
    - Efficient management
    - Marketing options
    - Road infrastructure
    - Distance travelled.
    - Wear and tear.
    - Handling and storage costs.
    - Safex differential.
    - Turnaround time.
    - Other.

3. Would you consider erecting an on-farm storage facility and if so what would constitute such a decision?

4. Would you prefer alternative grain storage facilities above traditional grain silos?

5. What in your opinion differentiate alternative grain storage facilities from other commercial grain storage facilities, like silos?

6. If possible, what value added services would you say there is a need for at alternative grain storage facilities

QUESTIONNAIRES

SECTION A

BIOGRAPHICAL INFORMATION

Please complete the following questions by placing an "x"
in the appropriate square.

Age	
Under 25	
25 - 34	
35 - 44	
45 - 54	
55 - 64	
65 - 74	
Over 75	

Highest Qualification	
High School	
Diploma	
B. Degree	
Post Graduate	
M. Degree	
PhD	

Sex	
Male	
Female	

Ethnic Group	
White	
Black	
Coloured	
Indian	

OPERATIONAL CRITERIA				

The type of alternative grain storage facility I make use off.	
Silo Bags	
Grain Bunker	
Grain Dams	
Zink Silo	

I consider my own on-farm grain storage facility in the future.	
Yes	
No	

Tent Silo	

Primary reason for producing and storing grain.	
Animal Feed	
Market and Sell	

Please complete the following questions by filling in the closest answer.

The quantity of grain I produce. (Hectares) (Fill in please)

The quantity of grain I deliver to alternative grain storage facilities. (Tonnage) (Fill in please)

The quantity of land I cultivate. (Hectares) (Fill in please)

The quantity of land I rent. (Hectares) (Fill in please)

SECTION B

PRIMARY REASONS FOR MAKING USE OF AN ALTERNATIVE GRAIN STORGAE FACILITY

Question	Strongly Agree	Agree	Uncertain	Disagree	Completely Disagree
Alternative grain storage facilities plays an important role in the grain storage supply chain.					

Please arrange the following reasons in order of importance. Place 1 in the box if you consider the reason as the most important. Place 2 in the box if you consider the reason as second most important and so on.	
Service delivery	
Flexible marketing options	
Wear and tear	
Cost management	
Handling and storage costs	

SECTION C

QUESTIONS

No	Question	Strongly Agree	Agree	Uncertain	Disagree	Completely Disagree
C1	I am satisfied with the service I receive from alternative grain storage facilities.					
C2	It is worth investing in on-farm storage facilities when primarily producing for animal feed purposes,					
C3	Having different marketing and pricing options is a primary consideration when I consider where to deliver my grain.					
C4	The turnaround time for delivering my grain is an important consideration when I decide where to deliver my grain.					
C5	Buyers offer better premiums to transport my grain directly from the farm.					

C6	The conditions of our road infrastructure is a primary consideration when I decide where to deliver my grain.					
C7	Alternative grain storage facilities are sufficient to handle and store my grain harvest.					
C8	The Safex differential is an important consideration in deciding where to deliver my grain					
C9	Being able to retrieve grain quickly for farm usage is an important consideration when I decide where to deliver my grain.					
C10	The distance I need to travel to deliver my grain is a primary consideration when I decide where to deliver my grain.					
C11	Grain handling and storage costs is a primary consideration when I decide where to deliver my grain.					
C12	By lowering the wear and tear on my vehicles I can manage my other farming operations more efficiently.					

C13	Value added services, like sifting and drying of grain, is an important consideration when I decide where to deliver my grain.					
C14	I enjoy the fact that the quality of my grain is guaranteed once my grain is screened and delivered at the alternative grain storage facility.					
C15	Being offered a premium for my grain is a primary consideration when I decide where to deliver my grain.					
C16	By delivering my grain to alternative grain storage facilities I can spent my time more efficiently on other divisions of my farming operations.					
C17	I would consider delivering more grain to alternative grain storage facilities by getting a quality premium for the grain I produce.					
C18	The risk of using my tractors and wagons on public roads is a primary consideration when I decide where to deliver my grain.					
C19	The ability to upgrade my grain with an on-farm storage facility does not provide enough reasoning to invest in on-farm storage facilities.					

C20	The ability to market my grain within a specific time period from harvesting is an important consideration when deciding where to deliver my grain.					
C21	It is not cost effective to deliver my grain to alternative grain storage facilities when grain is primarily used for animal feed purposes.					
C22	Alternative grain storage facilities enables me to store my grain at competitive rates.					
C23	I receive value by storing my grain at alternative grain storage facilities.					
C24	By getting a quantity discount for my grain I would consider delivering more grain at alternative grain storage facilities.					
C25	Delivering grain to an alternative grain storage facility allows me to effectively manage and market my grain.					
C26	The saving in storage costs does not provide enough reason to invest in on-farm storage facilities.					

C27	I would deliver more grain to alternative grain storage facilities if I had the option to withdraw grain for own use.					

C28	By collecting my grain from the land and delivering it to alternative grain storage facilities is a cost effective option.					

C29	The handling and storage costs I pay at alternative grain storage facilities is in line with the costs at traditional grain storage facilities.					

C30	I can attain better yields per hectare by lowering the wear and tear cost on my vehicles.					

Appendix B – Informed Consent

Dear Respondent

Thank you for your time with the completion of this questionnaire.

The aim of this questionnaire is to establish the feasibility of alternative grain storage facilities. This study is conducted as part of the completion of the MBA degree at the North-west University Business School.

Your participation in this study is completely voluntary and all information that is attained through this study will be treated as confidential at all times. Results will only be presented in a collective format for research purposes.

Through the completion of this study the respondent gives her/his cooperation by completing every question to ensure the validity and integrity of the study. The researcher undertakes to treat all information as confidential only for the use of research purposes.

Instructions

This series of questions represents a range of evaluation criteria which a producer / consumer would consider in making use of alternative grain storage facilities.

Each criteria has to be evaluated through indicating with an “x” in the box next to each criteria. The respondent must choose the most accurate or closely correct statement.

Example

AGE	
Over 35	
Under 35	**x**

No	Question	Strongly Agree	Agree	Uncertain	Disagree	Completely Disagree
	Alternative grain storage facilities plays an important role in grain storage.	**x**				

Thank you for your contribution towards this study

Yours sincerely

C.A. Gresse

Appendix C – Language Editing

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To whom it may concern,

LANGUAGE EDITING

This letter serves as proof that the following document was submitted for language editing in November 2018:

Author: Cecil Gresse

Document type: Mini-Dissertation: MBA

Title: ***AN ANALYSIS OF THE ECONOMICAL FEASIBILITY OF ALTERNATIVE GRAIN STORAGE METHODS***

I applied all reasonable effort to identify errors and made recommendations about spelling, grammar, style and punctuation.

I attempted to be consistent regarding language usage and presentation.

The bibliography was also checked and corrections were made where necessary.

I confirmed the content as far as possible, but cannot be held responsible for this as all facts could not be confirmed. This remains the responsibility of the author.

Thank you very much.

Kind regards.

Rentia Mynhardt