

Quality, pricing and the performance of the wheat industry in South Africa

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Declaration

I declare that the thesis hereby submitted for the PhD degree with specialisation in Agricultural Economics at the North-West University is my own independent work and has not previously been submitted by me to another university or facility.

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Abstract

Statistics paint a picture of a wheat industry under severe pressure, with the number of hectares dedicated to wheat production that have decreased while imports notably increased since 1997. This has had a negative impact on the industry's global competitiveness. The direct and indirect linkages between wheat and wheat products, together with the benefits that the industry can bring to the economy in the form of heightened food security and employment opportunities, highlight the need for a competitive wheat industry in South Africa. Clearly, the underlying causes of the declining wheat production in South Africa need to be investigated and understood.

The presence of strict wheat quality standards and the fact that one of the general characteristics of wheat is the defect of conversion (that is, yield declines as quality improves) help to explain why wheat production in South Africa has declined in recent years. This can also negatively affect prices received for produce because South African wheat prices are determined by the lowest import parity price and not by the specific quality of the wheat. The fact that market concentration has been observed in certain parts of the wheat industry in South Africa has raised concerns that this phenomenon could potentially have had a negative impact on the performance of the country's wheat production sector.

Consequently, this study revolves around the following main questions: "could the evident market concentration in the South African wheat industry influence the performance of the wheat production sector by prescribing certain quality standards which attract relatively low prices?", and if so, "can the wheat quality standards and prices be held responsible for the decline in the industry's performance, and to what extent?"

Both qualitative and quantitative approaches were used in pursuit to answer these questions. The qualitative approach was used to describe the theoretical basis of performance, competitiveness and concentration. Three different quantitative approaches were employed to determine the current state of competitiveness (Relative Trade Advantage (RTA) method),

the factors influencing it (hedonic price model) and the extent of such influence (dynamic linear model). From the RTA, it was clear that South Africa is the only country, compared to its trading partners, that has an uncompetitive unprocessed (production) wheat sector alongside a competitive semi-processed (flour) wheat sector. The hedonic price model supported the finding that the institutional environment of the wheat industry uses quality-related mechanisms such as the cultivar release criteria to influence the competitiveness of the wheat production sector.

Four comparisons were developed to determine whether the strict qualities required for the release of new cultivars are justified. It was found that with all four of these comparisons, the strict prescribed wheat quality was not justified in terms of the quality and demand considerations. It was found that when prescribed wheat quality could be relaxed to accommodate market supply and demand, an estimated 12.8 percent increase in yields could have been realised equating to a loss of approximately R606 million in Net Farm Income (NFI) per annum. When increasing this percentage to 20 percent, it was seen that the effect on NFI per annum would be R920 million.

This study therefore provides evidence as to why the performance of the wheat industry has been declining over the last two decades and also contributes to the development of a framework for policy and decision makers which will encourage more competition and a freer market in terms of quality standards. Further contributions of this study lies in the body of literature on competitive behaviour by showing how concentrated industries can use statutory bodies to manipulate markets for rent-seeking purposes. It further shows how these decisions impact on important aspects like the profits of role players in an industry.

Keywords: Wheat industry, market concentration, performance, relative trade advantage, hedonic price model

Table of Contents

<u>Contents</u>	<u>Page</u>
Acknowledgements.....	i
Abstract.....	ii
Table of Contents.....	iv
List of Figures.....	ix
List of Tables.....	xi
List of Abbreviations.....	xiii

Chapter 1

Introduction

1.1	Background.....	1
1.2	Problem statement.....	4
1.3	Motivation.....	5
1.4	Objectives.....	7
1.5	Methodology and data used.....	8
1.6	Outline of the study.....	9

Chapter 2

Literary Review

2.1	Introduction.....	11
2.2	Performance and the link to competitiveness.....	12
2.2.1	Porter's diamond model.....	17
2.3	Market concentration.....	22
2.4	Methods employed to determine performance.....	26
2.4.1	Real exchange rate.....	26

2.4.2	Foreign Direct Investment	26
2.4.3	Trade and market share indicators	27
2.4.4	Relative Trade Advantage	28
2.5	Methods to identify the specific factors that influence the performance of an industry	29
2.5.1	Policy Analysis Matrix	29
2.5.2	Hedonic price models	31
2.5.2.1	Product differentiation in pure competition.....	32
2.5.2.2	Prices and demands for input characteristics.....	34
2.5.2.3	Various quality attributes of cotton lint and the impact on producer prices	35
2.5.2.4	The estimation of demand parameters.....	36
2.5.2.5	Various quality attributes of Kansas wheat and the impact on producer prices.....	37
2.5.2.6	The market valuation of wheat quality characteristics	40
2.5.2.7	Demand for wheat protein quantity and quality	40
2.5.2.8	Bread wheat characteristics and the impact on prices	42
2.6	Methods to determine the impact on the performance of an industry	44
2.6.1	Input-output analysis	45
2.6.2	SAM-based macroeconomic models	46
2.6.3	Social Accounting Matrix (SAM)	48
2.6.4	Mathematical programming	49
2.6.4.1	A simple linear model	50
2.6.4.2	Dynamic linear programming.....	53
2.7	Conclusion.....	55

Chapter 3

Global Wheat Industry Overview

3.1	Background.....	56
3.2	Historic development of the global wheat industry.....	57
3.3	Major role players in global wheat trade	58
3.4	Performance of the major role players in the global wheat industry.....	60
3.4.1	Global wheat production	60

3.4.2	Global wheat consumption	64
3.5	Competitive status of the SAWI compared to global trading partners.....	65
3.5.1	Model development	66
3.5.2	Data requirements	67
3.5.3	Results from the RTA.....	67
3.6	Conclusion.....	73

Chapter 4

South African Wheat Industry

4.1	Introduction	75
4.2	Structure of the wheat industry in South Africa.....	76
4.3	Factors influencing the performance of the wheat industry in South Africa	78
4.3.1	Wheat quality.....	79
4.3.1.1	Release criteria for new wheat cultivars.....	79
4.3.1.2	Wheat grading.....	81
4.3.2	Wheat prices	84
4.3.2.1	Import parity price	85
4.3.2.2	Prices for different grades of wheat.....	89
4.3.2.3	Location differential	90
4.3.3	Supporting and related industries	91
4.3.3.1	Transport and storage	91
4.3.3.2	The milling industry	93
4.3.3.3	The baking industry	95
4.3.4	Wheat consumption in South Africa	97
4.3.5	South African wheat trade	99
4.4	Performance of the wheat producers in South Africa	105
4.4.1	Wheat production in South Africa.....	105
4.4.1.1	Western Cape.....	108
4.4.1.2	Free State	111
4.4.1.3	Northern Cape	113

4.5	Conclusion.....	115
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Chapter 5

Hedonic Price Model

5.1	Introduction	116
5.2	Development of a theoretical hedonic price model	118
5.2.1	Discussion of data used	120
5.2.2	Application of the hedonic price model and key results	122
5.3	Conclusion.....	128

Chapter 6

Wheat Quality Standards and their Potential Impact on Performance

6.1	Introduction	129
6.2	Wheat quality prescribed to South African producers	130
6.3	Wheat quality standards compared to wheat quality supplied	131
6.4	Wheat quality standards compared to wheat flour quality	137
6.5	Wheat quality standards compared to the quality of price determining wheat-importing countries	141
6.6	Potential higher yields if the criteria are relaxed.....	145
6.7	Conclusion.....	146

Chapter 7

Financial Impact Analysis

7.1	Introduction	148
7.2	Model description.....	149
7.2.1	Theoretical model specification.....	150
7.2.2	Basic modelling framework.....	151
7.3	Application of the model through different farm model scenarios	157
7.4	Effects of increased yields on the performance of the wheat industry.....	158
7.4.1	Changes in NFI.....	159

7.4.2	National effects of increased wheat yields on the performance of the wheat industry	160
7.5	Conclusion.....	163

Chapter 8

Summary, Conclusions and Recommendations

8.1	Introduction	164
8.2	Objectives of the study	165
8.3	Summary of the study.....	166
8.3.1	Main issues from literature	166
8.3.2	Global wheat industry overview	167
8.3.3	Structure, conduct and performance of the South African wheat industry	168
8.3.4	Factors influencing the competitiveness of the South African wheat industry	169
8.3.5	Wheat quality standards and their potential impact on performance	171
8.3.6	Financial impact analysis.....	172
8.4	Strategies and recommendations	173
References		176
Annexure A		196

List of Figures

Figure 2.1:	Factors driving profitability	14
Figure 2.2:	The evolution of competitiveness theory	17
Figure 2.3:	Porter's diamond model	20
Figure 3.1:	Major wheat-exporting countries in 2013	59
Figure 3.2:	Major wheat-importing countries in 2013.....	60
Figure 3.3:	World wheat stock and production (1990/91 to 2014/15).....	61
Figure 3.4:	Wheat production per selected country and percentage change (1990–92 to 2011–13).....	62
Figure 3.5:	Wheat hectares harvested by peer countries and annual percentage growth rate (1990–92 to 2011–13)	63
Figure 3.6:	Wheat yields in peer countries and annual percentage growth rate (1990–92 to 2011–13).....	64
Figure 3.7:	World wheat trade and consumption (1990/91 to 2014/15).....	65
Figure 3.8:	Trends in the RTA index values for unprocessed, semi-processed and processed wheat in South Africa (1992–2012)	69
Figure 3.9:	Trends in RTA index values for unprocessed, semi-processed and processed wheat in Argentina (1992–2012).....	70
Figure 3.10:	Trends in RTA index values for unprocessed, semi-processed and processed wheat in Brazil (1992–2012).....	71
Figure 3.11:	Trends in RTA index values for unprocessed, semi-processed and processed wheat in Australia (1992–2012).....	71
Figure 3.12:	Trends in RTA index values for unprocessed, semi-processed and processed wheat in Canada (1992–2012).....	72
Figure 3.13:	Trends in RTA index values for unprocessed, semi-processed and processed wheat in Germany (1992–2012).....	72
Figure 3.14:	Trends in RTA index values for unprocessed, semi-processed and processed wheat in the USA (1992–2012).....	73

Figure 4.1:	Percentages of different wheat grades in South African from 2004/05 to 2011/2012.....	84
Figure 4.2:	World wheat prices from 1990/1991 to 2012/2013	86
Figure 4.3:	Import tariffs	88
Figure 4.4:	SAFEX price at Randfontein.....	89
Figure 4.5:	Location differentials for selected silo locations.....	91
Figure 4.6:	Wheat transport by component	92
Figure 4.7:	Number of wheat silos and associated co-ops.....	93
Figure 4.8:	Tonnage of milled wheat in South Africa from 1998/1999 to 2008/2009	95
Figure 4.9:	Private consumption expenditure on food in South Africa	98
Figure 4.10:	Total and per capita consumption of wheat in South Africa.....	99
Figure 4.11:	South African wheat imports from 1990/1991 to 2012/2013	100
Figure 4.12:	Percentage of wheat imports to South Africa per country in 2012	101
Figure 4.13:	Value of the Southern African Customs Union imports of wheat	102
Figure 4.14:	Annual protein percentage of local and imported wheat.....	103
Figure 4.15:	Annual hectolitre mass content of local and imported wheat	104
Figure 4.16:	Annual falling number in seconds of local and imported wheat.....	105
Figure 4.17:	Total wheat deliveries in South Africa as well as the moving average from 1984 to 2015.....	106
Figure 4.18:	Total yield and total area dedicated to wheat in South Africa from 1984 to 2015	107
Figure 4.19:	Percentage wheat producer deliveries per province in 2014/15.....	108
Figure 4.20:	Wheat production, area and yield in the Western Cape from 1989/90 to 2014/15.....	109
Figure 4.21:	Swartland: Actual production costs per hectare, income per hectare and profits/losses from wheat from 2001 to 2012.....	110
Figure 4.22:	Southern Cape: Actual production costs per hectare, income per hectare and profits/losses of wheat from 2002 to 2012	111
Figure 4.23:	Wheat production, area and yield in the Free State from 1989/90 to 2014/15	112
Figure 4.24:	Eastern Free State: Actual production costs per hectare, income per hectare and profits/losses from wheat from 2001 to 2012.....	113
Figure 4.25:	Wheat production, area and yield in the Northern Cape from 1989/90 to 2014/15.....	114

Figure 4.26: Northern Cape: Estimated production costs per hectare, income per hectare and profits/losses from wheat from 2001 to 2012.....	115
Figure 7.1: Typical farm DLP modelling structure	152

List of Tables

Table 3.1: RTA indexes of unprocessed wheat	68
Table 4.1: Composition of the RTC.....	78
Table 4.2: Average biological standard for the three production regions in South Africa..	81
Table 4.3: Standard of different Class Bread Wheat grades.....	83
Table 4.4: SAFEX annual discount prices per grade.....	90
Table 4.5: Number of employees, revenue and number of wheat mills in the milling industry	94
Table 4.6: Bread market share of major role players in 2013.....	97
Table 5.1: Relevant factors in the determination of wheat prices in South Africa.....	120
Table 5.2: Summary of statistics for variables utilised in the analysis.....	122
Table 5.3: Hedonic price parameter estimates: Step 1 of 3	123
Table 5.4: Correlations between PROT and independent variables	124
Table 5.5: Correlations between additional independent variables	124
Table 5.6: Included variables that serve as proxies for excluded variables.....	125
Table 5.7: Hedonic price parameter estimates: Step 2 of 3	126
Table 5.8: Hedonic price parameter estimates: Step 3 of 3	127
Table 6.1: Annual weighted average of wheat quality of local and imported wheat	132
Table 6.2: A comparison between wheat quality supplied and biological standards in the three wheat production regions in South Africa.....	134
Table 6.3: Proposed deviation from biological standards based on wheat quality supplied in South Africa of unprocessed wheat.....	135
Table 6.4: Potential increase in yield if criteria were relaxed	137

Table 6.5:	Comparison between unprocessed wheat qualities provided to consumers and biological standards in the three wheat production regions in South Africa....	139
Table 6.6:	Proposed deviation from biological standards based on processed wheat quality in South Africa.....	140
Table 6.7:	Comparison between wheat qualities imported from countries having a meaningful impact on price and biological standards in the three wheat production regions in South Africa	143
Table 6.8:	Proposed deviation from biological standards based on imported wheat quality from countries having a meaningful impact on price	144
Table 6.9:	Potential higher yields if the criteria are relaxed and the focus is shifted to yield	146
Table 7.1:	Typical farm model sets (Augrabies-Blouputs example)	153
Table 7.2:	Typical farm equations (20 basic equations)	155
Table 7.3:	Description of wheat farm scenarios	158
Table 7.4:	Expected increase in NFI under dry land conditions.....	159
Table 7.5:	Expected increase of NFI on irrigated land	160
Table 7.6:	Effect of increased yields on NFI on a national scale	162

List of Abbreviations

ABSORP	Absorption
ALVSTAB	Alveogram Stability
ARC	Agricultural Research Council
ASW	Australian Soft Wheat
BU	Brabender Unit
CARD	Centre for Agricultural and Rural Development
CBW	Class Bread Wheat
COLOUR	Colour in KJ76
COW	Class Other Wheat
CWRS	Canadian Western Red Spring
DAR	Dummy Variable for wheat originating in Argentina
DAU	Dummy Variable for wheat originating in Australia
DB	Dummy Variable for wheat originating in Brazil
DC	Dummy Variable for wheat originating in Canada
DEFECTS	Total Percentage of Defects
DEVELOP	Development Time
DG	Dummy Variable for wheat originating in Germany
DISTENS	Distensibility
DUK	Dummy Variable for wheat originating in Ukraine
DUR	Dummy Variable for wheat originating in Uruguay
DUS	Dummy Variable for wheat originating in the USA
DLP	Dynamic Linear Programming
DNS	Dark Northern Spring
DRC	Domestic Resource Cost
EXCRATE	Exchange Rate
EXTRAC	Buhler Extraction Percentage
FALL	Falling Number

FAO	Food and Agricultural Organization of the United Nations
FARSTAB	Farinogram Stability
FDI	Foreign Direct Investment
GE	General Equilibrium
GDP	Gross Domestic Product
GLS	Generalised Least Square
HECT	Hectolitre Mass
HRW	Hard Red Winter
IFRI	International Forestry Resource and Institutions
JSE	Johannesburg Stock Exchange
KERMASS	Thousand Kernel Mass
Kg/hl	Kilogram per Hectolitre Mass
KJ	Kent Jones
LP	Linear Programming
MP	Mathematical Programming
MTI	Mixing Tolerance Index
NCM	National Chamber of Milling
NFI	Net Farm Income
PAM	Policy Analysis Matrix
PE	Partial Equilibrium
PEAK	Peak Time
P/L-value	Stability/Distensibility
PROT	Protein Content
RAP	Risk Aversion Parameter
RDP	Reconstruction and Development Programme
RCA	Relative Comparative Advantage
RMA	Relative Import Advantage
RMB	Rand Merchant Bank
ROIC	Return on Invested Capital
RTA	Relative Trade Advantage
RTC	Research Technical Committee
RXA	Relative Export Advantage
SAFEX	South African Futures Exchange

SAGIS	South African Grain Information Services
SAGL	South African Grain Laboratory
SAM	Social Accounting Matrix
SAWI	South African Wheat Industry
STR	Strength
USA	United States of America
UT	Utility Grade
VOL	Corrected Volume
WPROD	World Production
WTC	Wheat Technical Committee

Chapter 1

Introduction

1.1 Background

Projections made by the Food and Agricultural Organization (FAO) suggest that in order to feed an estimated 9.1 billion people in 2050, overall food production will be required to increase by approximately 70 percent (FAO, 2009). This implies that agricultural production needs to double while also addressing the challenges of a declining rural labour force and growing feedstock demand for the bio-energy market, as well as the need to contribute to overall development in agriculture-dependent countries and adapt to efficient and sustainable production methods and climate change (FAO, 2009). Over and above these global challenges, each country and industry has its own identity and characteristics, and therefore its own unique challenges. The South African Wheat Industry (SAWI) is a prime example of an industry that faces not only global challenges but also local challenges, both of which continuously affect the performance of the industry.

The importance of the wheat industry in South Africa is summed up in the fact that wheat is currently the second most heavily-consumed field crop in the country (StatsSA, 2014) and together with the local wheat processing sector provides a large number of job opportunities. Furthermore, wheat flour, which is used mainly for the baking of bread, is regarded as the second most important food source in South Africa and therefore plays an essential role in the fight against food insecurity (NAMC, 2005). Testimony to this is the fact that bread—especially brown bread—is regarded as an essential part of the National School Nutrition Programme, which is feeding the workers of tomorrow and is at the forefront of the fight against food insecurity in South Africa (ETU, 2012). Bread, the main product of the SAWI, is also fast becoming a staple food, particularly in informal settlements where people lack access to electricity and ovens. As a result, the consumption of wheat recently increased

relative to the consumption of maize, which is regarded as the premier grain crop in South Africa (Cock, 2009). The importance of the SAWI not only stems from its ability to provide food for the poor, but also from the indirect contribution it makes to the domestic economy via job creation, skills development, poverty alleviation, etc.

Recent statistics, however, indicate that the production of wheat in South Africa is under severe pressure and that since 1997, the number of hectares dedicated to wheat production has decreased and imports have increased significantly to meet the growing local demand. Van Schalkwyk and Van Deventer (2005) stated that this is due to the development of a specific policy environment that had and still has a severe impact on the performance of the industry. Prior to 1997, the SAWI was characterised by a single-channel marketing system which was responsible for determining wheat prices. This system, according to the NAMC (2006), controlled the movement, pricing, selling and supply of agricultural products with the aim of securing price stability and narrowing the gap between producer and consumer prices in South Africa. The subsidy received by the wheat industry was intended to keep consumer prices of wheat and wheat products (flour and bread) as low as possible (Vink and Kirsten, 2000). According to Stanwix (2012), throughout the apartheid era the government paid an expensive, redistributive bread subsidy which ultimately benefitted black South Africans—something hardly mentioned in the historiography.

Following extensive negotiations among all directly-affected groups in the agricultural marketing field, all the control boards were dismantled in 1996. The then new Marketing of Agricultural Products Act of 1996 set out to prevent, rather than enable, undesirable intervention. However, the winter cereal industry expressed the desire to continue with certain functions that were previously carried out by the Wheat Board (Winter Cereal Trust, 2014). The functions identified for continuation were the provision of market information, laboratory services and financial support to research projects. It was decided that the so-called Research Technical Committee (RTC) would drive research and would need to be consulted before any research on winter cereals was undertaken (Winter Cereal Trust, 2014). The RTC for wheat was, and still is, composed of all representatives of the industry, its functions being related to the classification of new cultivars, grading requirements and quality specifications. In other words, the RTC for wheat is responsible for influencing wheat quality by prescribing certain quality standards for commercial production in South Africa.

Accompanying this drastic change in policy were severe structural changes in the agricultural industry, evidenced in changing land use patterns and farm sizes and farmers coming under pressure to improve their productivity for ecological reasons. This had a significant impact on farmers' financial performance (Vink and Kirsten, 2000). Furthermore, the international environment started to play an increasingly important role in the local wheat industry as markets became less protected against imports. The National Agricultural Marketing Council (NAMC) (2005) and Sosland (2011) pointed out that the subsequent "freeing up" of the market had several unintended consequences and argued that this resulted in a drive towards higher efficiency and a subsequent decline in the number of wheat buyers. However, Stanwix (2012) stated that the strict control of agricultural markets prior to deregulation fostered a powerful elite which benefitted from privileged access to state support and protection from competition through restricted market access. Although the post-apartheid liberalisation was brought about with the noble intention of generating a more competitive environment and breaking down these structures of power, it mainly served to cement monopoly control (Stanwix, 2012).

The effects of the concentrated wheat market in South Africa are highlighted in the findings of the Competition Commission (2009) which imposed a fine of R195 million in 2007 on the bread cartel that involved the four primary bakeries. The bakeries in question were Tiger (Albany), Premier (Blue Ribbon), Foodcorp (Sunbake) and Pioneer (Sasko and Duens bakeries). Together these four companies enjoyed a market share of between 50 percent and 60 percent of the domestic bread market in South Africa in 2007 and colluded to manipulate bread prices. Further evidence of the effects of the concentrated wheat market in South Africa is in other findings of the Competition Commission which uncovered a flour cartel in 2007 (Mncube, 2012). The cartel was revealed when Premier Foods, one of the firms involved, applied for and was granted corporate leniency in terms of the Competition Commission's corporate leniency policy. The cartel fixed the price of flour, bread and maize meal 1996 to 2007 (Mcnube, 2012).

When considering that wheat asserts the defect of conversion (that is, yield declines as quality improves) as a general characteristic, the question that comes to mind is whether or not the dictating of wheat quality to primary producers and the associated prices can be held responsible for a primary wheat sector that is clearly struggling financially.

This study will therefore attempt to determine whether or not declining wheat production in South Africa can be attributed to prescribed standards of wheat quality and wheat prices (as set by a perceived concentrated market) and if so, to what extent. This will be done by studying various data sources and quantification methods.

1.2 Problem statement

As indicated earlier, the decommissioning of the Wheat Board in 1997 and the implementation of the Marketing of Agricultural Products Act of 1996 produced many unintended consequences. In this regard, statistics show that wheat production declined in South Africa while imports increased significantly from 1997/1998 onwards. The decline in local production had severe, negative effects on the sector's ability to provide employment, which automatically resulted in the sector contributing less to economic growth and welfare (Cock, 2009). Moreover, a decline in food production in any Sub-Saharan country is of concern, especially seeing that countries in the region are regarded by many as being part of the future food basket of the world.

The NAMC (2005) and Sosland (2011) elaborated on the findings of Van Schalkwyk and Van Deventer (2005), suggesting that concentration in the marketplace could be the reason behind the decline in local wheat production. The GAO (2004) is of the opinion that concentrated markets can lead to cost savings and lower prices for companies involved, which, in turn, influence the downstream segment (production segment) of the industry. A high correlation between prices and wheat quality makes wheat quality a likely factor that is used by concentrated markets to influence prices for their inputs (Fossati, Brabant and Kleijer, 2010). Therefore, among the factors that can easily be influenced by a concentrated market, resulting in cost savings and lower prices for the companies involved, are wheat quality and prices.

As mentioned, the RTC for wheat, which represents the entire wheat industry, is responsible for guiding wheat quality production by prescribing certain quality standards to primary producers. The question that must be asked is, "if the representatives in the RTC operate in a concentrated market, do they have the ability to get involved in uncompetitive behaviour?"

The primary concern of the RTC is to guide wheat quality production in such a manner that it is beneficial for the entire industry, while also meeting consumer demand. Before a new cultivar can be released for commercial production in South Africa, the quality characteristics of this cultivar are discussed by the RTC. If the cultivar does not comply with set quality requirements, its name will not be listed on the cultivar list for bakers and millers, and silos will not accept the produce from producers. So, although this is not regarded as a regulation within the wheat industry, the standards are enforced on producers through demand or market availability. The RTC sets high standards for the release of new wheat cultivars with regard to their bread-making characteristics. This is a necessary requirement for baking processes in South Africa which produce certain types of bread that consumers demand (Van Schalkwyk and Van Deventer, 2005).

Fossati *et al.* (2010) stated that certain wheat quality characteristics—such as protein content, which is regarded as one of the most important criteria for wheat buyers in South Africa—are negatively correlated with yield. This means that higher wheat quality in terms of protein content will result in lower yields for primary producers, while lower wheat quality in terms of protein content will result in higher yields. In a free market system, lower yields will be negated by higher prices associated with higher-quality wheat. The fact that the international environment started to play an increasingly important role in the SAWI through imports means that local prices are determined by the lowest import parity price and not the specific quality of the wheat. Because South Africa is a net importer of wheat, prices of South African wheat are determined by the import parity price (Hawkins, 2014).

Again, the question that can be raised is, “could potential market concentration in the SAWI influence the performance of the wheat production sector in South Africa by prescribing certain quality standards that attract relatively low prices?”, and if so, “could the wheat quality standards and prices be held responsible for the decline in performance, and to what extent?”

1.3 Motivation

The existence of elements of concentration in the wheat market in South Africa was already proved in 2007 by the Competition Commission which imposed a hefty fine on four large companies. However, research into the possible effect of this concentrated market on the

performance of the production sector of the wheat industry has been neglected so far. The contribution of this study is at both a practical and a theoretical level. From a practical point of view, the study provides evidence as to why the performance of the wheat industry has been declining over the last two decades. It also offers a basis for policy and decision makers to develop a framework for wheat, which will encourage more competition and a freer market in terms of quality standards. From a theoretical standpoint, this study contributes to the body of literature on competitive behaviour by showing how concentrated industries can use statutory bodies to manipulate markets for rent-seeking purposes. It also shows how these decisions impact on important aspects like the profits of role players in an industry. All of this is done by applying certain analytical techniques. The direct and indirect linkages of wheat and wheat products coupled with the benefits the industry can bring to the economy—which are needed to address pressing issues such as food insecurity and unemployment—highlight the need to improve the competitiveness of the entire wheat industry in South Africa. Actual results and the course that is being taken to improve the performance of a specific industry ultimately determine the long-term competitiveness of that industry (Van Zyl, Van Schalkwyk and Thirtle, 1993).

Achieving perfect, competitive market conditions in any industry would be impossible, but it is only in the pursuit of such a goal that we can truly achieve excellence and realise our highest potential (Varughese, 2005). In other words, in the pursuit of a perfect, competitive market, we should strive to adapt to an ever-changing global environment and, most importantly, bring about a sustainable and efficient industry, thus reaching our highest potential. Market concentration, by contrast, has the ability to give unprecedented market power to buyers, thus having negative effects on prices, regulations and innovation (Porter, 1998).

Porter (1990) stated that in order to successfully determine whether or not the competitiveness of any industry has been influenced, the current state of competitiveness must first be identified. This implies that to convert the SAWI into a more competitive industry—which can tackle the issues of food security, job creation, skills development and poverty alleviation—the current state of competitiveness of the industry must first be measured and analysed. According to Porter (1990), factors responsible for the decline in local production levels and thus competitiveness must also be identified, so that constructive

solutions can be found to enable the industry to make a difference in the crucial areas of securing access to food, creating jobs, developing skills and alleviating poverty.

1.4 Objectives

The challenge of the SAWI is to achieve and maintain competitiveness in order to survive in the cut-throat environment of the new global economy. The industry must achieve this while addressing societal issues, such as social and economic equity, environmental responsibilities and ethical business practices—all against the backdrop of possible market distortions.

The key question that has been raised, i.e. “could potential market concentration in the SAWI influence the performance of the wheat production sector in South Africa by prescribing certain quality standards that attract relatively low prices?”, and if so, “could the wheat quality standards and prices be held responsible for the decline in performance, and to what extent?” will be broken down into three major objectives. They are:

- To determine the long-term competitiveness of the South African wheat industry in relation to its major global markets. Porter (1998) asserted that the definition of competitiveness as well as the way in which competitiveness is measured must first be determined. Only after these issues have been clarified can the globally competitive state of an industry be determined.
- To identify the factors constraining performance and their relative impact, and to determine the implications thereof for long-term competitiveness. According to Porter (1998), these factors must be identified and addressed if the competitiveness of an industry is ultimately to be improved.
- To establish how the long-term competitiveness of the SAWI can be improved given the enriched knowledge of the factors constraining performance.

According to Esterhuizen (2006), by answering these questions it will be possible to explain the role played by the economic environment, institutions and policies in the competitive success of the SAWI. Esterhuizen (2006) further stated that such an analysis will reveal the ability of each activity in a particular value chain (production, marketing, processing, etc.) to adapt to market changes and structures, and to produce and adopt technological innovations.

It will also highlight each activity's access to capital and its capacity to secure and retain a share of the international market. In other words, the analysis will focus on measuring and evaluating the efficiency, effectiveness and sustainability of the industry.

Specific objectives of the study therefore include:

- To describe the theoretical basis of performance and the link to competitiveness;
- To determine the exact state of competitiveness of the SAWI compared to that of major trading partners by means of a Relative Trade Advantage (RTA) method;
- To identify specific factors that can be influenced by a concentrated market and that will affect the performance and long-term competitiveness of the wheat production sector in South Africa, using a hedonic price model;
- To determine the extent of the impact of a concentrated market on the economy in South Africa, using a dynamic linear programming model;
- To provide recommendations from the results with a view to enhancing the performance of the wheat production sector in South Africa.

1.5 Methodology and data used

Owing to restrictions on the availability of industry data in the wheat industry, it was necessary to employ qualitative and quantitative approaches in the study to meet the objectives outlined in the previous section. Industry data were withdrawn by the industry in 2007 after the Competition Commission started to suspect, and to investigate allegations into, uncompetitive behaviour. A qualitative approach will be used to describe the theoretical basis of performance, competitiveness and concentration, as well as the possible factors and tools used by concentrated markets that can affect the performance of an industry. Three different quantitative approaches will be employed to determine the current state of competitiveness, the factors influencing it and the extent of such influence.

To determine the exact state of competitiveness of the wheat industry in South Africa compared to that of major trading partners, a number of methodologies can be used. In this case, an RTA is regarded as the most appropriate method (Vollrath, 1991). This method takes both exports and imports into account and is considered to be a superior and more comprehensive measure of competitiveness compared to methods that only consider exports

or imports (Esterhuizen, 2006). A limitation of this method, though, is that it only quantifies the state of competitiveness and does not explain how the country acquired its international market share and competitive status. The sustainability of the competitive position may thus be in question, especially in view of the on-going global movement to “free up” markets and reduce subsidies and protection (Esterhuizen, 2006). This method will therefore only define the competitive status of the SAWI and will be the starting point in the analysis.

To identify specific factors that can be influenced by a concentrated market and that will affect the performance of the wheat industry, a hedonic price model will be employed. This will assist in determining the factors that affect the volatility of wheat prices. It is the opinion of Espinosa and Goodwin (1991) that to effectively determine the exact factors impacting on the performance of the industry, the effects of the characteristics of wheat on the price must be determined and an economic evaluation of the market’s willingness to pay for certain product characteristics must be conducted. The hedonic price model is thus an ideal method to tackle these questions.

To determine the extent of the impact of what is perceived to be a concentrated market on the primary wheat sector, a qualitative approach will be used. Wheat quality data of locally produced and imported wheat into South Africa were gathered, analysed and compared to the demand for wheat quality in South Africa. From this analysis, comparisons will be developed and used to simulate the impact of the concentrated market on the productivity of the wheat producer in South Africa. Results from these comparisons will then be used in a dynamic linear programming model to determine the effect of a change in productivity on the financial performance of the country’s wheat producers. In the concluding remarks, the results from these analyses will be consolidated and discussed, and suggestions will be made as to how the performance of the production sector of the South African wheat industry can be improved.

1.6 Outline of the study

The outline of the study follows a similar pattern to that of the specific objectives stated earlier. Chapter 2 describes the theoretical basis of performance and concentration, as well as the effects that a concentrated market can have on the performance of an industry. In addition, the chapter elaborates on a review of previous studies that used different methods to determine the state of competitiveness and the effects of a concentrated market on the

financial performance of an industry. Chapter 3 presents an overview of the current international trends in the wheat industry as well as links to the South African market. The chapter also determines and discusses the state of competitiveness of the South African wheat industry in relation to its international rivals and serves as the analytical starting point of the study. Chapter 4 focuses on the South African wheat industry and the development of the industry from the pre-apartheid era until the present day. The analysis of the conduct of the industry focuses on specific factors that can influence the performance of producers. The resulting performance in terms of production, consumption, trade and prices is also discussed.

Chapter 5 makes use of a hedonic price model to exactly determine the factors affecting the performance of the wheat industry in South Africa. Chapter 6 presents four comparisons to determine the effect of the high quality standards prescribed by the RTC on the productivity and competitiveness of the wheat producer. Chapter 6 also determines whether these high quality standards are justified by the supply and demand factors evident in the industry. Chapter 7 then determines the effect on the economy by assessing the financial performance of primary producers in the industry, using the results from the four scenarios. Finally, Chapter 8 provides concluding remarks and recommends possible strategies for improving the competitiveness of the SAWI.

Chapter 2

Literary Review

2.1 Introduction

Hofstrand (2009) stated that profitability is the primary goal of all business ventures and without it, businesses would not survive in the long run. Behn (2003) further stated that a performance measure like profitability is not an end in itself, and questioned why it should be measured in the first place. Behn (2003) came to the conclusion that performance measures like these can be used to evaluate, control, budget, motivate, promote, celebrate, learn and improve. Smith (2000) was of a similar opinion, stating that agricultural producers are generally preoccupied with maximising the profitability of their operations while avoiding excessive financial risks.

According to Hofstrand (2009) and Van Zyl *et al.* (1993), profit is the result of the difference between revenues and costs, and a sector or business can generate more profit through productivity growth or price over-recovery, or both. The course that is taken, however, has important implications for the longer term competitive position of a business or industry (Van Zyl *et al.*, 1993). From the 1990s into the early years of the 21st century, the constitutional nature of competition underwent radical transformation, creating the need for new fundamental principles to steer scientific research on the concept (Tapscott, 2001; George and Manasis, 2010).

This transformation of competition has been especially evident in the South African economy, which has seen significant policy shifts over the last two decades. Prior to 1997, the economy was rigid, protected, constrained by inefficient institutions, highly monopolised and concentrated. The high level of concentration prior to 1997 was evident in the patterns of ownership and control of companies listed on the Johannesburg Stock Exchange (JSE)

(Competition Commission, 2009). Following the collapse of apartheid and the subsequent deregulation of the market in 1997, market power became a key point of policy debate, with the competition policy reflected in the 1994 Reconstruction and Development Programme (RDP) ultimately foreshadowing the Competition Act of 1998 (Competition Commission, 2009). With liberalisation came the expectation that millers would compete in the hopes that it would lead to low prices of flour and bread. Chabane, Roberts and Goldstein (2006) stated that although ownership concentration has declined significantly since the deregulation of the market in 1997, patterns of merger activity (along with various prohibiting practices) suggest that markets are still highly concentrated and a great deal of vertical integration has taken place. According to Cock (2009), Mncube (2012) and the Competition Commission (2009), a high degree of market concentration is evident in the South African Wheat Industry (SAWI).

This chapter will therefore attempt to explain the concept of profitability and what it entails, while also providing a detailed discussion on market concentration, the mechanisms employed by concentrated markets and the possible effects thereof on the performance of a market. In addition, the chapter will look at methods to determine the performance of an industry, methods to identify the specific factors that influence the profitability of an industry and finally, methods to determine the impact on the performance of an industry.

2.2 Performance and the link to competitiveness

As mentioned in the previous section, the performance of an industry or business can be directly linked to the profitability of that industry or business, which in turn is dependent on the difference between revenues and costs. However, Van Zyl *et al.* (1993) were of the opinion that these two factors alone do not provide the necessary insight into the interactions of all factors that are ultimately translated into the firm's bottom line. Van Zyl *et al.* (1993) stated that there is a network of uncontrollable and controllable factors that underpin a sector's or company's revenues and costs. Using the same basic accounting information used to calculate revenues and costs, it is possible to acquire more insight into precisely what is driving profits (Van Zyl *et al.*, 1993).

Figure 2.1 shows that profitability is directly dependent on revenue and cost. It further illustrates that revenue is defined by the relationship between product quantity and product price, while cost is defined by the relationship between resource quantity and resource price.

Van Zyl *et al.* (1993) stated that productivity, as shown in Figure 2.1, is the product quantity divided by the resource quantity. A business unit or economic sector can undergo productivity improvement when product quantity increases at a faster rate than resource quantity, and vice versa. All other factors held constant, productivity improvement will result in profit improvement.

Furthermore, the relationship between the product price and the resource price is known as the price-recovery relationship. Van Zyl *et al.* (1993) stated that when the product price increases at a faster rate than the resource price, the result is “price over-recovery”, which will result in increased profits if all other factors are held constant. On the other hand, “price under-recovery” occurs when the resource price increases at a faster rate than the product price, which will directly result in a decrease in profits if all other factors are held constant.

As mentioned, there are uncontrollable as well as controllable factors that underpin the profitability of an industry or business. Smith (2000) was of the opinion that within any class of wheat and across some wheat classes, production costs for any given producer are generally similar. Therefore, a producer’s varietal choice is to a large extent determined by expected yields and prices for each variety at the time of marketing (Smith, 2000). Smith (2000) further stated that wheat quality and wheat yields are highly correlated, although negatively. This makes wheat quality and the demands for such quality essential elements to consider when one is evaluating factors impacting the profitability and performance of an industry.

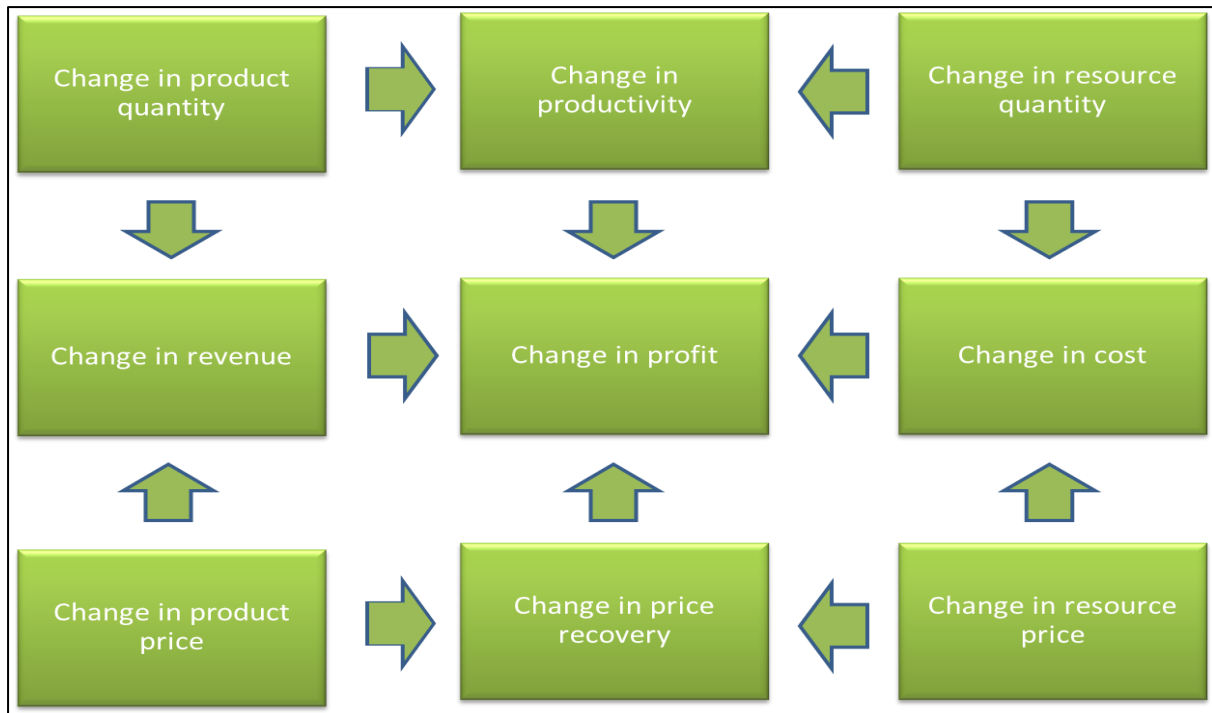


Figure 2.1: Factors driving profitability

Source: Van Zyl *et al.* (1993)

As discussed, the performance of an industry and the course taken to bring about improvements ultimately determine the long-term competitiveness of that specific industry (Van Zyl *et al.*, 1993). Porter (1990) stated that in the modern economy, prosperity is a nation's choice and competitiveness is no longer limited to those nations with a favourable inheritance. Nations choose prosperity if they organise their policies, laws and institutions around the notion of productivity. Nations choose poverty and limit their wealth if they allow their policies to erode the productivity of the business environment (Porter, 1990).

Traditionally, a nation's competitiveness has been explained in international trade theories originating with Adam Smith in 1776 and David Ricardo in 1817. According to Adam Smith's theory of absolute advantage, a country can enhance its prosperity if it specialises in producing goods and services in which it has an absolute advantage over other countries and import those goods and services in which it has an absolute cost disadvantage (Smit, 2010). Adam Smith viewed trade as a positive sum game, which is in contrast to the viewpoint of the traditional mercantilists of the 16th century that trade is a zero sum game. The theory of absolute advantage contradicted itself, however, in the sense that a country with an absolute advantage in all products or services would not import because it could produce everything

more efficiently. Krugman (1995) stated that Smith's theory excludes some countries from importing and thus also from the gains from trade. In terms of Smith's theory, it was believed that if countries wanted to become rich and powerful, they must export more and restrict imports to the minimum (Smit, 2010).

In 1817, Ricardo made a valuable contribution to Adam Smith's theory of absolute advantage by saying that even if a country is more efficient in producing all commodities, trade with a less efficient producing country can nevertheless be mutually beneficial. This is known as the Ricardian law of comparative advantage, which in short states that a country exports that commodity in which it has a comparative labour-productivity advantage. Cho and Moon (2002) were, however, of the opinion that this model is also flawed. Firstly, the model predicts an extreme level of specialisation, which in reality is not the case because countries produce many products, including import-competing products. Secondly, it explains trade based on differences in productivity levels between countries, but it does not explain why these differences exist (Cho and Moon, 2002, as cited by Esterhuizen, 2006).

Neo-classical trade theorists, such as Heckscher (1919), Ohlin (1933) and Samuelson (1941), have long influenced researchers to define competition in terms of comparative advantage—a notion that lends itself especially well to agriculture—with the relatively simplistic division of factor endowments among land, capital, and natural and human resources (Esterhuizen, 2006). After a thorough review of all the classical and neo-classical models, Esterhuizen (2006) came to the conclusion that these models are all fundamentally compatible and deliver the same conclusions as the central determinant of comparative advantage. They suggest that the pattern of national comparative advantage can best be measured by comparing production costs with product value, where non-traded goods and national resources are valued at domestic opportunity costs while tradable goods are valued at opportunity costs in trade. This theory is better known as the Heckscher-Ohlin theory.

According to Smit (2010), a number of empirical studies have been developed to verify the Heckscher-Ohlin theory. One of the first studies was conducted by Leontief in 1953. He found that, despite the general belief that the United States of America (USA) was expected to be an exporter of capital-intensive products and an importer of labour-intensive products, the result pointed to just the opposite. The Leontief Paradox led economists to look for alternative explanations to the Heckscher-Ohlin theory. The most important modifications of

this theory were the introduction of differences in human capital (Karvis, 1956; Kenen, 1965; Keesing, 1966; Baldwin, 1971; Bowen, 1985), the product cycle theory (Vernon, 1966) and the technology gap theories (Gurber, Metha and Vernon, 1967; Gold, 1981). These theories, however, did not undermine the validity of the Heckscher-Ohlin theory and were merely extensions. While it is generally accepted that these theories explain inter-industry trade sufficiently, they fail to explain intra-industry trade (Grubel and Lloyd, 1975).

To explain intra-industry trade, economists put forth a new set of trade theories that relax the assumptions of perfect competition and constant economies of scale. These new trade theories opened up the debate about government intervention as an active policy to advance the international competitiveness of a country (Smit, 2010). Such models worked well in the past when international trade and competitiveness were not as complex as they are today. No single theory is satisfactory and economists had to develop alternative theories which led to somewhat different measurement techniques. According to Esterhuizen (2006), new theories had to consider several important variables simultaneously. Porter (1990, 1998) was of a similar opinion, stating that comparative advantage rests on endowments of inputs, such as labour, natural resources and financial capital, which have become less and less valuable in an increasingly global economy. Michael Porter is widely regarded as the biggest contributor to competitive theory over the past two decades and a leading authority in the areas of: competitive strategy; the competitiveness and economic development of nations, states and regions; and the application of competitive principles to social problems in respect of health care, the environment and corporate responsibility. Porter (1990, 1998) developed his theories by questioning the ability of traditional trade theories to explain location advantages and the competitive advantage of nations.

The evolution of competitiveness-related theories from Adam Smith to Michael Porter is illustrated in Figure 2.2 which features the essential role players who have contributed to the development of economic theory in the area of competitiveness.

Adam Smith	<ul style="list-style-type: none"> • Trade theory—wealth is set by endowments (1776)
David Ricardo	<ul style="list-style-type: none"> • Comparative advantage (1817)
Heckscher-Ohlin	<ul style="list-style-type: none"> • Factor proportions theory (1877–1949)
Leontief	<ul style="list-style-type: none"> • The Leontief Paradox (1953)
Staffan Linder	<ul style="list-style-type: none"> • Overlapping demand (1961)
Raymond Vernon	<ul style="list-style-type: none"> • Product Cycle Theory (1966)
Krugman, Lancaster	<ul style="list-style-type: none"> • Economies of scale (1979)
Michael Porter	<ul style="list-style-type: none"> • Competitiveness theory—wealth is created by choices (1990)

Figure 2.2: The evolution of competitiveness theory

Source: Esterhuizen (2006)

2.2.1 Porter's diamond model

As mentioned, Porter (1990, 1998) argued that productivity—or the value created per day of work, per dollar of capital invested and per unit of the nation's physical resources employed—generates wealth. Porter (1990, 1998) further stated that the roots of productivity lie in the national and regional environment for competition, captured in a framework graphically depicted as a diamond made out of four primary facets. The diamond model, also known as “the diamond”, is widely regarded as the most inclusive interrelated framework for competitiveness, including almost every aspect relating to competitiveness. What makes competitiveness such an interesting topic—but also very challenging—is that no single policy or grand step can create competitiveness. All dimensions of a business environment must be addressed simultaneously to achieve any significant results (Porter, 1990). According to Porter (1990, 1998), the diamond addresses the information, incentives, infrastructure, and

pools of insight and skill in a location that support productivity and productivity growth in particular fields. These attributes include factor conditions, demand conditions, relating and supporting industries and firm strategy, structure and rivalry (also see Figure 2.2).

A nation's position in terms of **factor conditions** of production, such as skilled labour or infrastructure, is an essential element for competing in a given industry. Although the importance of these basic factors has been undervalued in recent times, they still play a crucial role in agriculture-based industries. In an agriculture-based industry such as the wheat industry, inherited and created factors of production make an equally important contribution to the competitive advantage of the industry.

The second broad determinant of national competitive advantage in an industry is **home demand conditions** for the industry's product or service. According to Porter (1990, 1998), home demand shapes the rate and character of improvement and innovation introduced by a nation's firms. Porter elaborated by stating that three broad attributes of home demand are significant. The composition of home demand is at the root of national advantage, while the size and pattern of growth of home demand can amplify this advantage by affecting behaviour, timing and motivation. The third way in which home demand conditions contribute is through a mechanism that enables a nation's domestic preferences to be transmitted to foreign markets.

According to Porter (1990, 1998), the third broad determinant of national competitive advantage in an industry is the presence, in the nation in question, of **supplier industries or related industries** that are internationally competitive. The presence of internationally-competitive supplier industries in a nation creates advantages in the downstream industries in several ways. However, foreign suppliers are rarely a complete substitute, which makes home-based suppliers an important ingredient in a nation's competitive advantage. Perhaps the most important benefit that home-based suppliers bring, according to Porter (1990, 1998), is the process of innovation and upgrading.

The fourth broad determinant of national competitive advantage in an industry is the context in which **firms are created, organised and managed as well as the nature of domestic rivalry** (Porter, 1990, 1998). The goals and strategies and the ways of engaging in business vary considerably between industries, while the pattern of domestic rivalry also plays a

profound role in the competitive advantage of firms. According to Porter (1990, 1998), the way in which firms are structured and managed depends largely on the national environment and no one managerial system is universally appropriate. Therefore, the national environment of each industry must be analysed to determine the most appropriate managerial system. This is very applicable to the wheat industry in South Africa which has shown very little innovation and improvement over the last two decades. The National Department of Agriculture (NDA, 2006) concurred with this view, stating that the millers or wheat buyers lack innovation—which can, according to Porter (1990, 1998), be attributed to the absence of vigorous domestic rivalry. Domestic rivalry will put pressure on firms to improve and innovate, thus pushing each other to lower costs, improve quality and services, and create new products and processes. Furthermore, Porter (1990) argued that intense domestic rivalry will push local firms to sharpen their advantage and to expand into exports, an outcome that is largely lacking in the South African wheat industry.

In addition, two outside variables are included in the diamond model (see Figure 2.3), namely the **role of chance** and the **role of government**. Chance events have little to do with the circumstances in a nation and more often than not are outside the control of, and cannot be influenced by, government or individual firms. Examples include new inventions, major new technologies such as biotechnology, and discontinuities in input costs such as the energy crisis, financial market shifts, foreign government decisions and wars. Such events have the ability to nullify competitive advantages and/or create new ones. The ability of an industry to respond to such changes will depend on the status of the other factors mentioned in the diamond model (Porter, 1990, as cited by Esterhuizen, 2006).

The second outside variable is the role of government and is best viewed in terms of its influence on the four determinants of competitiveness rather than as a separate entity. Porter (1990) warned that the role of government should be limited to creating an enabling environment so that companies can raise their aspirations and move to higher levels of competitive performance. Furthermore, Porter (1990) was of the opinion that government cannot create competitive industries; only companies can do that. Therefore, government's ability to amplify and transmit the forces of the diamond must be handled with care as it is very powerful.

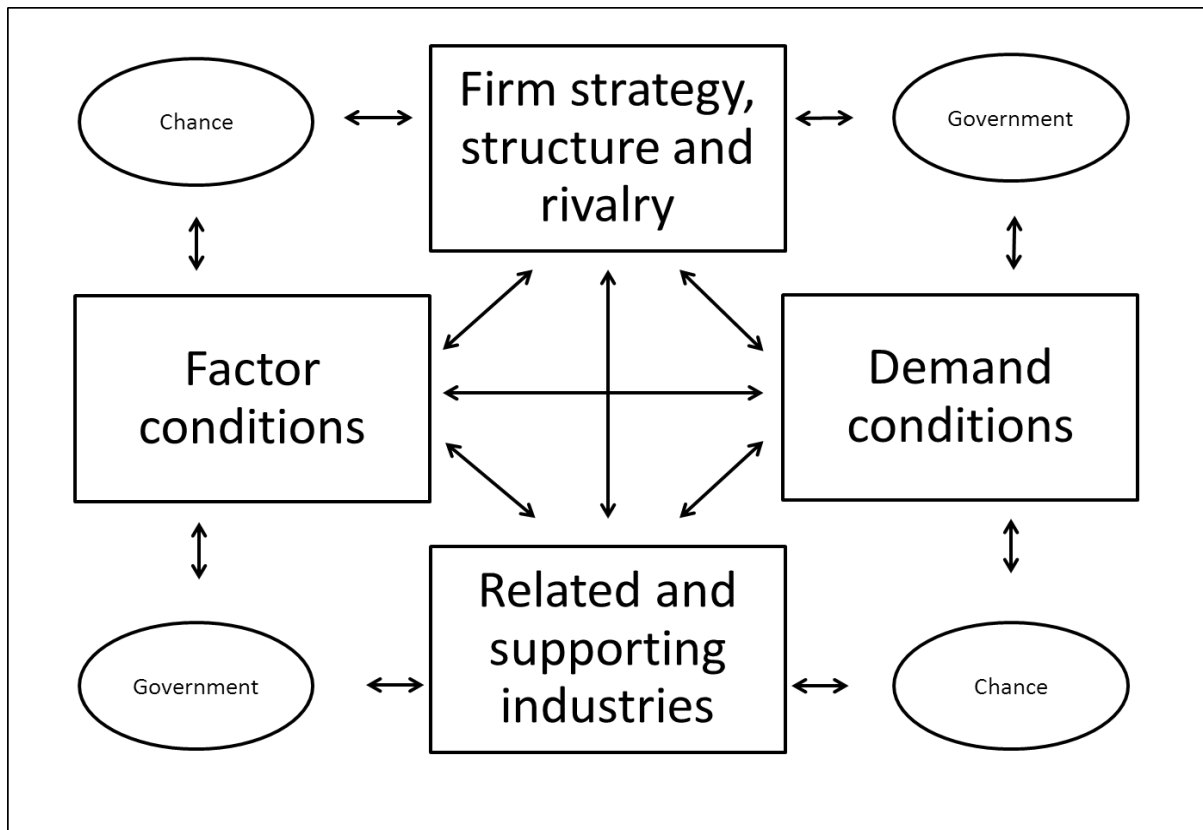


Figure 2.3: Porter's diamond model

Source: Esterhuizen (2006)

In an effort to develop a similar framework to that of Porter for measuring and analysing competitiveness in the agribusiness sector, Esterhuizen (2006) developed a five-step framework which is primarily based on Porter's (1990) work. The framework rests on the following questions:

- How is competitiveness defined and measured?
- How competitive is the South African agribusiness sector globally?
- What are the key success factors and the constraints impacting on the competitiveness of the South African agribusiness sector?
- How favourable is the decision-making environment in which South African agribusinesses operate?
- What strategies are needed to enhance the competitiveness of the South African agribusiness sector?

According to Esterhuizen (2006), by answering these questions it will be possible to explain the role played by the economic environment, institutions and policies in the competitive success of a sector in South Africa. Esterhuizen (2006) further explained that such an analysis will reveal the ability of each activity in a particular value chain to adapt to market changes and structures, and to produce and adopt technological innovations. It will also highlight each sector's access to capital and its capacity to obtain and retain a share of the international market. In short, these variables have the ability to measure and evaluate the efficiency, effectiveness and sustainability of a sector in South Africa.

Van Rooyen (2006) developed a framework with a view to determining the competitiveness of the flower industry in South Africa. Van Rooyen (2006) also went back to the basics, as provided by Porter (1990). In a similar vein to the previous study, Van Rooyen (2006) focused on the key questions—identified by Porter (1990)—that need to be answered if the competitiveness of an industry is to be determined and analysed. As a result, he arrived at the following objectives:

- To contextualise South Africa's position in the international environment;
- To assess growers' perceptions and marketing activities;
- To identify producers' problems and discuss means of overcoming them;
- To establish the extent to which South Africa and Australia are able to compete in the international flower industry;
- To indicate the extent to which South Africa and Australia are able to compete with each other.

By answering these questions, institutional and policy-related factors affecting the competitiveness and subsequently the performance of the wheat industry can be identified and analysed. However, the main question of this study relates to factors that can be influenced by a concentrated market. Therefore, market concentration and its possible effects on a market environment (through certain factors) must be fully understood.

2.3 Market concentration

As already discussed, a high degree of market concentration—which can be determined from the number and size of firms in a specific industry as well as the manner in which they conduct business—is present in the wheat industry in South Africa (Harkin, 2004). According to Harkin (2004), if concentration reaches a certain level, the actions of one or more of the few remaining firms can significantly affect prices for goods. A firm having this capability to affect prices (paid or received) possesses market power (Harkin, 2004). Harkin (2004) further stated that the process of firms growing and participating in mergers is usually described as consolidation. It is generally agreed that as consolidation increases, it will at some point bring about changes in the economic structure and functioning of markets in the particular sector. Extensive consolidation results in what is called concentration or economic concentration, the extent of which can be measured by economic formulas (Harkin, 2004).

High concentration levels typically raise concerns about the degradation of competition in an industry and the resulting welfare implications for upstream suppliers and downstream consumers (Stiegert and Carton, 1998). However, Stiegert and Carton (1998) were of the opinion that reshaping the nature of competition by increasing concentration is far more complex than suggested by the structure-performance link to increased market power. Increased concentration is also linked to economies of scale and technical efficiency improvements, which can drive the price of outputs down and the price of principal inputs up causing an increase in output (Stiegert and Carton, 1998).

Considerable concern has arisen over how consolidation and economic concentration in the food and agriculture sector is generating market power that negatively affects those participants in the sector who are not consolidated or concentrated, such as individual agricultural producers, production workers and consumers. With buyer concentration, more economic decision making, control and profit potential are transferred from the producer to the consolidated agricultural-processing and input industries (Harkin, 2004). Brester and Goodwin (1993) were, likewise, of the opinion that increased industry concentration in agricultural markets often increases the risk of large processors using their market power to adversely influence the prices paid to producers for the raw product, as well as the prices that are paid by consumers at the wholesale and retail levels.

Brester and Goodwin (1993) stated that in the wheat industry, a lack of competition may manifest in three different ways. First, the difference between the price that producers receive for wheat and the price that bakers pay for flour may be larger than that suggested by a competitive market. Second, a lack of competition may cause a breakdown in spatial price linkages. In other words, competitive activities are not ensuring that regional market prices differ by transportation costs only, assuming that such costs include risk and normal rates of return. Third, if oligopolistic wheat purchasers compete only within a limited geographical area, increased concentration may strengthen spatial price linkages if the firms pursue basing-point pricing practices (Brester and Goodwin, 1993).

In recent years, authorities in the USA have placed less emphasis on concentration, simply because it is hard to define the market in which concentration should be measured (Domina and Taylor, 2009). Domina and Taylor (2009) were further of the opinion that the mere difficulty in defining the market is not a sufficiently compelling reason to de-emphasise the dangers of concentration in markets. As a result, more emphasis has been given to market power. According to Domina and Taylor (2009), market power exists when one buyer or seller in a market has the ability to exert significant influence over the quantity of goods and services traded or the price at which they are sold. Market power does not exist when effective competition is present, but it does when there is a monopoly, monopsony or oligopoly present. These industries are used by economists as a reference to buyers who face an upwardly sloping supply curve (Domina and Taylor, 2009).

Domina and Taylor (2009) were of the view that market power abuses can squeeze farmers to the extent that income is drained from rural agricultural areas and moved to corporate financial centres. This has an adverse, multiplier effect on the rural economy. Farmers are impacted by supra-competitive (monopoly) prices charged by input suppliers, and by sub-competitive (monopsony) prices paid by purchasers of raw agricultural commodities. A very small percentage effect on prices can turn modest profits into debilitating losses for producers of agricultural products, and lead to money no longer flowing to rural areas (Domina and Taylor, 2009). Sekhar (2010) had a similar opinion, stating that the way in which a market is structured is intricately linked to the process of price formation. This, in turn, has implications for changes in the comparative advantage of a business or country.

In a similar vein, Howard (2009) stated that an important consequence of market concentration is that when it reaches a certain level, the largest firms have the ability to stop competing on the basis of price and ensure stable profits. According to Howard (2009), when four firms control in excess of 40 percent of the market, it can be regarded as non-competitive. Howard was further of the opinion that a number of agricultural input industries had exceeded this threshold in recent decades. It is estimated, for example, that the top four pesticide firms currently control 59 percent of the global market, and the top four seed firms control 56 percent of the global proprietary (e.g. brand name) seed market (Howard, 2009). He further stated that competition may remain fierce in areas such as advertising, and research and development, primarily because it can serve as an additional barrier to entry for other firms.

Howard (2009) stated that price and/or outputs constitute the primary reason why highly concentrated markets are mostly non-competitive. The recent dismantling of obstacles to large companies expanding is enabling them to expand horizontally, thus giving rise to horizontal integration. In addition, acquisition strategies are increasingly extending vertically (through multiple stages) and globally (into new markets). According to Howard (2009), the goal of vertical integration in the seed industry is to own both the research and development companies as well as the companies delivering the final product to customers. Howard (2009) was of the view that large, integrated firms can influence the market in a number of areas—such as changing national and international regulations—in ways that diminish the prospects for renewable agriculture.

Howard (2009) stated further that one way of slowing the process of consolidation would be through greater antitrust enforcement. Furthermore, ending the practice of granting patents on living organisms and boosting the efforts of farmers and non-farmer allies to resist agricultural treadmills might also serve as ways to slow the process of consolidation (Howard, 2009).

Similar to the situation in South Africa, Kazakhstan inherited a highly concentrated wheat market after the privatisation of its wheat marketing system (Petrick, Oshakbaev and Wandel, 2014). Petrick *et al.* (2014) stated that producers often complained about constraining factors that resulted in low producer prices. The first of these constraining factors was that primary wheat buyers (silo owners) mixed high-quality wheat with lower-

quality wheat and thus benefitted from an improved average quality. The second benefit for wheat buyers, at the expense of producers, was that they were able to obtain more wheat for less money. As a result, primary producers started to seek alternative markets for their produce. These alternative markets, according to Petrick *et al.* (2014), would sell directly to a grain mill or the export market. However, the use of such marketing channels was largely constrained by high transportation costs and non-tariff barriers in the case of exports to China (Petrick *et al.*, 2014).

In 2013, the President of Kazakhstan initiated the creation of the United Grain Holding (UGH) in response to persistent complaints from grain producers about low prices. The UGH was established with the sole purpose of being a consortium of actors in the grain market that must buy grain from farmers and then sell it on both domestic and external markets (Petrick *et al.*, 2014). It is expected that participants in the UGH will benefit from the preferential access to UGH grain purchases and from securing a share of the profits expected from grain sales. The real effects of this state-mandated marketing association remain to be seen as they will to a large extent depend on the circumstances surrounding implementation (Petrick *et al.*, 2014). Government policies to increase the competitive nature of the wheat industry are one of the methods that can possibly rectify uncompetitive behaviour.

The grains industry in Australia has developed a number of functions and activities to ensure that it operates efficiently in a deregulated market. Grain Trade Australia has a well-developed set of tools to assist in the facilitation of trade, and supports this with a communications and professional development programme to ensure all parties understand their obligations. According to AGEA (Australian Grain Exporters Association) (2009), the wheat industry arrangements should have the objective of developing a whole-of-industry, integrated approach, i.e. all sectors of the industry should work together.

Domina and Taylor (2009) stated that such corrective action is an urgent market need because concentration and integration risk will continue to drive food prices up, bringing an end to affordable food policies. It will also most likely contribute to a rapidly deteriorating agricultural rural economy. Concentration in too few corporate hands poses price, biosecurity and lack of redundancy risks to consumers, affecting competitiveness in the long run (Domina and Taylor, 2009).

2.4 Methods employed to determine performance

Frohberg and Hartman (1997) identified indicators that are able to measure the past performance of competitiveness of an industry or, in other words, the comparative advantage of the industry compared to other industries or nations. This element is, according to Porter (1990, 1998), an essential component in successfully determining the competitiveness of an industry. According to Frohberg and Hartman (1997), several approaches can be used to analyse the comparative advantage of an industry. The most frequently employed are: the real exchange rate, Foreign Direct Investment (FDI), and trade and market share indicators. These methods differ widely in their methodologies and data requirements. However, one indisputable and overarching characteristic of all the methodologies is that they provide relative measures, meaning that there must always be a comparison with a base value (Frohberg and Hartman, 1997). Latruffe (2010) was of a similar opinion, stating that competitiveness should be measured in terms of a benchmark as it is a relative measure.

2.4.1 Real exchange rate

The real exchange rate is a widely-used measure of competitiveness. This method is, however, at its most useful when attempts are made to determine the comparative advantage of an entire economy and not a sector or part of it. The real exchange rate is defined as the ratio of the price index of tradable commodities to that of non-tradable commodities. Although data are readily available for this measure, its main shortcoming is that it measures the price of demand, excluding many intermediate goods and factor prices (Frohberg and Hartman, 1997).

Although the real exchange rate is often used as a measure of international comparative advantage, an interpretation of the divergent movement of real exchange rates between countries is rather difficult. This is because these changes can be a reflection of, or the cause of, a change in international competitiveness (Frohberg and Hartman, 1997).

2.4.2 Foreign Direct Investment

FDI is regarded as a partial substitute for exports and a way of overcoming trade barriers in destination countries. Such investments often mirror the comparative advantage of the donor

country. They can also point to the comparative advantage of the recipient country, region or sector. On the other hand, the amount of FDI that a foreign country attracts is frequently seen as a sign of the relative competitiveness of that nation as a whole, rather than the sector or regions attracting the investment. It is thus extremely difficult to pinpoint the specific area that has a comparative advantage, as it can also serve as an overall indicator of the international competitiveness of the entire country (Frohberg and Hartman, 1997).

2.4.3 Trade and market share indicators

Although trade and market share indicators can be used to contrast the competitiveness of different regions, they were mainly designed for the purpose of international comparison and are usually calculated for single products or an aggregate of products (Frohberg and Hartman, 1997). Data used for these methods are mostly based on trade rather than on domestic market information. This has the advantage of considering supply and demand responses simultaneously. An added advantage of using trade data is that marketing and transport costs are taken into account (Frohberg and Hartman, 1997).

These indicators, however, can be very simplistic and therefore less appropriate. Because they are relative measures, indicators that compare one sector or industry with another must be used. According to Balassa (1989), Scott and Vollrath (1992) and Vollrath (1991), more sophisticated measures, which are more suitable for determining the international comparative advantage of an industry or sector, include the following: the Relative Export Advantage Index, the Relative Import Penetration Index and the Relative Trade Advantage Index.

Bernatonyte and Normantiene (2009) elaborated by saying that various methods can be used to establish the extent of foreign trade, including: the Balassa index, the Donges and Riedel index, the Hine and Greenaway method, and the Sapir method. However, the indicator of the Revealed Comparative Advantage (RCA) provides a more concise picture of foreign trade. The concept of RCA was first introduced by Liesner (1958), but was refined and popularised by Balassa and came to be known as the 'Balassa index' (Balassa, 1965). It has been widely used in empirical studies to identify a country's weak and strong export sectors by calculating the relative export performance of a country, sector or product (Batra and Khan, 2005).

In an attempt to calculate the export performance of India and China, Batra and Khan (2005) used an RCA method to determine the sectors that have a comparative trade advantage. The authors stated that movements in the RCA are due to economic structural change, improved world demand and trade specialisation. As a result, the RCA is defined as a country's share of world exports of a commodity divided by its share of total world exports. The advantage of using this index is that it considers the intrinsic advantages of a particular export commodity and is consistent with changes in an economy's relative factor endowment and productivity. This index, however, only considers the export—and neglects the import—advantage of a particular country or sector. An alternative method was therefore developed by Vollrath in 1991, called the Relative Trade Advantage (RTA). The RTA expands on the RCA by incorporating a Relative Import Advantage (RMA) index and subtracting it from the Relative Export Advantage (RXA) to arrive at the RTA index.

2.4.4 Relative Trade Advantage

By analysing the flow of trade as well as the sector where growth occurred through an RTA method, the comparative advantage of a specific sector in a specific country can be determined more accurately (Beratonyte and Normantiene, 2009). By using an RTA index and standard international trade classification, Beratonyte and Normantiene (2009) determined that the intra-industry trade share between the Baltic States and the European Union (EU) has been growing rapidly. Furthermore, in a comparison of measures to analyse comparative advantage, Bojnec and Ferto (2012) came to the conclusion that an RTA captures more stable, long-run structural features of a sector and economy than any other trade competition theory. Results from their study indicate that complementarities and consistencies in measures of relative comparative trade advantages and trade competition categories are clearly confirmed.

In an effort to analyse the competitiveness, productivity and efficiency of wheat production in Bulgaria, Aleksiev (2011) made use of an RTA index. From this analysis it was concluded that Bulgaria had a comparative advantage in wheat production and that the country's competitiveness had grown as the quantity and share of Bulgarian wheat had increased in the EU market. The main factor contributing to the success of Bulgaria in the grain market was the high level of efficiency in production. Both the level of productivity of input use and the

concentration of wheat production are contributing to the rise of production efficiency and the competitiveness of wheat in international markets (Aleksiev, 2011).

Similarly, in an effort to analyse the international competitiveness of South African agricultural exports relative to those of Argentina and Australia, Mosoma (2004) measured the competitiveness in terms of the RTA. From the results of this study it was concluded that South Africa's agricultural food chains are marginally competitive internationally, whereas Argentina's and Australia's agricultural food chains are internationally competitive (Mosoma, 2004). The study further found that competitiveness decreased in all three countries when moving from primary to processed products in the chains. This, according to the authors, implies that value-adding opportunities are limited and there is potential in certain agro-food chains for supply chain integration and co-operation (Mosoma, 2004). In an analysis to determine the competitiveness of South Africa's potato export industry, Chogo (2009) expressed a similar view to that of Mosoma (2004), stating that the potato chain in South Africa exhibited a negative trend in competitiveness when moving from primary to processed products. Additional results from the study pointed to the conclusion that the potato chain in South Africa is quite marginal as far as international competitiveness is concerned (Chogo, 2009).

As mentioned, it must be noted that a fundamental shortcoming of the RTA model is that it can only determine the comparative advantage of an industry or sector, and lacks the ability to identify factors explaining the current status (Frohberg and Hartman, 1997).

2.5 Methods to identify the specific factors that influence the performance of an industry

2.5.1 Policy Analysis Matrix

The Policy Analysis Matrix (PAM), as developed by Monke and Pearson (1989), was developed for computation of input-use efficiency in production, comparative advantage and degree of divergence between social and private costs (Basavaraj, Roa, Achoth and Reddy, 2013). The Domestic Resource Cost (DRC) ratio, calculated from the PAM, was and still is used in calculating the level of efficiency with which resources are used. Tsakok

(1990) stated that the DRC compares the opportunity costs of domestic production to the added value that it generates.

Basavaraj *et al.* (2013) stated that the PAM is essentially a product of two accounting identities: one defining profitability, which is the difference between revenues and costs, and the other measuring the effects of divergences (distorting policies and market failures), which constitute the difference between observed prices and the social prices that would exist if the divergences were removed. The PAM is presented in a table where the first row provides a measure of private profitability, which is defined as the difference between observed revenues and costs valued at actual market prices. This calculates the competitiveness of a commodity with the present technologies, output and inputs valued at the current market prices (Basavaraj *et al.*, 2013).

The second row in the matrix provides the social profitability, measured at social prices that reflect social opportunity costs. This measures the comparative advantage or efficiency of the system. A positive social profit indicates that the country uses its scarce resources efficiently and has a static comparative advantage in the production of that commodity at margin. On the other hand, a negative social profit indicates that the sector cannot sustain its current output without the assistance of government, resulting in waste or the inefficient use of resources (Basavaraj *et al.*, 2013).

According to Monke and Person (1989), the PAM can be used to investigate the following:

- The impact of policy on competitiveness and farm-level profits;
- The influence of investment policy on economic efficiency and comparative advantages; and
- The impact of agricultural research policy on changing technology.

PAM models are recognised as an important way of systematically analysing agricultural policies and market failures at a low computational cost. According to Zheng, Lambert, Wang and Wang (2013), PAM models have been used by many policy research institutions, including the International Forestry Resource and Institutions (IFRI), the Centre for

Agricultural and Rural Development (CARD), the Food and Agriculture Organization (FAO) and the World Bank (Zheng *et al.*, 2013).

2.5.2 Hedonic price models

Sekhar (2010) stated that the way in which a market is structured is inextricably linked to the process of price formation, which to a large extent determines the profitability and thus the performance of an industry (Smith, 2000). Therefore, factors that influence a commodity's price in the marketplace are of fundamental concern to competitive studies and agricultural market participants (Espinosa and Goodwin, 1991). Commodities are often of a heterogeneous nature, exhibiting differences in quality, variety and physical attributes (Espinosa and Goodwin, 1991). These fundamental forces operate in the marketplace to efficiently assign a price to a particular commodity that reflects the presence and quality of such attributes. Differential prices reflect the relative utility provided by a differentiated commodity's attributes. A commodity's market price is often viewed as being determined by some combination of implicit (or hedonic) prices which are assigned to individual attributes of the commodity (Espinosa and Goodwin, 1991).

Karaman, Cetin, Oguzlar and Yagdi (2008) stated that the attributes of wheat are an important factor for the grain milling industry sector when it comes to the demand created. The quality of wheat is generally determined by attributes such as protein content, hectolitre mass, falling number, etc. Karaman *et al.* stated that bread wheat has the defect of conversion (i.e. loses yield while quality improves) as a general characteristic. This situation (similar to the case of Turkey) results in there being an insufficient supply to meet the domestic demand in the South African wheat market. Required wheat for the South African grain milling industry is thus procured from foreign markets (Karaman *et al.*, 2008). The quality attributes of wheat in South Africa, the quality attributes of the imported wheat and the price formation in respect of quality attributes of wheat are considered to be of great importance (Karaman *et al.*, 2008).

According to Triplett (1986), hedonic models were developed and employed in price indexes long before their conceptual framework was understood. Although the origin of hedonic price analysis can be traced back to 1928, with Waugh publishing his pioneering paper on the quality factors influencing vegetable prices, Bartik (1987) stated that the first formal

contributions to hedonic price theory were those made by Court (1941) and Tinbergen (1951, 1956). Court (1941) allowed the use of marginal analysis while Tinbergen (1951, 1956) demonstrated the dependence of hedonic wage functions on the distributions of worker and firm characteristics and the parameters of utility and production functions. According to Bartik (1987), Tinbergen showed that utility and production function parameters may be recovered from estimated hedonic parameters assuming distributional and functional form. Lancaster (1966) developed a new approach to consumer theory and is regarded as one of the early contributors to this theory.

According to Karaman *et al.* (2008), the basic theoretical premise for hedonic price analysis was formulated by Rosen in 1974 in a model of pure competition of differentiated products. The application of hedonic price modelling techniques to agricultural commodity markets includes works by Ladd and Martin (1976), Perrin (1980), Ethridge and Davis (1982), Espinosa and Goodwin (1991), Nerlove (1995), and Misra and Bondurant (2000). More recent studies on hedonic price analysis as applied to agricultural commodities include works by Chavas and Kim (2005), Karaman *et al.* (2008), Suthamathy (2012) and Terfa, Haile, Baker and Kassie (2013).

Each of these applications of the hedonic price model by different authors will be described in more detail in the following subsections. However, it must be noted that the basic formulation of all these analyses is aimed at arriving at observations about prices of varieties of a differentiated commodity, units of which embody varying amounts of attributes or qualities (Nerlove, 1995).

2.5.2.1 Product differentiation in pure competition

Rosen (1974) sketched a model of product differentiation based on the hedonic hypothesis that goods are valued for their utility-bearing attributes or characteristics. Rosen (1974) stated that hedonic prices are defined as the implicit prices of attributes and are revealed to economic agents from observed prices of differentiated products and the specific amounts of characteristics associated with them. Econometrically, implicit prices are estimated by the first-step regression analysis in the construction of hedonic price indexes. The primary goal of the work done by Rosen (1974) was to exhibit a generating mechanism for the observations in the competitive case and use that structure to clarify the meaning and

interpretation of estimated implicit prices. According to Rosen (1974), this model can often identify the underlying structural parameters of interest.

Rosen examined how to estimate a consumer marginal bid function for characteristics of a commodity, given estimates of the commodity's hedonic price function. Rosen (1974) stated that the model itself amounts to a description of competitive equilibrium in a plane where buyers and sellers are located, and that the class of goods under consideration is described by n objectively-measured characteristics. Thus, any location on the plane is represented by a vector of coordinates $z = (z_1, z_2, \dots, z_n)$, with z_i measuring the amount of the i th characteristic contained in each good. Furthermore, products in the class are completely described by numerical values of z and offer buyers distinct packages of characteristics. The fact that products are differentiated implies that a large number of alternate packages are available (Rosen, 1974).

A price is defined at each point on the plane in terms of the contents of the amount of characteristics in each package; it therefore guides consumers' and producers' location choices regarding characteristics and packages sold and bought. The price is thus defined as a function of $p(z) = p(z_1, z_2, \dots, z_n)$. The economic content of the relationship between observed prices and observed characteristics becomes evident once price differences among goods are recognised as equalising differences for the alternative packages they embody. Price differences are generally only equalising on the margin and not on the average. Hence, Rosen (1974) came to the conclusion that estimated hedonic price characteristics functions typically identify neither demand nor supply. In fact, those observations are described by a joint envelope function and cannot by themselves identify the structure of consumer preferences or the producer technologies that generate them.

In the study, a feasible econometric procedure for estimating the underlying generating structure has been derived through the use of derivative transformation. When constraints are nonlinear, marginal prices serve the same role as average prices do in the linear case. Rosen further concluded that the essential spatial context of the problem means that substitution and income effects must be more carefully distinguished than usual (Rosen, 1974).

Both Rosen (1974) and Freeman (1979) analysed the estimation problem as a standard identification problem caused by demand and supply interaction. For any plane of observed characteristics z_i , the hedonic marginal price for a characteristic z_j is an estimate of both the marginal bid for z_j of the household purchasing z_i and the marginal offer for z_j of the firm producing z_i (Bartik, 1987). Linear versions of these marginal bid and marginal offer functions are:

$$\frac{\partial p}{\partial z_j}(Z_i) = W_{ij} = B_0 + B_1 Z_i + B_2 X_i + B_3 D_{oi} + e_{ij} \dots\dots\dots(1)$$

$$\frac{\partial p}{\partial z_j}(Z_i) = G_{ij} = A_0 + A_1 Z_i + A_2 S_{oi} + u_{ij} \dots\dots\dots(2)$$

Where:

$\frac{\partial p}{\partial z_j}(Z_i)$ is the estimated hedonic marginal price of characteristic z_j ;

W_{ij} is consumer i 's marginal bid for z_j ;

X_i is consumer expenditure on commodities other than Z ;

D_{oi} is a vector or plane of observed demander traits affecting the marginal bid;

G_{ij} is firm i 's marginal offer price for z_j ;

S_{oi} is a vector or plane of observed supplier traits affecting the marginal offer;

e_{ij} and u_{ij} are disturbance terms.

Rosen (1974) suggested that this equation system presents a “garden variety identification problem” which can be solved by simultaneous estimation methods, such as two-stage least squares. However, applying this function to the marginal bid function requires the assumption that individual supplier traits (S_{oi}) are appropriate instruments for the endogenous variables in the marginal bid function (Z_i and X_i).

2.5.2.2 Prices and demands for input characteristics

Ladd and Martin (1976) stated that for some analyses, it is adequate to assume product homogeneity, but the essence of some problems involves product heterogeneity. Among the latter are problems involving product differentiation, quality, and grades and standards. Ladd

and Martin (1976) suggested that in the case of heterogeneous products, a product must be viewed as a collection of characteristics. In their work, they applied the product characteristics approach to production inputs, taking product characteristics as the basic element. Showing similarities to the work of Rosen (1974), Ladd and Martin (1976) assumed the hypothesis that for each input purchased, the price paid equals the sum of products of marginal yield of characteristics and marginal implicit prices of characteristics. The testing of this hypothesis is simplified by assuming $\frac{\partial x_{jh}}{\partial v_{ih}} = x_{jih} = \text{constant}$. At the time of the study, data on product yields of characteristics, e.g. protein per bushel of yellow corn, thiamine per pound of steak, etc., treated yields of characteristics as constants.

Ladd and Martin (1976) argued that a multiple regression is one method of assigning monetary values to characteristics of inputs.

2.5.2.3 Various quality attributes of cotton lint and the impact on producer prices

Ethridge and Davis (1982) developed a hedonic price model which estimated the relative importance of various quality attributes of cotton lint by using regression analysis from sample data on observed sales of cotton. Similar to Rosen (1974), the authors used the hypothesis that goods are valued for their utility-bearing characteristics and that prices of goods vary with the specific amounts of those characteristics associated with them. The general purpose of their study was to present an approach to the estimation of hedonic prices for an agricultural commodity. The specific purpose was to determine how much various quality attributes contribute to the value of a bundle of cotton in which it is embodied.

In contrast to the assumption by Ladd and Martin (1976), Ethridge and Davis (1982) implied that the value of an embodied quality attribute may not be constant over time and must vary with the specific market due to market forces affecting demand and/or supply. The authors stated that the hedonic estimation process may then have to be adjusted for effects of changes in market forces over time when time-series data are used, and provide a means of comparison of hedonic prices at different points in time when cross-section data are employed. The approach also entails the use of generalised least squares estimation procedures to handle data problems, especially autocorrelation.

From the consideration of factors that are likely to impact on prices—excluding the market forces that affect general price levels and vary with time—the hedonic price model for cotton was estimated as: $P = h(G_1, G_2, \dots, G_n)$. This illustrates that price is a function of goods' utility-bearing characteristics and that prices of goods vary with the specific amounts of those characteristics associated with them. The model was estimated using both ordinary and generalised least squares. Generalised least squares were also used because possible autocorrelation problems were expected—both because this is common in time-series data in general and because the data tend to exhibit seasonal price patterns which give rise to autocorrelation (Ethridge and Davis, 1982).

From the Ethridge and Davis (1982) study it was concluded that many factors other than quality attributes affect producer cotton prices. It was found that producers have significant influence over the values associated with lot size and the standard deviation of micronaire readings within a lot of cotton through their approach to formulating mixed lots for sale. However, these two variables have the least relative impact on price. Further results indicated that producer prices were sensitive to variations in fibre length, micronaire and trash content. Differences in the relative importance and sensitivity between years were also revealed. Political decisions to support research in plant genetics and/or educational programmes as well as market information on the value of quality attributes are positive ways in which policy makers can help producers in the long term (Ethridge and Davis, 1982).

2.5.2.4 The estimation of demand parameters

Bartik (1987), however, was somewhat critical of these approaches, which are based on the work of Rosen, in that the hedonic estimation problem is not due to demand-supply interaction. Bartik (1987) stated that an individual consumer's decision cannot affect suppliers in the hedonic model because an individual consumer does not affect the hedonic price function. The nonlinearity of the hedonic price function allows the consumers to endogenously choose both quantities and marginal prices. Bartik (1987) illustrated the econometric problem by decomposing the disturbance term in the marginal bid equation in an unobserved component, “tastes” (D_{ui}), and a purely random component (r_{ij}). The equation thus becomes:

$$\frac{\partial p}{\partial z_j}(Z_i) = W_{ij} = B_0 + B_1Z_i + B_2X_i + B_3D_{oi} + D_{ui} + r_{ij} \dots\dots\dots(3)$$

Bartik stated that the ordinary least squares estimation of equation (3) will be biased because the household's choice of Z and X is correlated with the unobserved component in the disturbance term. Even with perfectly elastic supply, households can choose marginal prices, and the econometric problem persists (Bartik, 1987).

Bartik (1987) suggested an alternative instrumental variable approach in order to consistently estimate the marginal bid function with the correct instruments. He suggested that appropriate instrumental variables for this problem should exogenously shift the hedonic price function, which previously proposed instruments do not do. The practical problem for empirical hedonic research is finding instruments whose exogeneity can be defended with some plausibility (Bartik, 1987).

2.5.2.5 Various quality attributes of Kansas wheat and the impact on producer prices

Espinosa and Goodwin (1991) applied a hedonic price model to a cross-sectional time-series data set of Kansas wheat characteristics. The authors stated that the theoretical development of this model for understanding differentiated products draws heavily on work done by Lancaster (1966) and Rosen (1974). Wheat is an ideal example of a commodity that exhibits a wide array of characteristics that could influence the price. Wheat is generally characterised by attributes such as protein content, hectolitre mass, dockage and defects, and water content. In addition, less obvious characteristics, such as milling traits and physical dough properties, may also have an important effect on the price received by the producer (Espinosa and Goodwin, 1991).

According to Espinosa and Goodwin (1991), the general theory of hedonic prices has developed along two closely related lines. The first approach follows a consumer goods approach which considers each attribute to be utility providing in terms of a consumer's maximisation problem. The second approach views each attribute as an input in a productive process which is then demanded by processors because of the particular characteristics it possesses. The authors were of the opinion that in either case, a hedonic price function is yielded which expresses the price as a function of the attributes of the commodity.

Similar to the case of Ladd and Martin (1976), Espinosa and Goodwin (1991) assumed—in the development of the model—that the marginal implicit values of individual wheat characteristics are constant. Thus, the market level price for a particular bushel of wheat is determined by the linear sum of the marginal implicit values multiplied by the quantity or quality level of each characteristic. The relationship between wheat market prices and marginal implicit prices can be represented in the following linear sum:

$$P_{it} = \alpha_0 + \sum_{k=1}^m \beta_k Z_{itk} \dots\dots\dots (4)$$

Where:

P_{it} is the average price of wheat from the i th region in the year t ;

β_k s represent marginal implicit prices for the $k = 1, \dots, m$ wheat characteristics, as measured by the Z_{itk} s.

While most wheat characteristics are of a continuous nature, there are some characteristics that may be more accurately reflected through discrete measures. This is especially useful in the case of variables that exhibit an upper and/or lower limit (Espinosa and Goodwin, 1991).

According to Espinosa and Goodwin (1991), the estimation of empirical relationships that combine cross-sectional and time-series data can present special problems in econometric analyses. Owing to the nature of the price and characteristics data, the authors had to make special provision for possible unobserved effects common to each individual region represented in the cross-sectional unit, as well as any dynamic time-series effects that operate across years. In their analyses, they assumed that a varying intercept term will capture differences among cross-sectional units and therefore they amended the previous equation to include a variable intercept term:

$$P_{it} = \alpha_0 + \mu_i + \sum_{k=1}^m \beta_k Z_{itk} \dots\dots\dots (5)$$

Where:

P_{it} is the deflated price in region i in time t ;

$\alpha_0 = \alpha_0 + \mu_i$ is the intercept for the i th region;

α_0 is the mean intercept;

μ_i is the difference from this mean for the i th region.

Espinosa and Goodwin (1991) further stated that the appropriate econometric procedure for estimating the above-mentioned equation will depend largely on whether the cross-sectional effects are of a fixed or random nature. In their study, the standard Hausmann test revealed that the cross-sectional effects are of a fixed nature and that a series of regional dummy variables will be used to account for this fixed nature of cross-sectional effects. In addition, the authors stated that time-series data must be tested for heteroscedasticity which may be present in a panel of data. As a result, the authors utilised the Parks estimation procedure, which assumes that the residual errors for each cross-sectional unit are correlated over time and also allow for heteroscedasticity among the error terms among cross-sectional units. The Parks model is given by:

$$P_{it} = \alpha_0 + \sum_{k=1}^m \beta_k Z_{itk} + \sum_{i=1}^n \mu_i d_i + \mu_{it} \dots \dots \dots (6)$$

Where:

P_{it} is the deflated price;

d_i s are the regional dummy variables;

μ_{it} is allowed to follow a heteroscedastic first-order autocorrelation process:

$$E(\mu_{it}\mu_{jt}) = \sigma_{ij} \text{ for } i = j \text{ and } 0 \text{ otherwise,}$$

and

$$\mu_{it} = \rho\mu_{it-1} + e_{it}$$

In this analysis, the authors utilised the Parks estimation procedure for a consideration of hedonic prices in the Kansas wheat market.

Results from the above-mentioned study indicated that the standard grading characteristics as well as alternative end-use quality characteristics influenced the prices Kansas farmers received for their wheat at local and terminal elevators. The authors further concluded that

prices received by farmers were responsive to the included quality variables. Espinosa and Goodwin (1991) indicated that the results obtained in their study might be useful in addressing the efficiency of current grading and pricing practices for wheat. Although prices were responsive to differences in quality (indicating an efficient pricing system), the degree of efficiency was still called into question by standard grading characteristics displaying a degree of independence from end-use characteristics. In addition, several measures of wheat quality at the mill and bakery were not reflected in wheat prices. The authors suggested that a revision to the system of grades and standards be conducted to better reflect valued characteristics (Espinosa and Goodwin, 1991).

2.5.2.6 The market valuation of wheat quality characteristics

Uri and Hyberg (1996) conducted a similar study to determine whether the information on grain quality (with special reference to wheat) was used sufficiently in determining the price of exported wheat. The study set out to examine whether the grain quality factors identified—including test weight, dockage, moisture content, percentage of foreign material, percentage of broken and shrunk kernels, and protein content—influenced the price of exported wheat. Results from the study suggest that only the test weight and protein content are characteristics consistently valued by the market (Uri and Hyberg, 1996). Similar to the study conducted by Espinosa and Goodwin (1991), Uri and Hyberg (1996) suggested that the system of grades and standards must be revised to reflect the characteristics valued by the market.

2.5.2.7 Demand for wheat protein quantity and quality

In a study by Stiegert and Blanc (1997), which estimated the marginal value of wheat protein for Japanese imports, the theory of input characteristic demand was extended to consider the effect of non-contracted characteristics in the determination of the marginal value of contracted characteristics. In doing this, the authors were able to make definite statements about which end-use characteristics are important in defining the value of protein in quality-conscious markets.

The conceptual framework used in the work done by Stiegert and Blanc (1997) builds on the work of Ladd and Martin (1976) who extended the Lancaster characteristic demand model to derive the theory of characteristic demand for firm inputs. The extension of the Ladd and

Martin hedonic framework presented in their study imposed a physical linkage between the contracted characteristics and the non-contracted characteristics that they proxied.

Similar to the work of Espinosa and Goodwin (1991), the article by Stiegert and Blanc (1997) was estimated using the Parks generalised least squares (GLS) procedure, which assumes cross-sectional heteroscedasticity (with cross-sectional independence) and time-wise, first-order autocorrelation within each cross-section. Furthermore, the authors were of the opinion that because ordinary least squares violations of this nature are common in panel data analysis, the Parks procedure has become a fairly conventional estimation approach. The estimating model is specified by the following conceptual framework:

$$P = \gamma_0 + (\sum_{i=1}^n \gamma_i BIN_i) + (\beta_1 ASH + \beta_2 Color + \beta_3 Prot) + (\alpha_1 Stab * Prot + \alpha_2 Propn * Prot + \alpha_3 Abs * Prot) + \epsilon, \dots \dots \dots (7)$$

Where:

γ_0 is the intercept term;

ϵ is the error term with the usual properties.

In the first model, only the binary variables were used. The binary variables were introduced for Canada (CWRS), Australia (ASW), 13% hard red winter (HRW) and HRW ordinary. This model tested the hypothesis that individual wheat classes are not significant in determining prices. The authors did not introduce a binary term for U.S. dark northern spring (DNS) in order to avoid perfect multicollinearity. Therefore, each parameter is in reference to DNS wheat prices. In their results, the authors concluded that the hypothesis of model one was rejected as it only explained roughly half of the total price variability (for more detail regarding the tests used to determine this hypothesis, refer to Stiegert and Blanc, 1997).

In the second model, Stiegert and Blanc (1997) included the effects of flour colour, ash and protein. These three variables were also included as mean deviations from DNS prices. Similar to the first model, the authors rejected the hypothesis and concluded that the three additional variables did not fully explain the price differences between classes. In the third model, all the variables in the equation given above were included. The authors found that 93 percent of the variation in price could be explained by these variables. A fourth model, which

separated the terms in the proportional number ratio, explained 92 percent of the variation in prices (Stiegert and Blanc, 1997).

The authors further concluded that:

“Marketing wheat at the highest possible prices and volumes may depend critically on developing the quality characteristics these countries desire. As privatization takes hold in the global wheat marketing system, profit-seeking firms will not have current political allegiances or incentives to purchase wheat from any particular source. They will simply choose importers that provide the best quality at the lowest prices. Therefore, the challenge facing the U.S. wheat breeding and marketing system is to find efficient ways to compete in quantity and quality terms. A considerable research effort has shown that there are situations in which the benefits from providing clean wheat outweigh the costs in several regions worldwide. As the analysis in this article indicates, there are benefits to be derived in producing and internationally marketing wheat based on end-use characteristics.” (Stiegert and Blanc, 1997)

2.5.2.8 Bread wheat characteristics and the impact on prices

Karaman *et al.* (2008) applied a hedonic price model in an effort to determine the effects of the characteristics of bread wheat quality on the prices in the Turkish bread wheat market. Similar to the case of Ladd and Martin (1976), their study assumed that each characteristic of bread wheat is viewed as an input into a production process. This production function is assumed to be composed of the bread wheat characteristics as well as the other factors of production used in milling flour. According to the authors, it would then be possible to express the implicit price associated with each characteristic.

When assuming perfect market competition and a multi-product firm with independent production functions, the formal production function can be presented as:

$q_y = f(z_{1y}, \dots, z_{ny})$, q_y is the quantity of output y ;
 z_{jy} is the quantity of input characteristic j .

Derived from this production function, the hedonic price function as used by Karaman *et al.* (2008) can be illustrated by:

$$p_{xi} = \sum_{j=1}^n \beta_j z_{ij} \dots \dots \dots (8)$$

Where:

p_{xi} is the given price of input xi ;

β_j is the marginal value product of a unit of the j th characteristic used in producing y ;

z_{ij} is the marginal yield of characteristic j from the i th input in producing y .

In their attempt to determine the most important variables that might have an effect on the change in price, the authors conducted interviews with Turkish millers. The interviews were complemented by a review of the literature. Accordingly, the authors collected data on the following characteristics of bread wheat: hectolitre mass, test weight, sedimentation, wet-gluten content of the wheat flour, foreign material, other grain ingredients and wheat of other classes. An ordinary least square was then estimated for the five regions within Turkey where wheat was produced. Diagnostic tests included a Jarque-Berra test for normally distributed series data, a White test for heteroscedasticity and a Klien's rule test for multicollinearity. From the results of the study it was concluded that the included variables explained approximately 45 percent of the variation in price.

According to the results of the study conducted by Karaman *et al.* (2008), hectolitre mass and sedimentation are the factors that have the greatest effect and influence on the Turkish bread wheat market when it comes to quality aspects. The study further showed that the five regions in Turkey that are prominent in bread wheat production display differences in terms of bread wheat quality characteristics (Karaman *et al.*, 2008).

When assuming that the price of a product is the sum of all the values that a specific product possesses, factors influencing the change in price can easily be identified and analysed. Hedonic price models, which are primarily based on this assumption, will thus serve as an appropriate model when attempting to identify and analyse factors that have an influence on the performance of an industry through price-related differences.

2.6 Methods to determine the impact on the performance of an industry

The next objective of this study is to determine the extent of the impact of concentration in the marketplace on the financial performance of wheat producers in South Africa. In order to accomplish this, impact analyses/methodologies must be reviewed. According to Taljaard (2007), impact analysis is a means of empirically estimating the consequences of an exogenous change/shock on the economy or sector/industry in particular. Cloete (2010) stated that impact analysis can provide interested parties with information on how much employment, income, taxes, etc. a specific industry could generate or lose within a specific economy.

According to Adeyemo, Wise and Brent (2011), these models are primarily used to interrogate the possible effects (intended and unintended) that a new policy, programme or project will have on the socio-ecological system prior to its introduction. According to Adeyemo *et al.* (2011), the type of methodology used will depend on the type of policy, programme or project, the temporal and spatial scales of the analysis, the nature of the system and issues being investigated, and the purpose of the analysis. The authors were furthermore of the opinion that partial and general equilibrium models are the more popular approaches when evaluating the implications of projects at a macroeconomic level.

Taljaard (2007) stated that impact analysis is normally focused in two directions—firstly, the impact of other activities on the industry under investigation, and secondly, the impact of that specific industry on other industries. Similarly, Hussain and Buland (2006) stated that impact analysis models, which are based on the input-output frameworks, estimate economic impacts in two directions. These directions occur through forward and backward linkages in the economy. Backward linkages include purchased inputs, supplies and services. Forward linkages include further value-added economic activities, such as preparation and processing (Hussain and Buland, 2006). According to the author, by going beyond measuring direct impacts only, these models provide a more thorough representation of the economic effects of impacts.

According to Hussain, Jafri, Buland and Randals (2003), as cited by Cloete (2010), the most frequently-used impact analysis methods include input-output models and Social Accounting

Matrix (SAM) based models, such as the general and partial equilibrium models, and multiplier analysis. Buysse, Van Huylenbroeck and Lauwers. (2007) stated that mathematical programming models are a good alternative to these models. Furthermore, Preckel, Harrington and Dubman (2002) were of the opinion that an advantage of using these methods is that the computational power of mathematical programming (MP) allows much greater disaggregation for the analysis. The following section will thus present a review of the most frequently-used economic impact methodologies.

2.6.1 Input-output analysis

According to Vischio (2010), input-output modelling is one of the more commonly used and widely accepted methods of assessing the economic impacts of disruptive events that can be caused by concentrated markets. The author stated that this model's popularity can be ascribed to the fact that it provides a concise and accurate means of describing the relationship between sectors and its acceptance stems from the fact that its theories have been established for centuries. The first input-output analysis model, as it is known today, was developed by Wassily Leontief in the 1930s. Conningarth Economists (2013) stated that the basic structure of an input-output table is based on the same framework as Leontief's (1936) original statistical input-output table. However, early forms of the model were already developed by as early as the 18th century by a number of French authors (Vischio, 2010). Vischio (2010) further stated that these models were developed on the premise that the production of outputs requires inputs.

Today the information in input-output analysis concerns the flows of products from each industrial sector considered to be a producer to each sector considered to be consumers (Townsend, 1997). This information from which an input-output model is developed is placed in an inter-industry transaction table. The models therefore present a database with which to analyse the local economy (Cloete, 2010). According to Conningarth Economists (2013), the input-output table is an economic tool from which a system of national accounts is extended, classified and depicted in a tabular format. Input-output tables serve as the basis for a broad and rapidly-developing economic practice called input-output analysis. Currently different variations of the table are applicable to different situations. In most instances, an official authority compiles a standard input-output table for a particular country. In the case of South Africa, this is done by Statistics South Africa. The input-output table makes

provision for two kinds of transaction on a sectoral level, namely the purchase of intermediate and primary inputs, on the one hand, and the supply of intermediate and final outputs, on the other hand (Conningarth Economists, 2013).

Because of its ability to be modified to represent many different economic scales, input-output analysis is a very popular model among researchers. Input-output tables can be created to represent a city, province or country's economy (Vischio, 2010). Conningarth Economists (2013) stated that researchers usually remodel the official input-output table for a specific purpose.

Contributing to the popularity of the input-output analysis is its ability to explain inter-sectoral economic relationships within an economy, whether regional or national (Taljaard, 2007). By contrast, Midmore (1991), as cited by Cloete (2010), stated that an input-output analysis has three major weaknesses:

- The model relies on linear, average relationships;
- The model prevents substitution between inputs in productive processes but assumes that inputs are perfectly elastic in supply;
- Most national input-output tables are published infrequently, which is a serious drawback for the capability of the model.

Owing to shortcomings in this model, other methods are used more frequently. This will be discussed in more detail in the following sections.

2.6.2 SAM-based macroeconomic models

To evaluate the implications of policies, programmes and projects at a macroeconomic level, partial and general equilibrium modelling approaches—which are mostly based on a SAM database—are often utilised (Boulangera and Bréchet, 2005). The Partial Equilibrium (PE) methodology concentrates on a particular subsection of the economy, with all other variables treated as exogenous to the model (Adeyemo *et al.*, 2011). General Equilibrium (GE) models, on the other hand, are developed with the aim of describing the entire economic system by capturing not only the direct impact of policy, programme or project shock on the relevant

market, but also the impact on other areas of the economy (O'Toole and Matthews, 2002, as cited by Adeyemo, 2011).

Given the relatively narrow focus of a PE model, it is usually possible to model the particular industry associated with the chosen commodity in much greater detail than is possible with a GE model. PE models can provide valuable insight when it is possible to realistically isolate a system from its broader, global context. The PE models therefore focus more on a sub-economic system and ignore the larger, economy-wide effects, making it useful for contextual argumentation. GE models are subsequently more complicated and accurate in that they recognise, understand and communicate the complex interdependencies of industries.

Ferris (1998) stated that PE models can be classified as either dynamic or static models. Static models tend to be more transparent when looking at structural parameters and provide insight into how policies, programmes and projects affect a nation's agriculture. Static PE models generally refer to a single time period, the duration of which depends on the degree of fixity assumed in factor markets, from the treatment of technical change and from the reliability of behavioural parameters following significant changes in the exogenous variable (Conforti, 2001, as cited by De Beer, 2009). De Beer (2009) was furthermore of the opinion that static models are often used to generate projections of impacts at some future point in time. An artificial future dataset, also known as a baseline, is constructed by making assumptions about the growth of exogenous variables and parameters, and by subsequently letting the model solve an equilibrium that is consistent with the assumptions made (Van Tongeren, Meijl and Surry, 2001).

In dynamic models, the definition of several reference periods is frequently used for simulations, as this offers researchers the chance to take the adjustment of endogenous variables into account (Conforti, 2001, as cited by De Beer, 2009). Van Tongeren *et al.* (2001) were of the opinion that dynamic models allow the analysis of lagged transmission and adjustment processes over time. Unlike static models, dynamic models can therefore be used to trace the accumulation of stock variables as well as generate alternative endogenous growth rates. De Beer stated that dynamic features can be incorporated into equilibrium models in several ways, with the most frequent approach being to specify a recursive sequence of temporary equilibria. Recursive dynamics, however, do not ensure time-

consistent behaviour, but are usually synonymous with using rational expectation assumptions (De Beer, 2009).

Because the focus of this study is to determine the impact of competitiveness on the SAWI, the study is more focused on one commodity in a specific industry, which makes the application of a PE model ideal. As mentioned, the PE model will allow the study to model the impact of this project on the South African wheat industry in much greater detail. Conforti (2001) supported this by stating that analyses within the agricultural sector lend themselves more to PE models as agriculture is a relatively small economic sector with limited competition for factor use between it and other industries, particularly as far as land is concerned.

2.6.3 Social Accounting Matrix (SAM)

When the analysis of transactions within an economy is expanded to include the whole economy and its linkages, the original input-output transaction matrix can be set in the wider accounting framework of a Social Accounting Matrix (SAM) (Cloete, 2010). As mentioned, transactions within most macroeconomic models are based on the linkages created by a SAM database. Taljaard (2007) stated that a SAM is, in a sense, similar to an input-output table but with additional aspects built in. The SAM database is usually sourced from input-output tables, national income statistics, and household income and expenditure statistics. Adeyemo *et al.* (2011) held a similar view, stating that the SAM is an extension of conventional input-output tables. A SAM is a comprehensive, economy-wide database in the form of a matrix which contains information about the flows of resources between the different economic agents that exist within an economy during a given period of time. The accurate and consistent development of the SAM is pivotal to any analysis based on PE models, as the SAM provides a framework in which the activities of all economic agents are accentuated and properly identified (Adeyemo *et al.*, 2011).

Round (1981) identified a SAM as:

“... a matrix representation of transactions in a socio-economic system. It is a comprehensive, flexible, and disaggregated framework which elaborates and articulates the generation of income by activities of production and the distribution and redistribution of

income between social and institutional groups. A principal objective of compiling a SAM is, therefore, to reflect various interdependencies in the socio-economic system as a whole by recording, as comprehensively as possible, the actual and imputed transactions and transfers between various agents in the system.”

In short, Round (1981) defined the SAM as a single-entry accounting system where each macroeconomic account is represented by a column for expenditure payments and a row for income receipts. Cloete (2009) stated that King (1985) held the same view as he defined a SAM as nothing more than double-entry bookkeeping in accounting, with a series of accounts in which income and expenditure must balance in each case.

McDonald and Punt (2004), as cited by Cloete (2010), elaborated by highlighting two basic and important distinctions between a SAM and a conventional input-output table: the SAM captures the full circular flow, whereas the input-output table captures only part thereof. The input-output table does not record details of the interactions in factor markets, i.e. there is no functional link between activities and institutions via factor markets. Input-output tables also do not record the transactions between the various institutions in an economic system, or between the various components of an economic system and the rest of the world, with the exception of commodity transactions (McDonald and Punt, 2004, as cited by Cloete, 2010).

However, Zhu, Kim and Harris (2009) stated that when researchers or policy makers are interested in only economic impacts from production restrictions, there is no need to look into modified multipliers. The authors further suggested that linear mathematical programming is a useful and efficient tool for deriving modified multipliers and estimating correct regional impact from policy changes.

2.6.4 Mathematical programming

Mathematical programming has become an important and widely-used tool for analyses in agriculture and economics. The basic motivation for using programming methods in agricultural economic analysis is straightforward because the fundamental economic problem is making the best use of limited resources (Mills, 1984, as cited by Buysse *et al.*, 2007). Buysse *et al.* (2007) were therefore of the opinion that the use of optimisation models is a perfect fit with the neoclassical economic theory which perceives economic agents as

optimisers. The use of programming models can, however, also capture elements of other basic economic theories, such as the new institutional transactions cost theory which assumes that agents minimise their transaction costs. A final, and probably the most important, advantage of using mathematical programming is the close link between model elements and real world constraints, thus enhancing the comprehensibility of the model and the results for policy makers. As such, mathematical programming can be seen as a communication-facilitating instrument for the various stakeholders in a changing policy environment—in particular, the farmer and the policy maker (Fernagut *et al.*, 2004, as cited by Buysse *et al.*, 2007).

2.6.4.1 A simple linear model

The development of linear programming has been ranked among the most important scientific advances of the mid-20th century. According to Hillier and Lieberman (2001), its impact since 1950 has been extraordinary. Today a major proportion of all scientific computation is devoted to the use of linear programming. Linear programming uses a mathematical model to describe the problem of concern (Hillier and Lieberman, 2001). The adjective, “linear”, means that all the mathematical functions in this model are required to be linear functions. The word “programming” does not refer to computer programming but is rather a synonym for planning. Thus, linear programming essentially involves the planning activities to obtain an optimal result among all feasible alternatives (Hillier and Lieberman, 2001).

In its simplest form, linear programming is a method of determining a profit-maximising combination of enterprises that is feasible with respect to a set of fixed constraints (Hazell and Norton, 1986). Early applications of linear programming in farm planning assumed profit-maximising behaviour, a single-period planning horizon (no growth) and a certain environment (no uncertainty about prices, yields, and so forth). There have been many subsequent developments that have permitted the construction of more flexible and realistic models (Hazell and Norton, 1986).

When applying this model to a farming situation, Hazell and Norton (1986) stated that certain fundamental requirements must be specified. These include:

- Alternative farm activities, their unit of measurement, their resource requirements and any specific constraints that are not covered by the aforementioned;
- Fixed resource constraints of the farm;
- Forecasted activity returns net of variable costs—also known as gross margin.

Hazell and Norton (1986) further stated that the problem can be mathematically introduced by the following notation:

$$\max Z = \sum_{j=1}^n c_j X_j \dots\dots\dots (9)$$

Where:

X_j = the level of the j th farm activity, such as the hectares of wheat grown. Let n denote the number of possible activities; then $j = 1$ to n ;

c_j = the forecasted gross margin of a unit of the j th activity (e.g. Rand per ton);

a_{ij} = the quantity of the i th resource (e.g. hectares of land or days of labour) required to produce one unit of the j th activity. Let m denote the number of resources; then $i = 1$ to m ;

b_i = the amount of the i th resource available (e.g. hectares of land or days of labour).

Such that:

$$\sum_{j=1}^n a_{ij} X_j \leq b_i, \quad \text{all } i = 1 \text{ to } m$$

and

$$X_j \geq 0, \quad \text{all } j = 1 \text{ to } n$$

The aim of the equation as stipulated above is to find the set of activities that has the largest possible total gross margin (represented by Z), but which does not violate any of the fixed resource constraints or involve any negative activity levels. According to Hazell and Norton (1986), this problem is known as the primal linear programming problem.

Buyse *et al.* (2007) were of a similar opinion, stating that the solution of this primal model gives information from which activities should be chosen to maximise the gross margin.

However, the primal model provides no information on how to increase the gross margin by acquiring additional resources i , better known as the shadow cost of the resources.

Buyse *et al.* (2007) further stated that in order to calculate these shadow prices for the fixed resources, the dual problem can be used. By using this method, two problems can be solved at once, namely the primal resource allocation problem and the dual resource valuation problem. Buyse *et al.* (2007), as well as Hazell and Norton (1986), were of the opinion that the study of duality is very important in mathematical programming because duality increases insight into mathematical programming solution interpretation. The dual problem can be stated as follows:

$$\min W = \sum_i b_i \lambda_i \dots\dots\dots (10)$$

Subject to:

$$\sum_i a_{ij} \lambda_i \geq c_j$$

and:

$$\lambda_j \geq 0$$

The shadow costs λ_j found by the dual problem correspond with the Lagrange multipliers that are used in the first-order optimality conditions of the primal mathematical programming model. Duality is, for comprehensibility reasons, illustrated here for linear mathematical programming models, but it applies to non-linear models as well (Hazell and Norton, 1986, as cited by Buyse *et al.*, 2007).

Felix, Judith, Jonathan and Munashe (2013) were of the opinion that businesses have saved thousands of dollars by using LP models in their planning processes because they consider a wide range of situations, allowing for optimisation of profit or environmental outcomes. Scarpari and Beauclair (2010) held a similar view, stating that optimised agricultural planning through an LP model is a fundamental activity in recent business profitability because it can increase the returns from an operation with low additional costs.

In modelling the problem of planning a farming system within a world where environmental considerations are increasing, Felix *et al.* (2013) employed an LP model to a small farm livelihood system in Zimbabwe. The main objective of their study was to identify the best cropping and machinery options which were both profitable and resulted in improvements to the environment, depending upon the farm situation of market prices, potential crop yields, and soil and weather characteristics. As a result, Felix *et al.* (2013) developed an LP model that reflected these choices, selecting a combination of farm activities that was feasible (given a number of fixed farm constraints) and that maximised income while achieving other goals, such as food security. Felix *et al.* (2013) stated that the gross income increased by an estimated 44.6 percent when an LP model was implemented, instead of the traditional method of planning. They concluded by saying that the LP model is a superior method of planning compared to traditional planning methods (Felix *et al.*, 2013). Scarpari and Beauclair (2010) supported this by stating that an optimised planning LP model is a very useful tool for sugarcane management.

2.6.4.2 Dynamic linear programming

As mentioned earlier, in order to practically apply an LP model, a set of feasible mathematical equations must be specified and solved. However, the time-dependent processes of farming systems necessitate a more dynamic approach to modelling. Therefore, accurately describing these systems without including an element of time will be nearly impossible (Louw, Van Schalkwyk, Grovè and Taljaard, 2007). It is therefore necessary in some LP analyses to make explicit allowance for the peculiar influence of time on the structure of the system under study. Of the many ways in which this may be achieved, the so-called “multi-stage” or “dynamic” linear programming (DLP) provides a more adequate, analytical description of whole farm situations over time when compared to most other methods (Throsby, 1962). The initial aim of these models was to provide farmers and policy makers with a holistic (whole farm) answer to practical farm problems (Louw *et al.*, 2007).

Kennedy (1981) stated that some of the earliest considerations of DLP model application with agricultural examples were given by Agrawal and Heady (1972), Burt and Allison (1963), and Burt (1965). However, within regional spatial modelling, the use of DLP has been limited by computer capacity and it is only in recent years that it has become both

possible and practical to embed several DLP whole farm models in a spatial framework and to solve these models in a reasonable time (Louw *et al.*, 2007).

In more recent efforts to develop a DLP model to analyse the effects of different limiting factors on the conversion process of farms over time, Acs, Berentsen and Huirne (2006) showed that conversion to organic farming is more profitable than staying with conventional methods. Results from their study show that a two percent drop in organic prices lowers the labour income of the farmer and makes conversion less profitable than conventional farming. For farmers, a minimum labour income can be required to “survive” (Acs *et al.*, 2006). Furthermore, Hacıyev (2012) employed a DLP model in an effort to optimise investment at a mill factory. According to Hacıyev (2012), a DLP model is one of the most effective models to employ when setting out to prioritise investment decisions.

Louw *et al.* (2007) stated that DLP is an extremely useful tool in simulating the farm system and analysing “what if” questions. As a result of the possibilities that can be realised through DLP, Louw and Van Schalkwyk (1998) developed the first microcomputer whole farm linear planning model in South Africa, called OPTIMA. The objective of OPTIMA was to establish a holistic, user-friendly farm-planning model to contribute to improved farm planning, extension and the formulation of agricultural policy. During 2000, the basic model was converted from spreadsheet to algebraic formulation. This increased the capacity and flexibility of the model substantially. Louw *et al.* (2007) used this model to simulate the market risk, water management and multiplier effects of irrigation agriculture in the Northern Cape of South Africa. Results showed that a decrease of 20 percent in the price of table grapes reduced the return on capital investment from 37.4% to around 18.5% (reduction of more than 50% in net farm income). This represents a significant decrease in profitability for farmers.

In a similar study, Grovè (2009) aimed to develop models and procedures that would allow water managers to evaluate the impact of alternative water conservation and demand management principles on irrigated agriculture in the long run and the short run, while taking risk into account. One of the specific objectives of the study conducted by Grovè (2009) was to develop a generalised, whole farm, stochastic DLP model to evaluate the impact of price incentives to conserve water when irrigators have the option of adopting more efficient irrigation technology or cultivating high-value crops in the long run. The functionality and

accuracy of a DLP model resulted in the model being preferred over other, similar models. In conclusion, Grovè (2009) stated that the elasticity of irrigation water demand was low, and that risk aversion and individual farming situations will have an important impact on the effectiveness of water tariff increases when it comes to water conservation.

2.7 Conclusion

In this chapter an attempt was made to explain the concept of performance and to show the link to competitiveness. Coupled with this was a detailed discussion on what market concentration is and what the possible effects can be on the performance of a competitive market. Appropriate methods to analyse and evaluate the performance of an industry were subsequently discussed. However, before specific methodologies can be identified to determine and evaluate the performance of the wheat industry in South Africa, it is essential to determine the current market, institutional and policy environment, both globally and locally. The structure and conduct of these markets can to a large extent explain the current competitive status of the wheat industry in South Africa, which will assist in identifying the most appropriate models to be applied in attempting to determine the potential impact of concentration.

Chapter 3

Global Wheat Industry Overview

3.1 Background

The agricultural sector has achieved a great deal since the latter part of the 20th century. Since 1960, the world's population has more than doubled, while real per capita income has nearly doubled (Pardey, 2010). Over the same period, the total production of cereals has grown faster than the population, largely due to unprecedented increases in crop yields. Pardey (2010) stated that the improvement in agricultural productivity is the main reason why the world has not yet experienced a devastating food crisis.

However, a different picture emerges in the global wheat industry, with wheat production having generally failed to keep pace with the growth in the world's population (Pardey, 2010). This productivity slowdown has been preceded by a reduction in the rate of growth in agricultural research and development spending in many countries, as well as a shift away from farm productivity-oriented research and development in at least some of the largest research systems of the world (Pardey, 2010). Aleksiev (2011) was of the opinion that these tendencies have been accompanied by institutional interventions from the bigger participants in grain trade.

To gain a better understanding of this rapidly changing global environment, which plays a decisive role in the South African wheat industry, it is necessary to understand who the major role players in the global wheat market are, as well as what factors could influence their performance and competitiveness. In this chapter, an attempt will therefore be made to identify the major role players in the global wheat market and to give an overview of the structure of their local market. In addition, an effort will be made to determine the resulting competitive state of these countries using a Relative Trade Advantage method.

3.2 Historic development of the global wheat industry

Marchildon (2010) stated that the study of wheat trade provides a spectacular illustration of the effect of globalisation in terms of progressive market integration. For instance, in the second half of the 19th century, Britain and other countries in Europe became more industrialised, which resulted in a growing dependency on imported wheat as bread made from wheat flour became the staple food for most European Union (EU) workers (Marchildon, 2010). The growth in wheat trade encouraged expansion and development of new wheat-growing areas in other parts of the world where soil and climatic conditions were conducive, particularly in the United States of America (USA), Canada, Argentina and Australia. This growth in wheat trade was, according to Marchildon (2010), accompanied by lower trade costs and a more facilitative commercial, monetary and foreign policy environment.

In the 19th century, however, steam-powered trains were introduced which revolutionised the transportation industry, reducing transportation costs of bulk items such as wheat, by a considerable margin. At the same time, the plains and the pampas of the Americas and Australia were opened to new settlers, resulting in wheat becoming a key export commodity (Marchildon, 2010). The low cost of production in these “new” settled lands, coupled with relatively open trade, facilitated even more specialisation in manufacturing—all at the expense of wheat production in the EU. Increased world wheat production resulted in global prices going into a downward spiral. According to Marchildon (2010), the downward spiral in prices was ultimately reversed by significant wheat shortages in the face of continued droughts in North America, poor harvests in other major producing countries, and the dislocation and destruction caused by World War II.

With the recovery in wheat prices, greater harmony was achieved in the wheat trading environment. However, Marchildon (2010) noted that this unfortunately did not mean a more globalised wheat trade regime. Instead, as far as the global wheat trade was concerned, protectionism and managed trade became the dominant features of post-war prosperity. Domestic agricultural support in advanced industrial countries became a permanent part of the policy landscape, while managed trade agreements—such as the Canadian-British Wheat Agreement of 1946 and the International Wheat Agreement of 1949 (involving the USA,

Canada, Australia, France and Uruguay)—shaped the direction of wheat trade (Marchildon, 2010).

In the latter part of the 1980s and early 1990s, a wheat export subsidy competition ensued between the USA and the EU. The USA used the Export Enhancement Program while the EU subsidised exports through restitution (subsidy) payments for exports. Although the EU continues to subsidise exports, the subsidies have declined in recent years and are currently relatively small (Sekhar, 2010). Major wheat-importing countries such as Egypt have liberalised imports, allowing private imports which have allowed large grain trading companies to expand their influence in many other countries. These changes have made international wheat trade relatively more market-oriented in recent years (Sekhar, 2010).

Although the wheat trading industry has undergone changes in recent years, Sekhar (2010) expressed the view that agriculture is still one of the most distorted sectors in international trade, often characterised (in the developed countries) by high levels of both domestic and export subsidies. Sekhar further stated that the main objective of implementing these interventions is to provide income support to producers. Although these interventions are ineffective in meeting the stated objectives (Johnson 1991; Hertel and Keeney, 2006), the policies in question are likely to prevail for some time into the future—particularly in the USA and EU (OECD, 2005).

3.3 Major role players in global wheat trade

According to Sekhar (2010), the USA is the world's largest wheat exporter, with an average global share of 35 percent (in quantity terms) and 33 percent (in value terms) during the period 1960-2003. It is followed by Canada (19 percent and 20 percent), Australia (12 percent and 12 percent) and Argentina (6 percent and 5 percent). The average aggregate share of all four exporters during this period was 71 percent (in quantity terms) and 70 percent (in value terms). Including other major exporters (such as the EU), they collectively accounted for about 80 percent of world wheat exports during the period. Excluding Argentina and the EU, the aggregate share of the three traditional exporters was about 66 percent and 65 percent in quantity and value terms, respectively (Sekhar, 2010).

During 2013, the USA—exporting an estimated 32.9 million tonnes—was still considered to be the largest global role player in terms of wheat exports, while the EU, Canada, France, Australia, Russia and Germany were also regarded as major role players in the wheat export market (see Figure 3.1).

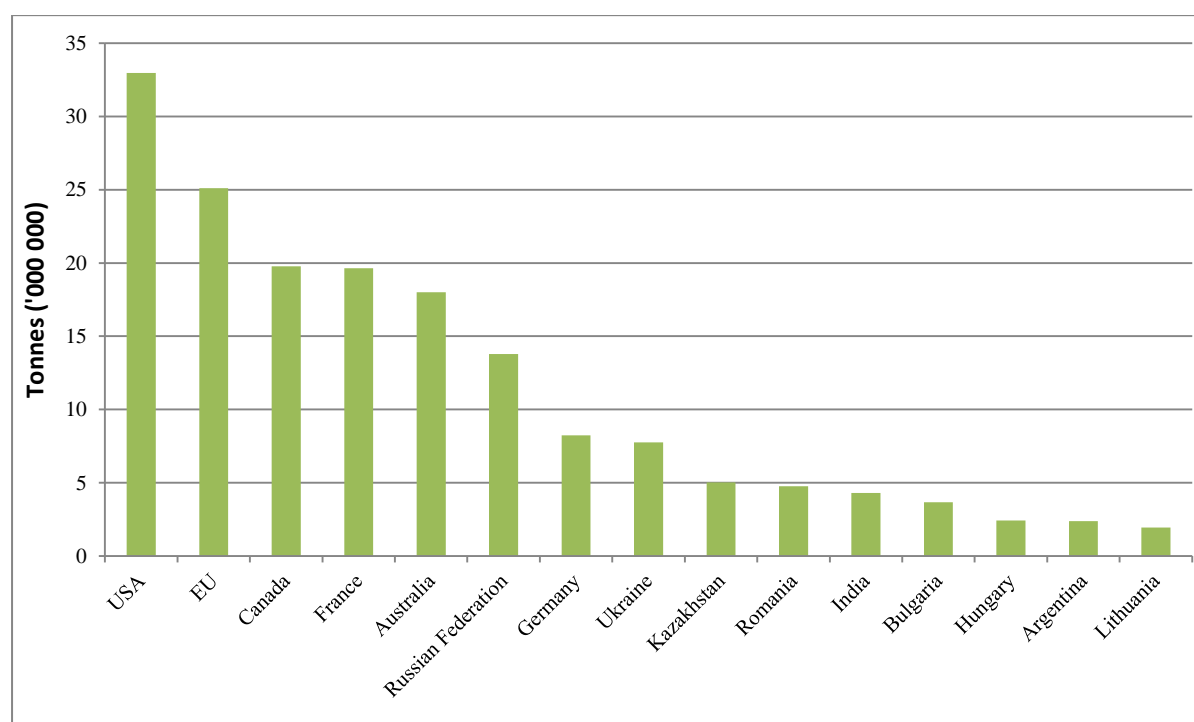


Figure 3.1: Major wheat-exporting countries in 2013

Source: Comtrade (2015)

Egypt has been the world's largest wheat importer for many years (Sekhar, 2010). However, Egypt's wheat imports showed a sharp drop in 2013 as the country struggled through a political and economic crisis (Alsiasi, 2015). This is also reflected in Figure 3.2 where it can be seen that Egypt does not even feature in the top 15 wheat-importing countries. Countries that are now considered to be the major wheat importers include Brazil (7.2 million tonnes), Indonesia (6.7 million tonnes), Algeria (6.3 million tonnes), Japan (6.1 million tonnes) and Italy (5.8 million tonnes). China is another major importer of wheat; however, China's wheat imports have fluctuated considerably over the last two decades due to shifts in government policy (Sekhar, 2010). Because the global import demand is much less concentrated than export supplies, many countries can afford to import smaller quantities (Sekhar, 2010). By comparison, South Africa is a relatively small importer, having imported only 1.4 million tonnes of wheat in 2013. It is interesting to note that countries such as Brazil and Germany,

which are regarded as major wheat-importing countries, are also exporting a large amount of wheat annually.

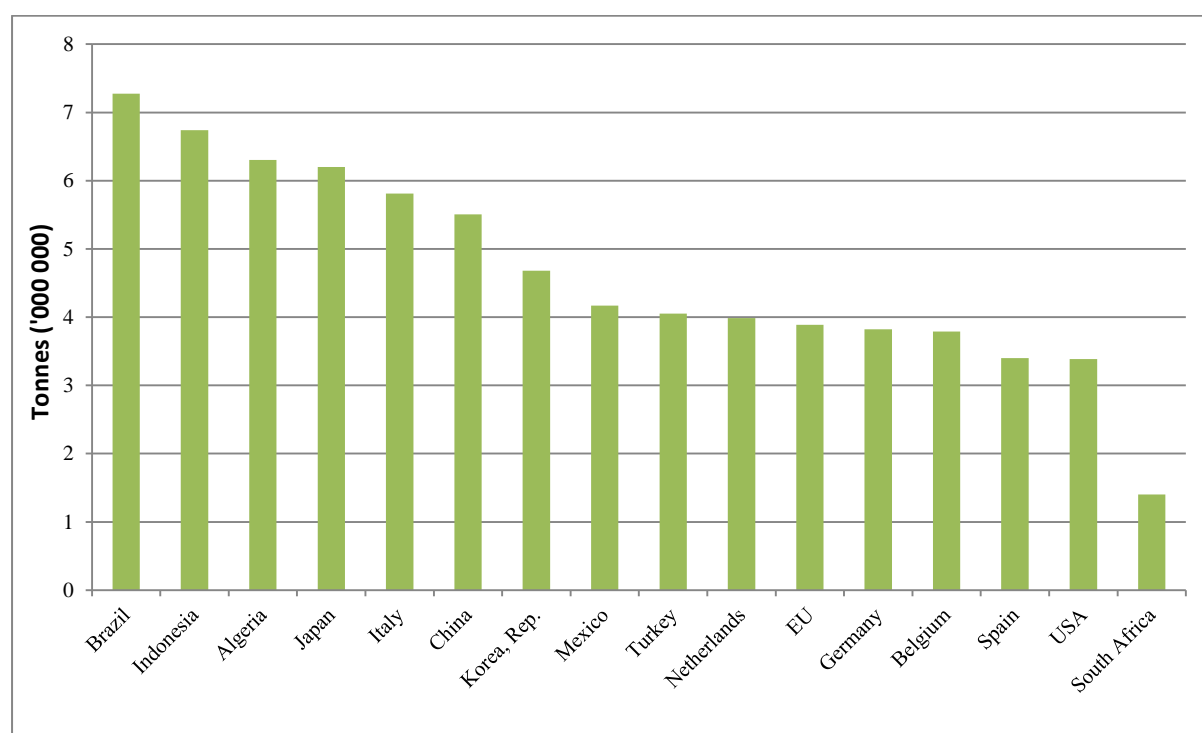


Figure 3.2: Major wheat-importing countries in 2013

Source: Comtrade (2015)

3.4 Performance of the major role players in the global wheat industry

3.4.1 Global wheat production

Combined global wheat production showed a gradual increase from 1990 to 2015 and is projected to reach an all-time high of 725 million tonnes in 2014/2015 (Figure 3.3). Although global wheat stocks surpassed the 200 million tonne mark in 2009/2010, they decreased to 181 million tonnes in 2013/2014. Decreasing global stocks are usually associated with higher producer prices triggered by supply and demand factors. However, the number bounced back to 198 million tonnes in 2014/2015.

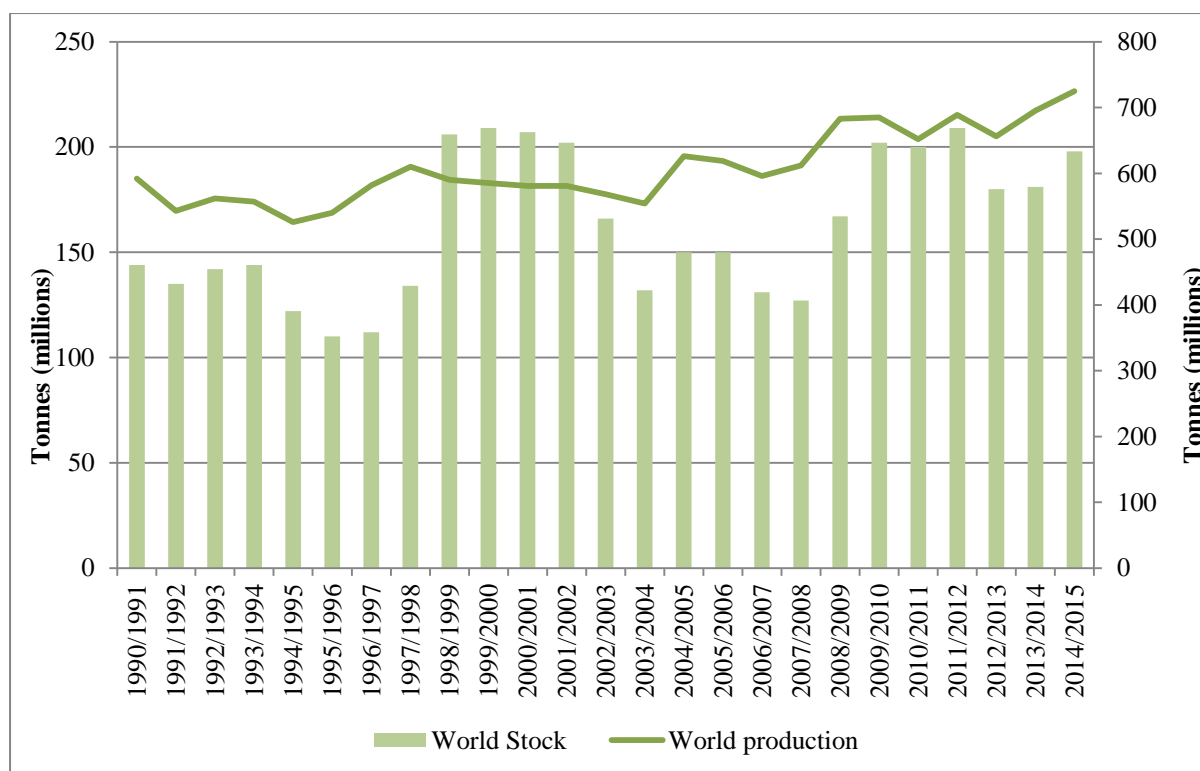


Figure 3.3: World wheat stock and production (1990/91 to 2014/15)

Source: SAGIS (2015)

As can be seen in Figure 3.4, China (120 million tonnes), India (91 million tonnes) and the USA (58 million tonnes) were regarded as the main role players in terms of wheat production in 2011–2013¹. By comparison, South Africa is a relatively small player in the world market, with approximately 1.93 million tonnes of produce in 2011–2013. Also depicted in Figure 3.4 is the average annual growth rate of production from 1990–1992 to 2011–2013. Uruguay (17.18 percent) had by far the highest average annual growth rate in production over the period. When compared to the global average annual growth rate of 0.91 (not shown), production growth in South Africa showed a below average annual growth rate of 0.55 percent over the period in question. The USA (-0.49 percent), Canada (-0.19 percent) and Argentina (-0.05 percent) were the only countries examined that reported negative average annual growth rates in production over the given period.

¹ An average period of three years was used in an attempt to reduce the effect of annual variations in uncontrollable factors such as climatic conditions.

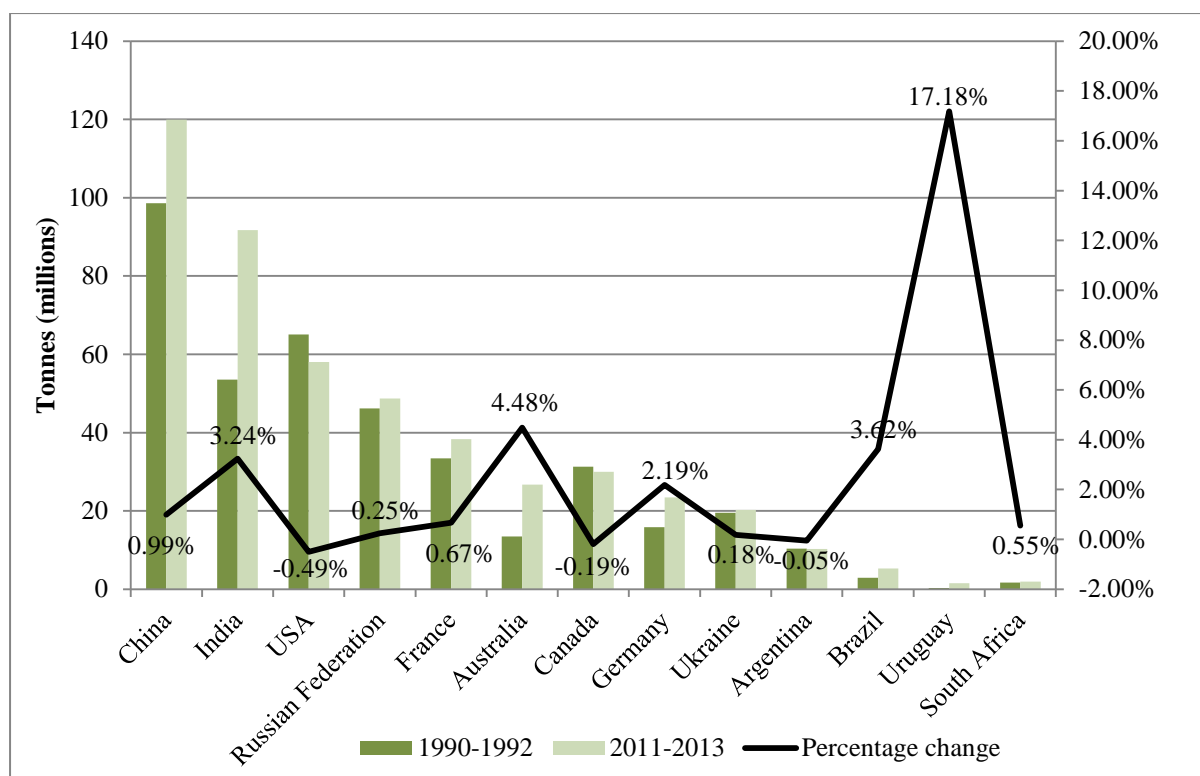


Figure 3.4: Wheat production per selected country and percentage change (1990–92 to 2011–13)

Source: FAO (2015)

Figure 3.5 depicts the number of hectares utilised for wheat production by major players in the global wheat industry, as well as the average annual percentage growth rate between 1990–1992 and 2011–2013. As can be seen, India (29.5 million ha), the Russian Federation (23.1 million ha) and China (24.1 million ha) had the most wheat hectares harvested in 2011–2013, while South Africa (545 233 hectares) is again regarded as a relatively small player in the global wheat market.

However, when examining the average annual percentage growth rate from 1990–1992 to 2011–2013, Uruguay (10.67 percent) and Australia (2.89 percent) had the highest average annual percentage growth rate in hectares utilised for wheat production. Figure 3.5 also reveals that the average annual percentage growth rate of wheat hectares harvested in South Africa (-2.56 percent) and Canada (-1.47 percent) declined the most, while the world average annual percentage growth rate (not shown) stayed relatively constant at -0.1 percent.

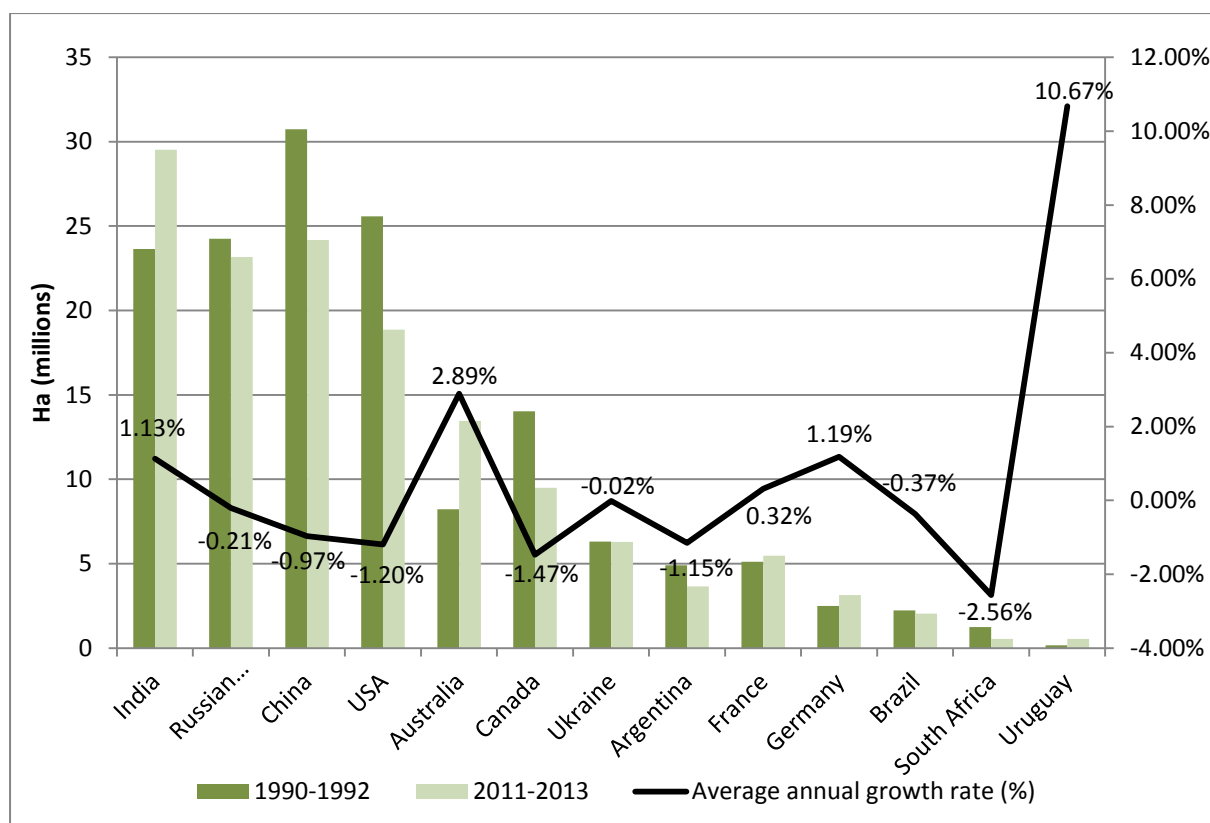


Figure 3.5: Wheat hectares harvested by peer countries and annual percentage growth rate (1990–92 to 2011–13)

Source: FAO (2015)

The fact that the number of hectares designated for wheat production has remained relatively constant on a global scale since 1990–1992, coupled with a growing global population and thus growing demand, shifts the focus towards a higher need for productivity. Figure 3.6 depicts the average wheat yield for major wheat-producing countries from 1990–1992 to 2011–2013. The average percentage growth rate from 1990–1992 to 2011–2013 is also included as it is a good indicator of the productivity of wheat production in each country over the last decade. The global average wheat yield in 2011–2013 was 3.09 tonnes per hectare (not shown), while countries such as Germany (7.45 tonnes per hectare) and France (7.01 tonnes per hectare) had significantly higher yields by comparison. In this period, Australia (1.98 tonnes per hectare) and the Russian Federation (2.09 tonnes per hectare) realised the lowest yields compared with peer countries. South Africa had an above average yield of 3.56 tonnes per hectare in 2011–2013.

As can be seen in Figure 3.6, the average annual percentage growth rate in wheat yields in South Africa (6.61 percent) was by far the highest, with Brazil (4.04 percent) and China (2.48 percent) also achieving significant growth rates. It is interesting to note that all three of these countries realised a decline in the number of hectares utilised for wheat production (see Figure 3.5). On the strength of this, it can be argued that one of the main reasons for the significant growth in yields in these countries is the fact that marginal land is taken out of production. This boosts the suitability of the natural resources, thus increasing the average annual yields—although the productivity of the cultivar does not necessarily improve.

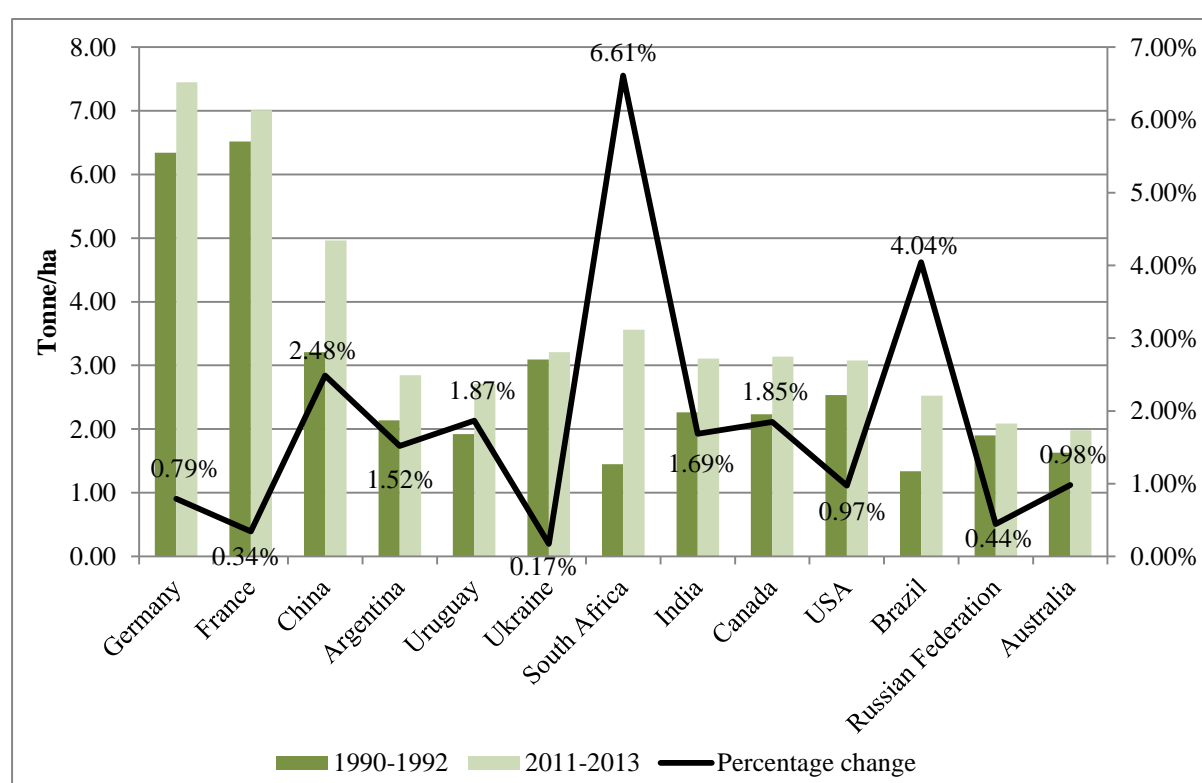


Figure 3.6: Wheat yields in peer countries and annual percentage growth rate (1990–92 to 2011–13)

Source: FAO (2015)

3.4.2 Global wheat consumption

Similar to the case of global wheat production, global wheat consumption (i.e. demand) also showed an overall increasing trend from 1991/1992 to 2014/2015. According to SAGIS (2015), global wheat consumption is projected to be 715 million tonnes in 2014/2015 (see Figure 3.7). It is interesting to note that global wheat trade, which is also shown in Figure 3.7,

will increase from 92 million tonnes in 1991/1992 to a projected 160 million tonnes in 2014/2015. This clearly reflects the increasing effect of globalisation and ease of trade worldwide. The increasing effect of globalisation will have a significant impact on the SAWI as it is reliant on imports to sustain local demand. This, coupled with the fact that South African wheat prices are determined by the import parity price, further reinforces the important role of the global environment for the SAWI.

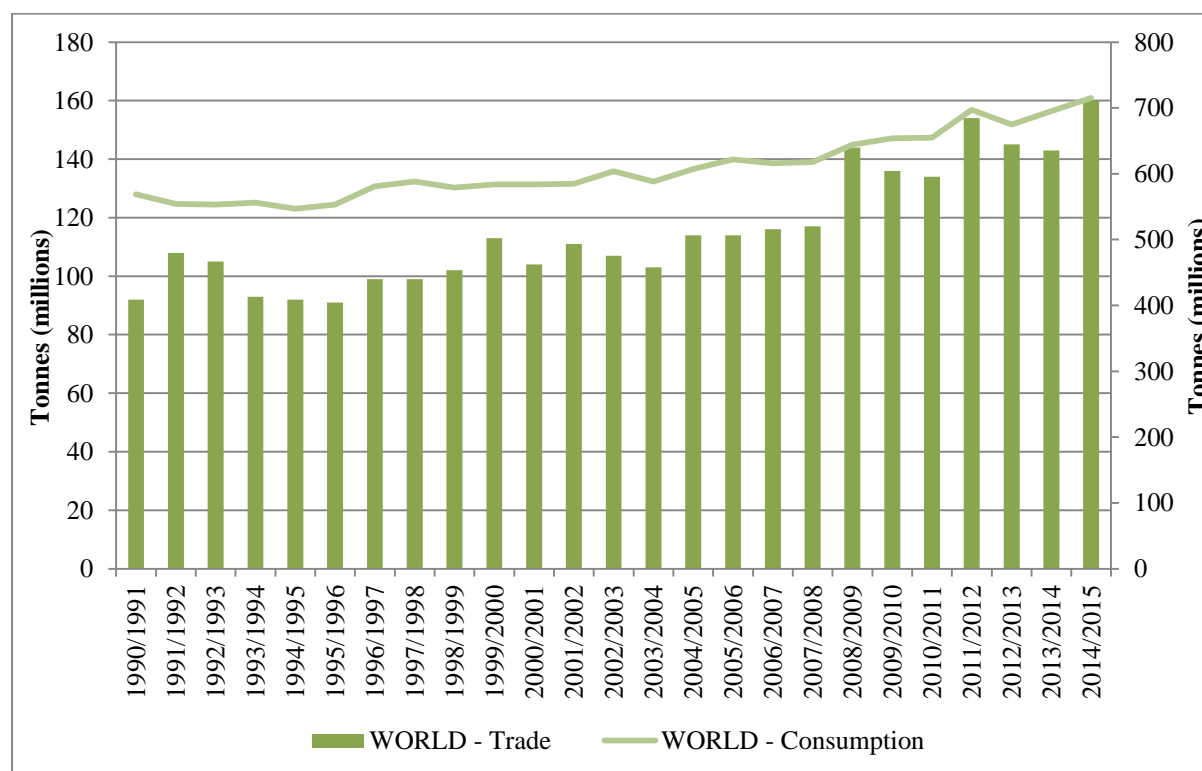


Figure 3.7: World wheat trade and consumption (1990/91 to 2014/15)

Source: SAGIS (2015)

3.5 Competitive status of the SAWI compared to global trading partners

Against the backdrop of the changing global environment, which plays a decisive role in the South African wheat industry, efforts must be made to determine the resulting competitive status of the countries in question. In order to accomplish this, a Relative Trade Advantage (RTA) was used to illustrate the current state of competitiveness of the upstream segment of the South African wheat industry compared to other segments and international competitors.

The trade performance of individual commodities can indicate the performance of different supply chains in different countries in the sense that each commodity's trade pattern reflects relative market costs as well as differences in non-price competitive factors, such as government policies (Vollrath, 1991). Following on from this, it is necessary to determine how successful the sector has been in selling its products over time in the local and global markets, relative to competitors. The RTA method makes provision for competitiveness to be measured under real world conditions—such as uneven economic “playing fields”, distorted economies and varying trade regimes—and is therefore the best suited for measuring the competitive status (Vollrath, 1991).

3.5.1 Model development

The RTA is calculated as the difference between relative export advantage (RXA) and relative import advantage (RMA), and is formulated as follows:

$$RTA_{iv} = RXA_{iv} - RMA_{iv} \dots\dots\dots(1)$$

Where for (n+v) countries and (m+i) products:

$$RXA_{iv} = [X_{iv}/X_{in}]/[X_{mv}/X_{mn}] \dots\dots\dots(2)$$

$$RMA_{iv} = [M_{iv}/M_{in}]/[M_{mv}/M_{mn}] \dots\dots\dots(3)$$

Where:

X represents exports;

M represents imports;

i is a country;

n is a specific country.

3.5.2 Data requirements

As mentioned, the RTA is a relative measure and must be compared to a base value. Thus, to determine the competitive status of the SAWI, it is necessary to establish how successful each section of the supply chain has been in trading its products, relative to the other sections. This approach is designed to identify the section(s) of the supply chain that is/are not competitive.

To this end, import and export data are needed for each section of the chain, with the product in each section of the chain representing that section. For instance, wheat will represent the unprocessed section of the wheat supply chain; wheat flour the semi-processed section; and pasta, bread and pastry the processed section.

To be able to compare performance with that of international peers, the RTAs for Argentina, Brazil, Australia, Canada, Germany and the USA were also calculated. Trade data (import and export values) from 1992 to 2012—drawn from the United Nations' Comtrade database—were used to determine changes in the competitive status of the SAWI and international peers, respectively.

3.5.3 Results from the RTA

The results show the RTA indexes for wheat, wheat flour, pasta, bread and pastry as representative of the competitiveness of the unprocessed, semi-processed and processed industries. Table 3.1 depicts the RTA indexes of unprocessed wheat in all the mentioned countries.

Negative values signify a lack of competitiveness and zero values signify marginal competitiveness, while positive values provide an indication of wheat or wheat products that can be regarded as competitive compared to those of international peers. Similar tables (not shown) are constructed for the semi-processed and processed industries.

Table 3.1: RTA indexes of unprocessed wheat

	Argentina	Australia	Brazil	Canada	Germany	South Africa	USA
1992		4.02		4.16	0.17	-0.68	1.46
1993	10.09	7.02	-0.01	2.81	0.09	-1.83	1.89
1994	12.48	9.97	-0.04	4.17	0.32	-1.03	2.13
1995	8.39	6.86	-0.03	4.09	0.24	-1.64	2.55
1996	9.82	12.75	-4.36	3.93	0.28	-1.71	2.46
1997	10.97	14.87	-4.06	4.86	0.31	-0.48	1.65
1998	16.36	13.42	-4.92	4.16	0.46	-0.79	1.78
1999	20.11	15.01	-6.20	3.43	0.35	-0.55	1.90
2000	14.48	13.20	-5.80	3.41	0.30	-0.97	1.74
2001	16.41	12.67	-5.54	3.43	0.41	0.12	1.73
2002	18.03	12.34	-6.23	2.74	0.34	-0.79	1.97
2003	14.82	7.24	-7.97	2.99	0.21	-1.09	2.41
2004	11.10	14.55	-3.63	3.69	0.22	-1.48	2.85
2005	16.83	10.62	-4.08	3.27	0.23	-1.49	2.64
2006	13.44	10.07	-5.06	4.33	0.26	-1.04	2.14
2007	10.31	4.58	-4.17	4.36	0.13	-1.12	3.02
2008	8.32	4.94	-2.96	4.43	0.27	-0.99	2.64
2009	14.31	7.59	-3.14	5.62	0.30	-1.33	1.64
2010	5.43	6.72	-3.06	4.57	0.23	-1.39	2.10
2011	3.15	6.84	-2.17	3.97	-0.01	-2.17	2.41
2012	9.98	7.99	-2.97	4.33	0.04	-2.26	1.65

Trends in the RTA index for especially the unprocessed and semi-processed wheat sectors in South Africa are very different from those of peer countries (see Figures 3.8 to 3.14). In all peer countries, there is a close correlation between the competitiveness of the unprocessed and semi-processed wheat sectors, i.e. if the unprocessed sector is competitive, the semi-processed sector would be as well, and vice versa. For instance, in the case of Brazil, the fact that the unprocessed wheat sector is regarded as uncompetitive means that the semi-processed wheat sector is also uncompetitive (see Figure 3.10). In all the other peer countries, the unprocessed wheat sector is competitive, as is the semi-processed wheat sector.

In South Africa, however, the RTA index values tell quite the opposite story (see Figure 3.8). South Africa is a wheat-importing country, and the RTA index value of the unprocessed wheat industry is negative, highlighting the fact that the industry is uncompetitive. However, a positive RTA index value is reported for wheat flour, indicating that South Africa is competitive in this sector. This means that South Africa is importing unprocessed wheat, processing it, and then exporting the wheat flour mainly to African countries, such as Zimbabwe, Mozambique and the Democratic Republic of Congo. This situation can mainly be attributed to the fact that the milling industry in South Africa (semi-processed) is highly concentrated, with only four large companies dominating the market (Louw, Troskie and

Geyser, 2013). These large millers have a competitive advantage when it comes to economies of scale, finance, skills and the ability to cope with price volatility, which enables them to import, process and export larger quantities of wheat than smaller millers (Louw *et al.*, 2013). This system thus creates direct and indirect benefits for the milling industry, but based on the findings of the RTA, it must be asked whether this system has contributed to the decline in local production and seriously harmed the competitiveness of local producers.

When considering the RTA index values for the unprocessed, semi-processed and processed sectors of the wheat industry in South Africa as is shown in Figure 3.8, it can be seen that wheat flour, which is regarded as a competitive sector, registered a significant decline from the early to mid-2000s, with a slight recovery from 2007 to 2012. In contrast, the unprocessed wheat sector, which is regarded as an uncompetitive sector, reported a general downward trend from 1997 to 2012, with a spike in 2001. Recently the unprocessed wheat sector saw its competitiveness drop to its lowest level in 20 years. South Africa's processed wheat sector is marginally competitive, with most of the values close to zero.

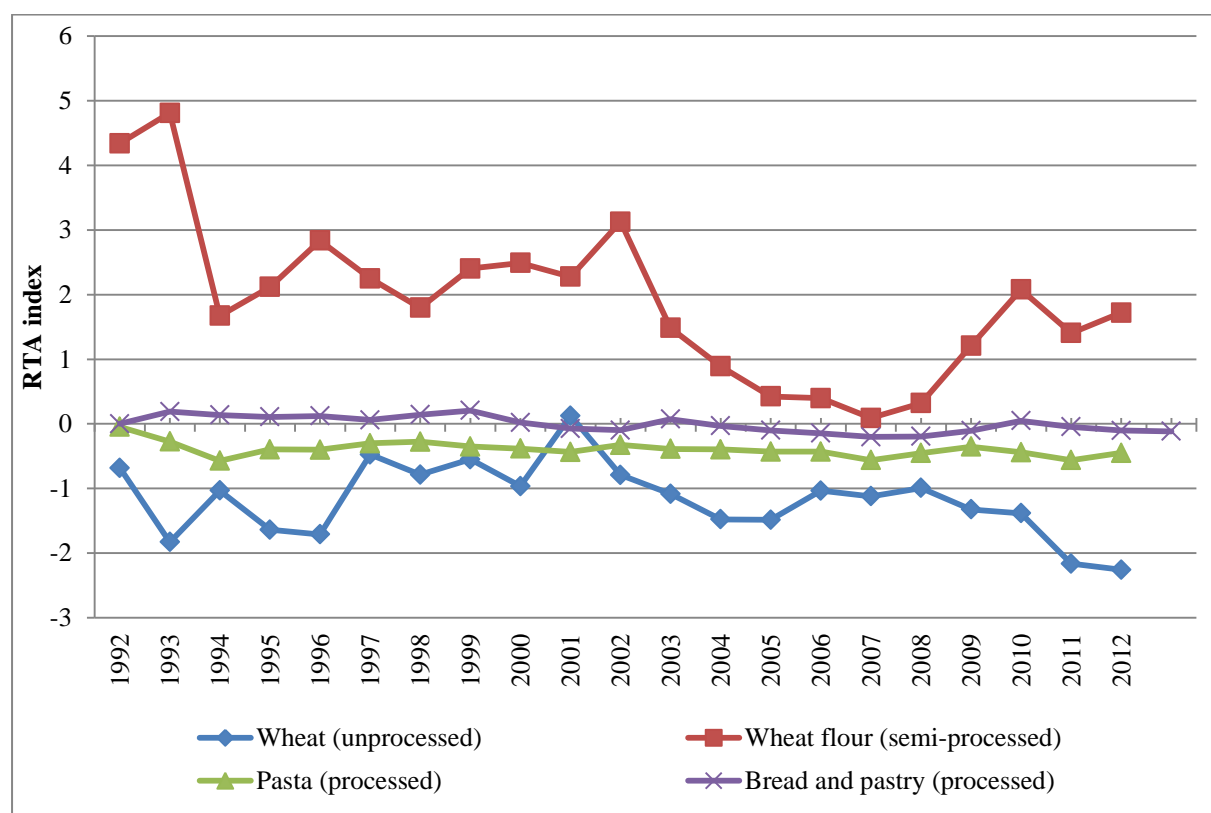


Figure 3.8: Trends in the RTA index values for unprocessed, semi-processed and processed wheat in South Africa (1992–2012)

The trends in the RTA index values for unprocessed, semi-processed and processed wheat in Argentina, Australia, Brazil, Canada, Germany and the USA were calculated and shown in Figures 3.9 to Figure 3.14.

In the majority of cases, the processed wheat sectors (green and purple lines) are marginally competitive, with most of the values being close to zero. The only real exception is the processed wheat sector in Germany, with pasta being highly uncompetitive (see Figure 3.13). This means that more pasta is imported into Germany than is exported, which can be attributed to factors such as close proximity to major pasta-producing countries. A significant difference in competitiveness is, however, noticeable in the unprocessed and semi-processed wheat sectors (blue and red lines).

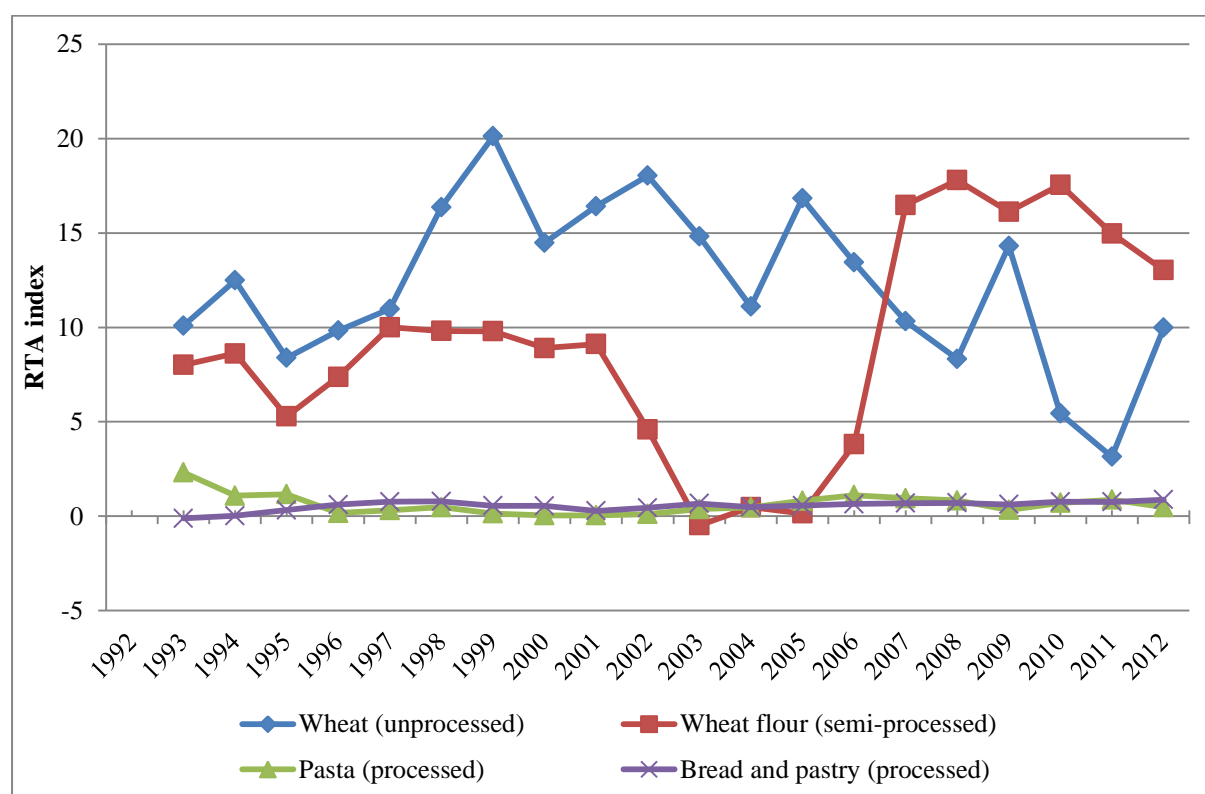


Figure 3.9: Trends in RTA index values for unprocessed, semi-processed and processed wheat in Argentina (1992–2012)

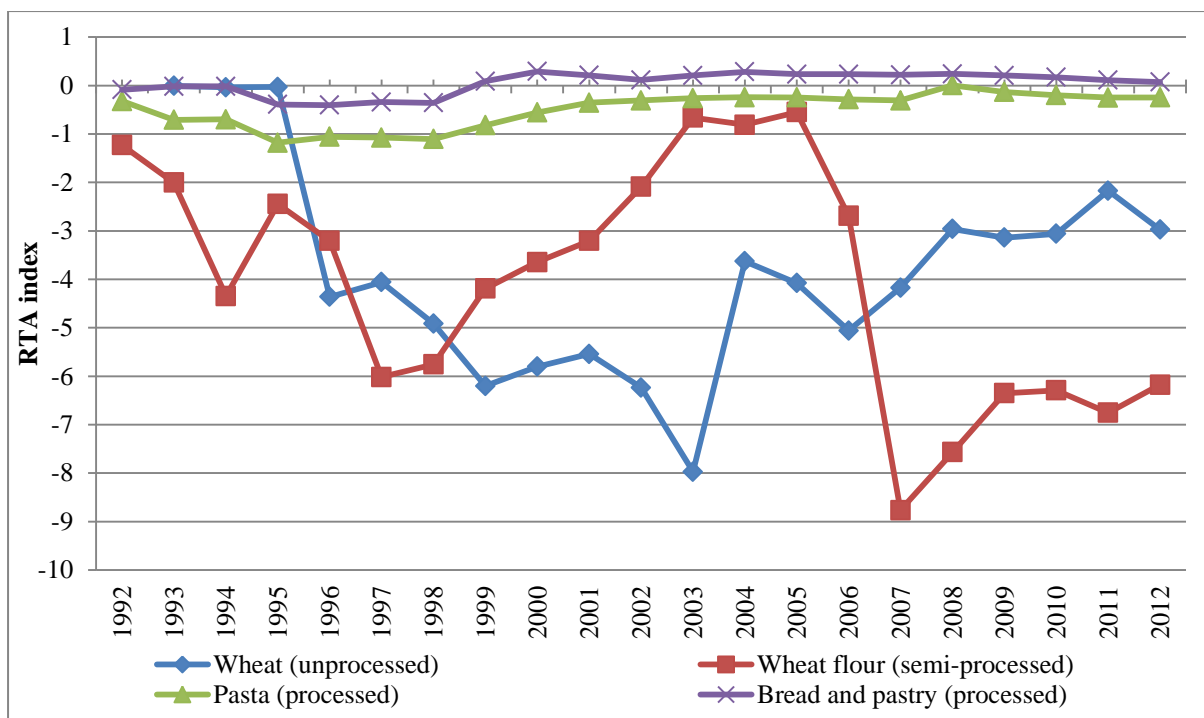


Figure 3.10: Trends in RTA index values for unprocessed, semi-processed and processed wheat in Brazil (1992–2012)

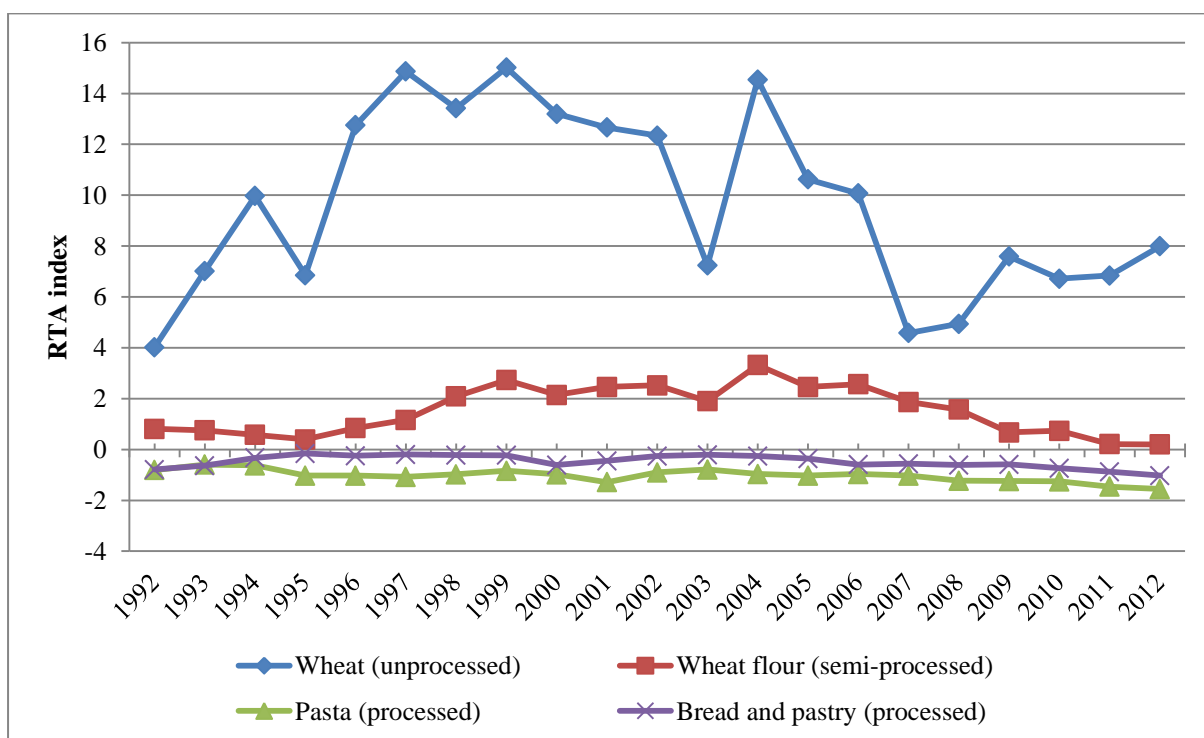


Figure 3.11: Trends in RTA index values for unprocessed, semi-processed and processed wheat in Australia (1992–2012)

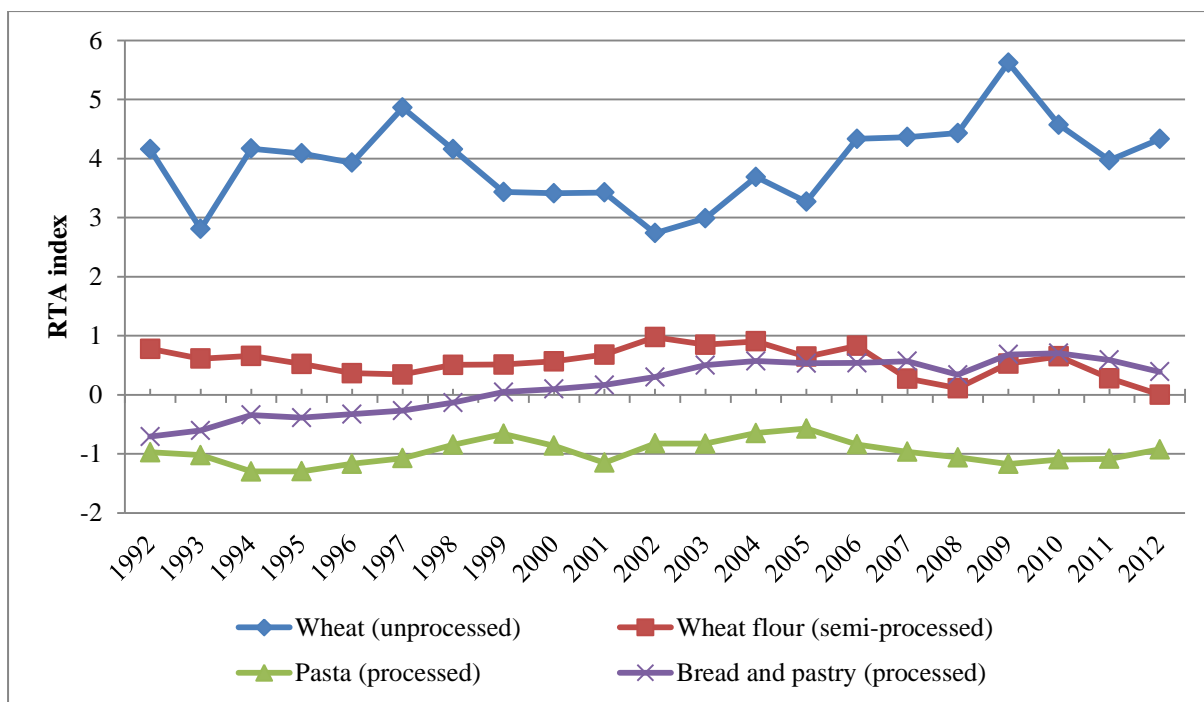


Figure 3.12: Trends in RTA index values for unprocessed, semi-processed and processed wheat in Canada (1992–2012)

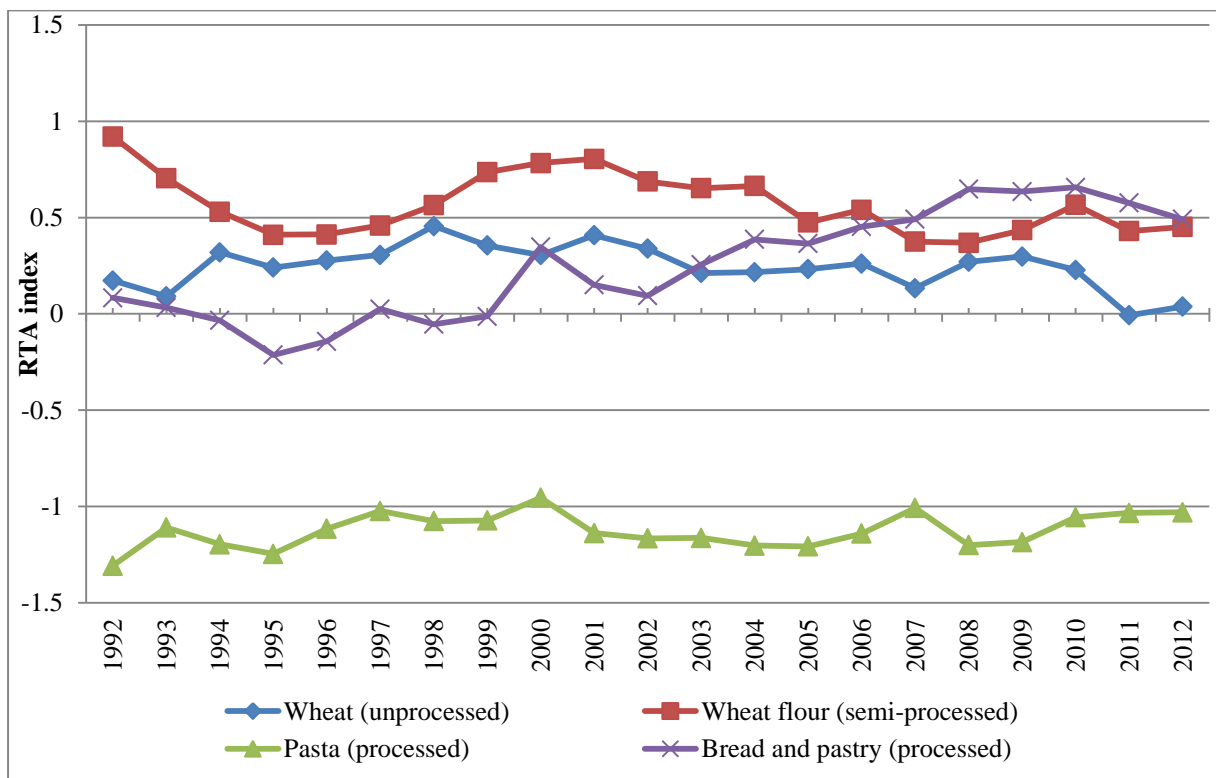


Figure 3.13: Trends in RTA index values for unprocessed, semi-processed and processed wheat in Germany (1992–2012)

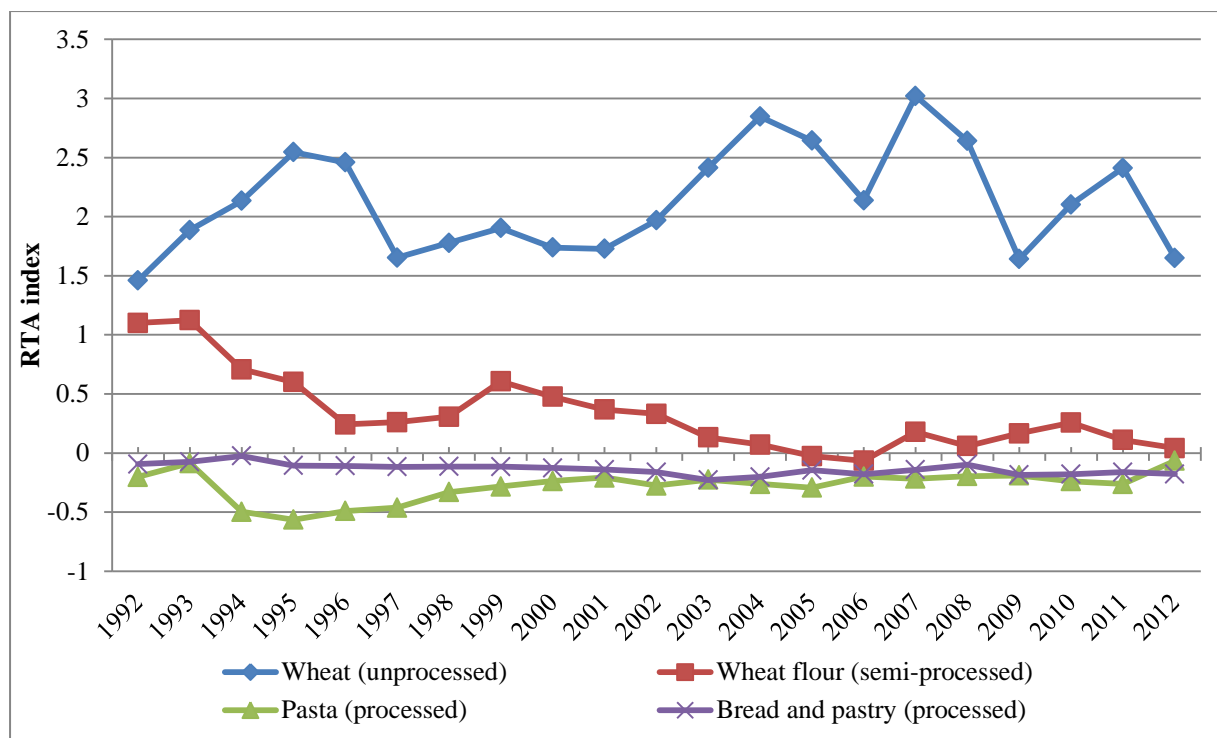


Figure 3.14: Trends in RTA index values for unprocessed, semi-processed and processed wheat in the USA (1992–2012)

3.6 Conclusion

It is clear from the results that the competitiveness of the South African unprocessed wheat sector has declined in recent years. This again raises the question as to whether the potential market concentration could have contributed to the decline in competitiveness of the unprocessed wheat industry by prescribing a certain wheat quality that attracts relatively low prices. Bikker, Spierdijk and Finnie (2007) found that market concentration in essence does not necessarily have an impact on competition. Bikker *et al.* (2007) instead showed that a country's institutional framework—or, in other words, the way in which an industry conducts business—will influence the competitiveness of that industry.

When the South African RTA index values were compared to those of peer countries, some concerns were raised about the institutional environment in which the South African producer must operate. What was evident from the results is that South Africa is the only country, among the countries reviewed, that has an uncompetitive unprocessed wheat sector alongside a competitive semi-processed wheat sector. A negative RTA index value for the unprocessed wheat industry (indicative of an uncompetitive industry) coupled with a positive RTA index

value for wheat flour (indicative of a competitive industry) means that South Africa is importing unprocessed wheat, processing it and then exporting the semi-processed product. The institutional environment therefore functions in a way that enables the secondary sectors to import raw wheat (resulting in the unprocessed sector being uncompetitive) at a lower cost than it can source it locally, process it into wheat flour, and then export it mainly to African countries (resulting in the processed sector being competitive).

Although the availability and expansion of the African market is exciting, the question must be asked why local production is rapidly declining and losing ground alongside its global competition. Fossati *et al.* (2010) stated that quality-related factors controlled by the institutional framework of the wheat industry can affect the competitiveness of an industry, as it is directly linked to productivity. As mentioned earlier and noted by Porter, productivity can be used as a proper definition of competitiveness. In this regard, certain wheat quality characteristics can be the cause of the declining productivity and thus competitiveness. Fossati *et al.* (2010) stated that certain wheat quality characteristics—such as protein content, which is regarded as one of the most important characteristics for wheat buyers in South Africa—are negatively correlated with yield and will thus affect productivity negatively. Therefore, prescribed wheat quality standards, as set by the institutional environment, and prices received can potentially be the major reasons why the unprocessed wheat sector in South Africa is uncompetitive, while the semi-processed industry is still competitive.

Chapter 4

South African Wheat Industry

4.1 Introduction

One of the critical roles that agriculture plays is to ensure a secure supply of food to consumers at reasonable prices. However, maintaining food supply extends beyond mere agricultural production. An effective food distribution system is also important. It is therefore crucial that South Africa maintains a competitive agricultural sector which is able to meet the demand for basic foodstuffs (Van Rooyen and Sigwele, 1998).

However, similar to the global wheat industry, the wheat industry in South Africa is characterised by a number of major historic events whose impact is being felt today. According to Vink and Kirsten (2000), the drastic changes in policy, which led to structural changes in the SAWI, have impacted the financial position of farmers, changing land use patterns, farm size and ecological considerations as farmers have been under pressure to improve their productivity. The global environment also started to play an increasingly important role in the local wheat industry. All industries now need to be more competitive internationally due to the spreading influence of globalisation. These influences are not only evident in the structure of the wheat industry, which has changed drastically since deregulation, but also in the conduct of the industry. This chapter focuses on the structure and conduct of the wheat industry in South Africa—two areas that are inextricably linked to the industry's performance, which will also be discussed in more detail in the chapter.

4.2 Structure of the wheat industry in South Africa

South Africa's agricultural history can be described as a marathon of government intervention (Stanwix, 2012). According to the NAMC (1999), the marketing of wheat has seen drastic changes in recent years. For instance, in 1976, the Wentzel Commission found that there was a need for some degree of state control over the marketing of agricultural products. This system of control was known as the single channel marketing system which was administered by the Wheat Board. As a result, the Board became the sole buyer and seller of wheat at predetermined prices, while also controlling imports and exports of wheat and wheat flour. Millers were obliged to take up all locally-produced wheat for milling. The flour price was fixed by the Wheat Board up to 1991, with available wheat allocated to millers according to milling capabilities and the location of the wheat (NAMC, 2004).

Significant policies in respect of the Winter Cereal Scheme and wheat industry, which were all implemented between 1979 and 1997, included:

- The control of wheat imports and exports should rest with government;
- The Wheat Board must retain the power to register mills and refuse any registrations as it deems fit;
- The system of restrictive registration by the Wheat Board should be replaced by formal registration in the case of confectioners;
- The system of restrictive registration by the Wheat Board should be retained in the case of bread bakers;
- The subsidisation of the bread price should be systematically reduced;
- The Act should be amended to afford the Minister the power to fix prices and margins following recommendation by the Boards and in consultation with the NAMC.

After the abolition of the single channel marketing system and import control in 1997, market forces determined the wheat price, while tariffs became the only protection against imports of wheat and wheat flour. This brought about the restructuring of both the primary and secondary industries (NAMC, 2004). The rapid deregulation that took hold at the end of apartheid was embraced by the new government, but instead of creating opportunities for

competition in the wheat to bread chain, it created “opportunities for extortion” by entrenched monopolies (Stanwix, 2012). Stanwix (2012) further stated that these distinctive “systems of regulation” profoundly altered agricultural development and facilitated the growth of monopolistic powers in the milling and baking industries. The post-apartheid liberalisation, which was intended to generate a more competitive environment and break down these structures of power, served rather to cement monopoly control (Stanwix, 2012).

During the phasing-out period of the Wheat Board, the winter cereal industry identified the need for certain functions executed by the Wheat Board to continue after the latter’s dissolution (Winter Cereal Trust, 2014). The functions that were identified for continuation were the provision of market information, laboratory services and financial support to research projects. The grain and oil seeds industries (previously serviced by the Wheat Board, Maize Board, Sorghum Board and Oil Seeds Board) decided to combine efforts to supply market information and laboratory services to the industries concerned. Two Section 21 companies, namely the South African Grain Information Service (SAGIS) and the South African Grain Laboratory (SAGL), were established to supply the above-mentioned services (Winter Cereal Trust, 2014).

The different industries also decided in terms of the (then) new Marketing of Agricultural Products Act (Act No. 47 of 1996) to establish Trusts, mainly to administer the assets of the control boards in question and to utilise funds to the benefit of the different industries. In the case of the winter cereal industry, it was decided to establish two separate trusts, namely the Winter Cereal General Trust and the Winter Cereal Research Trust (Winter Cereal Trust, 2014). In terms of paragraph 11.2 of the Trust of the Deed, the trustees shall, for the purpose of determining the interest of the beneficiaries, undertake research with regard to winter cereals only after consultation with the Research Technical Committees (Winter Cereal Trust, 2014).

The composition of the Research Technical Committee for Wheat (RTC) is representative of all sectors of the industry and includes two representatives from wheat breeders, two from the millers, two from the bakers, two from producers, one from the Agricultural Research Council (ARC), one from the South African Grain Laboratory and one from the grain handlers (see Table 4.1). According to the Winter Cereal Trust (2014), the Board of Trustees is not involved in matters related to the classification of new cultivars, grading requirements

and quality specifications; the RTC is authorised to handle these matters within their structures. The RTC is thus responsible for guiding wheat quality production by prescribing certain quality standards for commercial production in South Africa.

Table 4.1: Composition of the RTC

Representing	Number of representatives
Breeders of wheat cultivars	2
Wheat millers	2
Bakers	2
Wheat producers	2
Agricultural Research Council	1
SA Grain Laboratory	1
Grain handlers	1

Source: Winter Cereal Trust (2014)

4.3 Factors influencing the performance of the wheat industry in South Africa

The RTC is responsible for guiding wheat quality in South Africa. However, from interviews conducted with representatives of the various groups that serve on the RTC, it was revealed that the priorities of millers and bakers (i.e. quality) were promoted rather than productivity, which would have been to the benefit of producers. Wheat producers in South Africa are exposed to a number of factors that have the potential to influence not only their performance but also their competitiveness locally and abroad.

Among these factors is the fact that productivity (i.e. yields) decreases in correlation to higher quality demands. Unfortunately, higher quality in South Africa does not necessarily mean higher prices. Local wheat prices are linked to import parity prices which are determined by the lowest import parity prices. The latter are, more often than not, also linked to the lowest quality of wheat. Therefore, by only influencing the quality that South African wheat producers are allowed to produce, producers' productivity and prices will be affected. High quality demands can thus, to a certain extent, be held responsible for the declining performance of the wheat production sector.

4.3.1 Wheat quality

Wheat quality in South Africa is controlled, before production commences, through a list setting out the cultivars that are accepted by silos across the country. Additionally, wheat is graded in terms of its quality when delivered to the silos. These two factors are very influential when it comes to the quality of locally-produced wheat and will now be discussed in more detail.

4.3.1.1 Release criteria for new wheat cultivars

In South Africa, high standards are set for the release of new wheat cultivars as far as their bread-making characteristics are concerned. Before a new cultivar can be released for commercial production, the quality characteristics are discussed by the RTC. If the cultivar does not comply with quality requirements as set out by the RTC, its name will not be included on the cultivar list for bakers and millers, and silos will not accept the produce from producers (Du Plessis *et al.*, 2005). As mentioned, although the participants in the RTC are representative of the entire industry, the decision-making dynamics within the RTC mean that cultivars with superior quality often have precedence over cultivars with higher productivity, which has a negative effect on the performance of primary producers. It should, however, be noted that these criteria do not constitute a regulation but instead a suggested framework for producers. The reality of the situation is that these criteria are forced on the producers, who face the possibility of buyers being unwilling to accept their produce if the cultivar does not appear on the list of accepted cultivars.

For a wheat variety to be approved for commercial production and accepted by silos nationally, the rheological and baking characteristics of the wheat and wheat flour must first be determined. Rheology is the study of the deformation and flow of matter under the influence of applied stress. The different tests that are conducted to determine the rheological and baking characteristics of a specific cultivar are listed in Table 4.2. Once the rheology results are known, the performance of the dough during baking can be predicted (Engelbrecht, 2008). The RTC sets strict criteria regarding the rheological and baking characteristics during the final approval stages of potential wheat cultivars in South Africa. The primary rheological and baking characteristics are fixed, non-negotiable and include characteristics as illustrated in Table 4.2 (SAGL, 2010).

South Africa has three distinct wheat production regions which play a major role in quality variations and have three cultivars that set quality standards in each region. The three main wheat production areas are: the Western Cape, which is suitable for the production of hard red spring wheat; the Free State, which is suitable for the production of hard red winter (HRW) wheat; and the irrigation area, which is ideal for the production of hard red spring wheat (Van Schalkwyk and Van Deventer, 2005).

To adjust for seasonal variations in quality, cultivars with desired quality characteristics are used as biological standards for new cultivars and fixed variations from these standards are allowed. The cultivar that is used as the quality standard and prescribed by the millers and bakers in the Western Cape (dry land) is the Kariëga cultivar. The Elands cultivar is used as the quality standard in the dry land Free State regions and the SST806 cultivar is used in the northern irrigation areas. These cultivars are all hard red wheat cultivars and possess excellent milling and bread-making qualities.

Newly-developed cultivars are conventionally tested for three years in five different environments within the three main wheat production areas. The cultivars that are used as quality standards for each region are also included in these trials for reference purposes. The quality analysis is performed by the South African Grain Laboratory. As mentioned, the rheological and baking characteristics of a wheat cultivar play a key role in determining whether or not the cultivar can be released for commercial production. Subsequently, 15 tests are conducted to determine these characteristics. A detailed description of each of the 15 rheological and baking characteristic tests is provided in Annexure A.

Table 4.2 depicts data on recent trials of the biological standards of Elands, Kariëga and SST806, as well as the variation that is allowed for the release of new cultivars. As can be seen, each cultivar has its own weaknesses and strengths. For instance, the falling number of Elands (350.20 sec) is significantly lower than that of SST806 (443.57 sec) and Kariëga (427.33 sec), while the P/L value of Elands (1.27) is higher compared to SST806 (0.67) and Kariëga (0.77). The deviation allowed shows the maximum variation that can be tolerated for a cultivar to still be realised for commercial production. For instance, a maximum of -4 gram from the biological standard will be tolerated for the 1000 kernel mass test.

Table 4.2: Average biological standard for the three production regions in South Africa

	6-year biological standard for Elands (dry land Northern Standard)	4-year biological standard for SST806 (irrigation)	4-year biological standard for Kariëga (Southern Spring wheat)	Deviation allowed	
				Min	Max
Kg/hl (clean)	80.39	81.74	81.73	-1.8	
1000 kernel mass, g	32.37	37.93	41.38	-4	4
Falling number, sec	350.20	443.57	427.33	-15.00%	
Protein (12% mb)	13.02	12.46	12.48	-1.00%	
Buhler Extraction	75.54	77.16	75.33	-1.50%	
Colour (KJ 76)	-2.20	-2.99	-3.13		1
Break flour yield				-5.00%	5.00%
Mixogram					
Peak time (SST 806)		2.46		-10.00%	20.00%
Peak time (Elands)	3.07			-25.00%	15.00%
Peak time (Kariëga)			2.75	-25.00%	15.00%
Farinogram					
Absorption	63.17	62.01	62.45	-2.50%	2.50%
Development time, min	5.58	5.46	5.92	-25.00%	25.00%
Stability, min	9.93	7.56	10.87	-30.00%	10.00%
Baking test 100g					
Corrected volume, cm ³	877.50	946.14	939.17	-10.00%	
Dough characteristics					
Alveogram					
Strength, cm ³	44.54	40.86	43.78	-20.00%	20.00%
Stability, mm (P-value)	100.71	78.49	83.83	-20.00%	20.00%
Distensibility (L-value)	92.69	121.00	117.10	-10.00%	20.00%
P/L value	1.27	0.67	0.75	-25.00%	25.00%

Source: SAGL (2013)

4.3.1.2 Wheat grading

The Agricultural Product Act of 1990 (Act No. 119 of 1990) as compiled by the Department of Agriculture sets out certain regulations that guide grading, packing and marking of bread wheat intended for sale in South Africa. This Act stipulates that there are currently two active classes of wheat, namely Class Bread Wheat (CBW) and Class Other Wheat (COW). There

are no grades determined for COW, while five grades are determined for CBW. The grades for CBW as well as their standards are discussed in Table 4.3.

As can be seen from Table 4.3, four parameters are used to grade wheat in South Africa. Protein content, which is arguably the single most important characteristic of wheat, is used to gauge the end-use performance of a specific sample of wheat as higher percentages are often associated with better quality. Protein quantity is therefore considered a primary factor in measuring the potential of flour in relation to its end use (Mailhot and Patton, 1988). Wheat protein content is therefore one of the four parameters that are used to grade wheat in South Africa.

The second parameter used to grade wheat in South African is the falling number, which is a measure of sprout-induced starch damage in the wheat. Higher falling numbers indicate a lower degree of starch damage and thus should exhibit a positive relationship with market price (Goodwin and Espinosa, 1991). The falling number value represents the time, in seconds, required to stir a hot aqueous flour gel undergoing liquefaction in a viscometer and then allowing the viscometer stirrer to fall a measured distance through the gel (Kaldy and Rubenthaler, 1987).

Hectolitre mass, which is usually expressed as kilograms per hectolitre (kg/hl), is a measure of volume grain per unit. In other words, this parameter is a good indicator of grain soundness (Czarnecki and Evans, 1986, as cited by Miles, 2010). Since the soundness of grain directly influences the volume of wheat that needs to be transported, it also directly influences transportation costs. This, together with the fact that it is considered by some to be a good indication of the potential flour yield, makes hectolitre mass an important parameter in the wheat-grading system of South Africa (Posner and Hibbs, 1997). The SAGL (2010) was of a similar opinion, stating that hectolitre mass provides a measure of the bulk density of grain and is also useful as a guide to grain soundness and potential milling extraction. As a result, hectolitre mass is the third factor that is used to grade wheat in South Africa.

The total percentage of defects is the fourth parameter that is used to grade wheat in South Africa. This parameter comprises foreign material, damaged kernels, and shrunken and broken kernels, and is expected to have a negative correlation with wheat prices.

When wheat is received by the silos, the four parameters mentioned above are tested and a grade is awarded to a specific batch of wheat. The minimum requirements to obtain a certain grade of wheat are illustrated in Table 4.3. For example, to obtain a B1-grade, the batch of wheat must comply with all four of the parameters discussed.

Other evaluation methods include visual determination of damage from heat and insects, as well as presence of immature and sprouted kernels, foreign material, other grains and live insects. The grading characteristic, as evaluated for each consignment of wheat, must comply with specified criteria in order to be allocated a certain grade; the higher the grade, the better the quality of the wheat and the higher the remuneration (Engelbrecht, 2008).

Table 4.3: Standard of different Class Bread Wheat grades

Grading factors	Grade 1	Grade 2	Grade 3	Grade 4	Utility grade
	Minimum allowed				
Hectolitre mass	77kg	76kg	74kg	72kg	70kg
Falling number	250 seconds	250 seconds	250 seconds	200 seconds	150 seconds
Protein content	12%	11%	10%	9%	8%
Maximum percentage permissible deviation (m/m)					
a) Heavily frost-damaged kernels	5	5	5	5	10
b) Field fungi-infected kernels	2	2	2	2	2
c) Storage fungi-infected kernels	0.5	0.5	0.5	0.5	0.5
d) Screenings	3	3	3	4	10
e) Other grain and unthreshed ears	1	1	1	1	4
f) Gravel, stones, turf and glass	0.5	0.5	0.5	0.5	0.5
g) Foreign matter including gravel, stones, turf, glass: provided that such deviations are individually within the limits specified in item (f)	1	1	1	1	3
h) Heat-damaged kernels	0.5	0.5	0.5	0.5	0.5
i) Damaged kernels, including heat-damaged kernels: provided that such deviations are individually within the limit specified in item (h) and provided further that the minimum falling number value prescribed for the grade concerned is at least complied with	2	2	2	2	5
j) Deviations in items (d), (e), (g) and (i) collectively: provided that such deviations are individually within the limits of the said items	5	5	5	5	10

Source: SAGL (2013)

According to SAGL (2013), wheat that was analysed in the 2011/2012 production season was graded as follows: 40.6 percent was graded B1, 27.7 percent was graded B2, 14.1 percent was graded B3, 9 percent was graded B4 and 8.6 percent was graded UT or COW (Figure 4.1). In the 2010/2011 production season, grade B1 wheat in the Free State province amounted to 51 percent (45 percent the previous season) and grade B1 in other summer rainfall areas amounted to 45 percent (36 percent in the previous season). In the irrigation areas, 48 percent (43 percent in the previous season) of the wheat was graded as B1 and in the Western Cape province, 33 percent was graded as B1 (15 percent in the previous season).

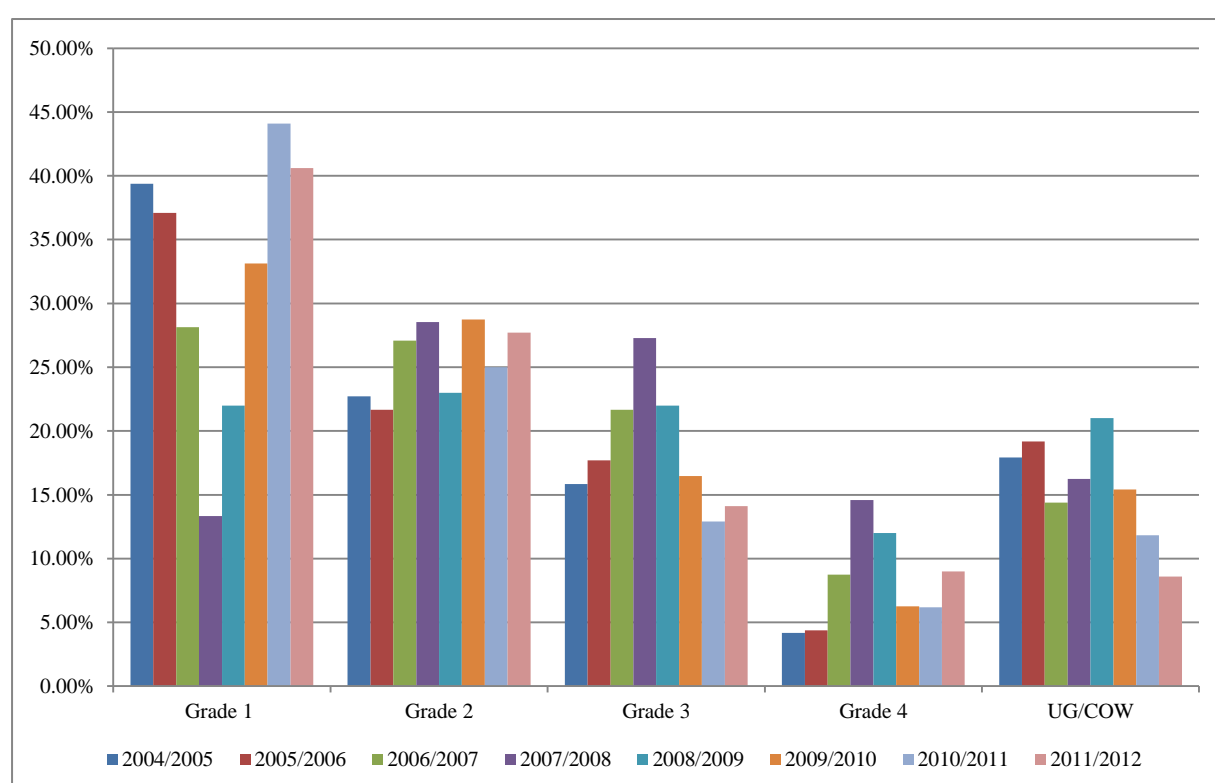


Figure 4.1: Percentages of different wheat grades in South African from 2004/05 to 2011/2012

Source: SAGL (2013)

4.3.2 Wheat prices

In 1987, the South African futures market started operating informally on an over-the-counter basis. The role of the clearing house and risk manager was fulfilled by Rand Merchant Bank (RMB). In 1988, the Johannesburg Stock Exchange (JSE), together with a group of banks and discount houses, formed an interim board to explore the viability of establishing a formal

futures exchange and clearing house (Du Plessis *et al.*, 2005). As a result, SAFEX opened for business on 30 April 1990 and issued a licence on 10 August 1990. Since then, all futures have been traded in terms of SAFEX rules and have been regulated by the Financial Markets Control Act No. 55 of 1989 (Du Plessis *et al.*, 2005).

The South African Futures Exchange (SAFEX) wheat contract was introduced in November 1997 with the underlying commodity being bread-milling wheat of sound, fair and merchantable quality, which was fit for human consumption and compliant with the stipulated grading criteria. During 1998, wheat originating from outside South Africa was allowed to be delivered on SAFEX. According to a report compiled by Du Plessis *et al.* (2005), although imported wheat met the stipulated grading requirements, the industry was in agreement that the wheat did not meet the intrinsic bread-milling requirements. Imported wheat was therefore not comparable to South African wheat in terms of quality. It was agreed by the industry that only a list of acceptable wheat be allowed to be traded on SAFEX.

The fact that the global market plays a key role in the South African wheat industry by supplementing the supply shortage has a significant effect on prices of primary produce. The international wheat price is thus a determining factor in the local price. Another factor that has an impact on the local price received by wheat producers is the wheat quality or, in other words, the quality of wheat that is produced and supplied to the local market. In an effort to develop mechanisms to attach a value to a specific quality, discount prices reflecting the quality of wheat were developed by SAFEX. Furthermore, the cost between the point where the grain is produced and the point where it is consumed must also be taken into account. In South Africa, SAFEX makes use of the location differential to determine these costs, which also impacts the price received by local producers.

4.3.2.1 Import parity price

After the deregulation of the market in 1997, prices were subjected to market forces and became more volatile. Wheat prices fluctuate between export and import parity levels, depending on whether there is a surplus or a shortfall in supply. However, wheat consumption in the past two decades has remained above supply, with shortfalls having to be imported (Parr, 2005).

Because local demand for wheat and wheat products outstrips the local supply thereof, wheat prices are determined by the import parity price. The import parity price is defined as: “the price at the border of a good that is imported, including tariffs and transport costs” (Parr, 2005). He further stated that the import parity price is determined by the lowest price worldwide. Thus, the dependence of the South African wheat price on imported wheat prices means that local prices are determined by the most affordable wheat globally, irrespective of the quality.

Figure 4.2 illustrates the free on board world wheat prices for the Argentinean Trigo Pan, Australian ASW, Canadian CWRS and American HRW from 1990/1991 to 2012/2013. Although following similar trends, the Canadian CWRS and Australian ASW consistently had the highest prices, while the Argentinean Trigo Pan had the lowest. As can be seen in Figure 4.2, international wheat prices were relatively constant from 1990/1991 to 2005/2006, with a significant increase being evident in the 2007/2008 season. Since then, prices have remained extremely volatile.

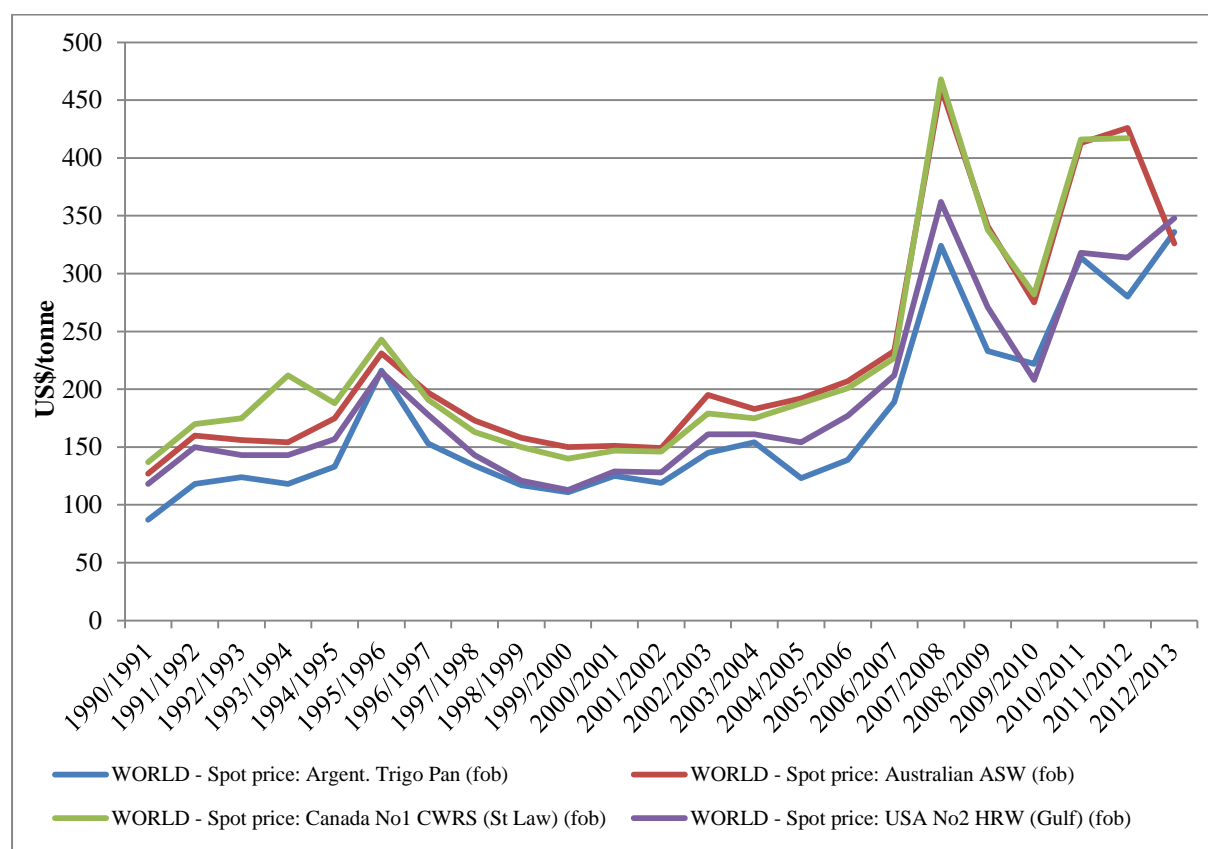


Figure 4.2: World wheat prices from 1990/1991 to 2012/2013

Source: SAGIS (2013)

Import tariffs are one of the trade barriers used to protect local industries against international competition. Therefore, lowering tariffs is expected to encourage freer trade between countries, but this would be to the detriment of domestic producers of grain whose welfare is compromised. At the same time, import tariffs are a main source of government income; thus, a lowering of tariffs would negatively affect the fiscus (Elsheikh, Elbushra and Salih, 2013). In a study to determine the impact of import tariffs on the economy, Elsheikh *et al.* (2013) came to the conclusion that changes in import tariffs had implications for the broad inter-linkages among the sectors concerned. The authors stated that, as expected, the lowering of tariffs would result in increased imports and decreased domestic production. This would lead to improved food availability at low prices but also greater foreign spending. Conversely, raising import tariffs would reduce imports and encourage domestic production geared at self-sufficiency, but this would lead to lower efficiency and a negative impact on Gross Domestic Product (GDP). Policy makers must therefore weigh up the pros and cons of these two options.

The result of decisions by policy makers in South Africa is illustrated in Figure 4.3 which depicts the wheat import tariff over the last decade. As can be seen, in 2010, the import tariff reached a high of R260.90 for every ton that was imported. However, the import tariff was removed that same year. Recently, an import tariff of R285 per ton was introduced for wheat imports. However, this tariff will only kick in once the international HRW nr.2 free on board wheat price is trading below \$10/ton of the new referencing level of \$294/ton for a period of three consecutive weeks (Grain SA, 2013).

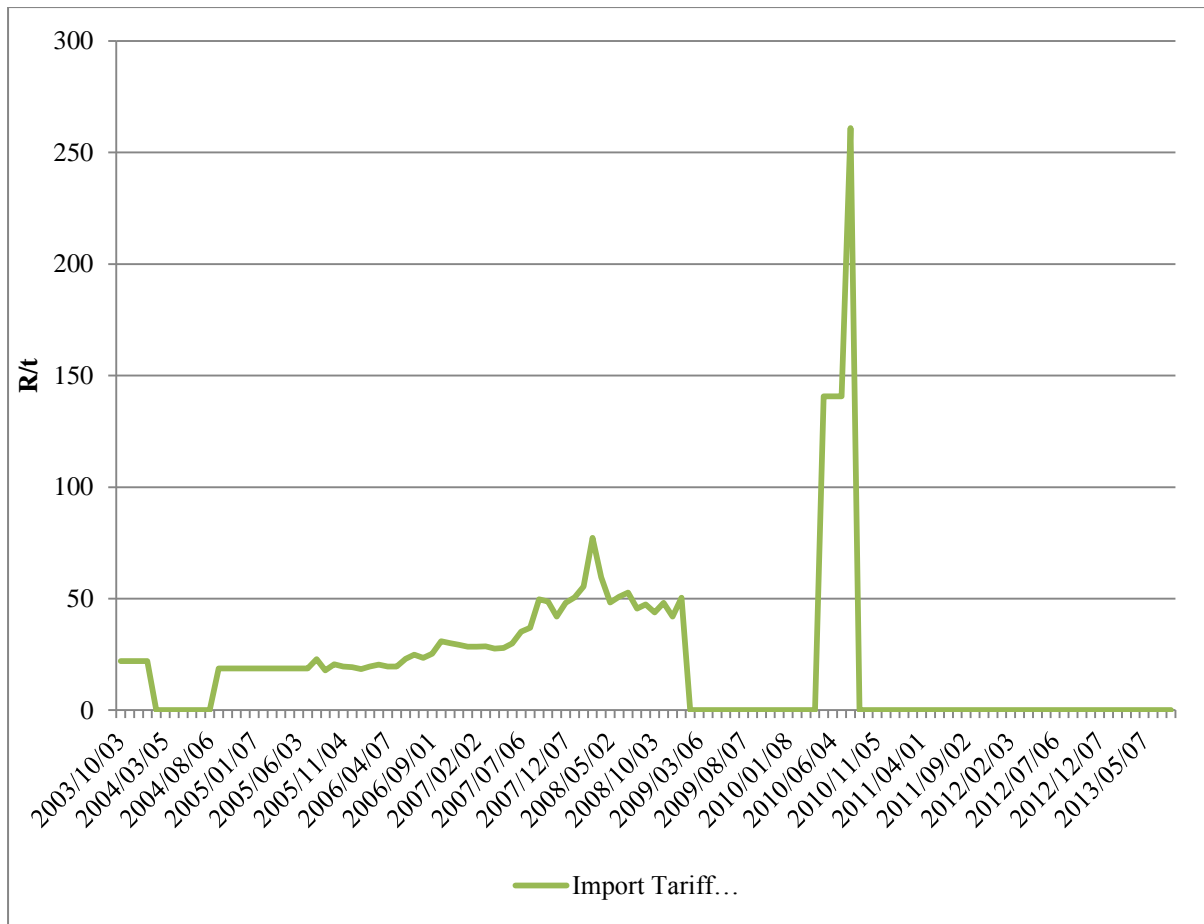


Figure 4.3: Import tariffs

Source: SAGIS (2013)

Figure 4.4 depicts the SAFEX wheat price at Randfontein from 1997 to 2013. As mentioned, South African wheat prices are highly correlated with international wheat prices and thus follow similar trends. The SAFEX price reached its highest point in March 2008 at R4 298 per tonne. After that, the price dropped significantly and a price as low as R2 080 was recorded in September 2009, which was mainly due to the global economic crisis. The price has since recovered well, standing at R3 528 (for example) in July 2013.



Figure 4.4: SAFEX price at Randfontein

Source: SAGIS (2013)

4.3.2.2 Prices for different grades of wheat

In order to incorporate different grades of wheat into the price mechanism, SAFEX suggested a price difference or discount for each grade that is determined annually (see Table 4.4). For example, to calculate the price you can expect for your wheat delivered at Randfontein, the associated discounted price for the specified grade must be subtracted from the current SAFEX price. It should be noted that SAFEX only accepts grades 1, 2 and 3. However, grade 4, utility grade (UG) and COW follow a similar pattern in the industry and are further discounted from the current discounted prices.

It must be noted that imported wheat is imported under the COW category but determines the price of grade 1 wheat in South Africa. Local producers thus receive prices that are not linked to their delivered quality.

Table 4.4: SAFEX annual discount prices per grade

Year	Grade 1	Grade 2	Grade 3	Grade 4 (indicated)	UT (indicated)	COW (indicated)
2003/2004	0	60	120	180	240	300
2004/2005	0	60	120	180	240	300
2005/2006	0	55	110	165	220	275
2006/2007	0	55	110	165	220	275
2007/2008	0	75	150	225	300	375
2008/2009	0	140	280	420	560	700
2009/2010	0	95	190	285	380	475
2010/2011	0	100	200	300	400	500
2011/2012	0	115	230	345	460	575
2012/2013	0	135	270	405	540	675

Source: SAFEX (2013)

4.3.2.3 Location differential

An additional regulation, which has a severe impact on the prices received by the producer and the prices paid by the consumer, is the location differential. The location differential is applied to contracts to show the cost of moving stock from any one of the 198 registered silos in the country to Randfontein which is situated in Gauteng province. Initially, the location differential was derived from published Spoornet rates with Randfontein as a basis. However, this situation changed when Spoornet's pricing model changed and road rates also had to be considered (Du Plessis *et al.*, 2005).

Since then, a broad spectrum of participants in the transport industry has supplied SAFEX with a perceived percentage increase in transport costs for the following year. This differential is used as an indicative rate for delivery in completion of a standardised futures contract, and is in no way prescribed to role players in the market. Moreover, the location differential is supposed to act as a guideline for the potential cost to move a commodity that is traded on SAFEX from a particular point in the market to a reference point—in this case, Randfontein (Du Plessis *et al.*, 2005). As can be seen in Figure 4.5, the location of each silo in relation to Randfontein is directly correlated to the difference in the location differential. For instance, the silo located near Battery, which is near Randfontein, has a relatively low location differential.

As can be seen in the figure, a silo that is located further from Randfontein, such as Bothaville, Bloemfontein or Bloedrivier, has higher location differentials. The Western Cape area has nearly double the location differential when compared with other locations in South Africa due to the distance from Randfontein.

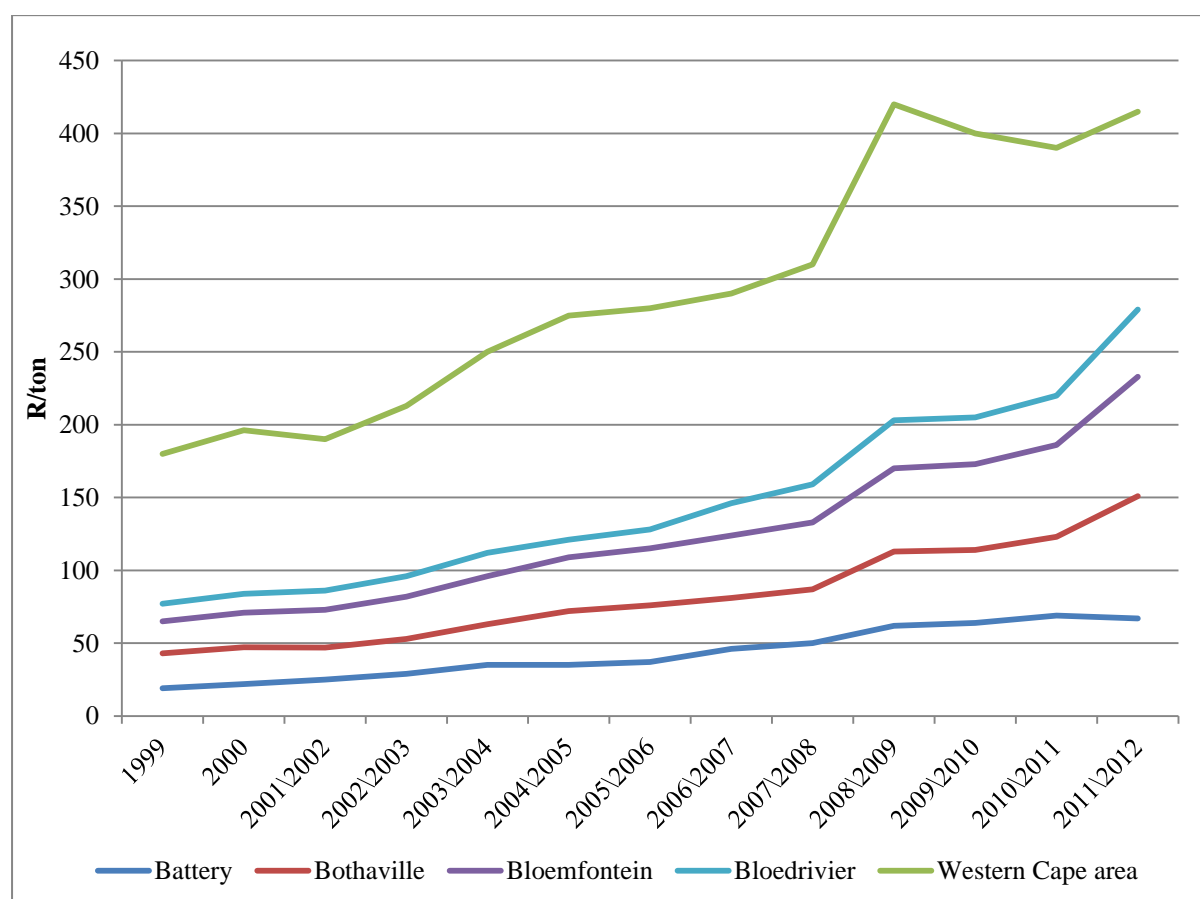


Figure 4.5: Location differentials for selected silo locations

Source: SAFEX (2013)

4.3.3 Supporting and related industries

4.3.3.1 Transport and storage

The point of receipt of grain marks the end of the line for the grower, but it marks the first point in the chain that takes grains from raw commodity to the first stage in processing and beyond. This is a chain that often includes the country elevator (wheat buyers), an inland terminal elevator or buyer, a mill or refinery, and an export terminal.

The upstream segment of the wheat industry consists of the milling and baking industries. However, certain elevators, such as transportation and storage (midstream segment), need to be in place for the primary and secondary industries to link up.

Since 2006, road transport has played an increasingly important role in the wheat industry, while the reliance on rail transport has decreased significantly (see Figure 4.6). This has resulted in faster deliveries but at a higher cost. In 2013, approximately 62 percent of the wheat industry's transportation needs were fulfilled by road transport, increasing from 39 percent in 2006. Conversely, freight rail decreased from 44 percent in 2006 to 24 percent in 2013. The use of conveyer belts also showed a slight decrease from 18 percent to 14 percent during the period under review.

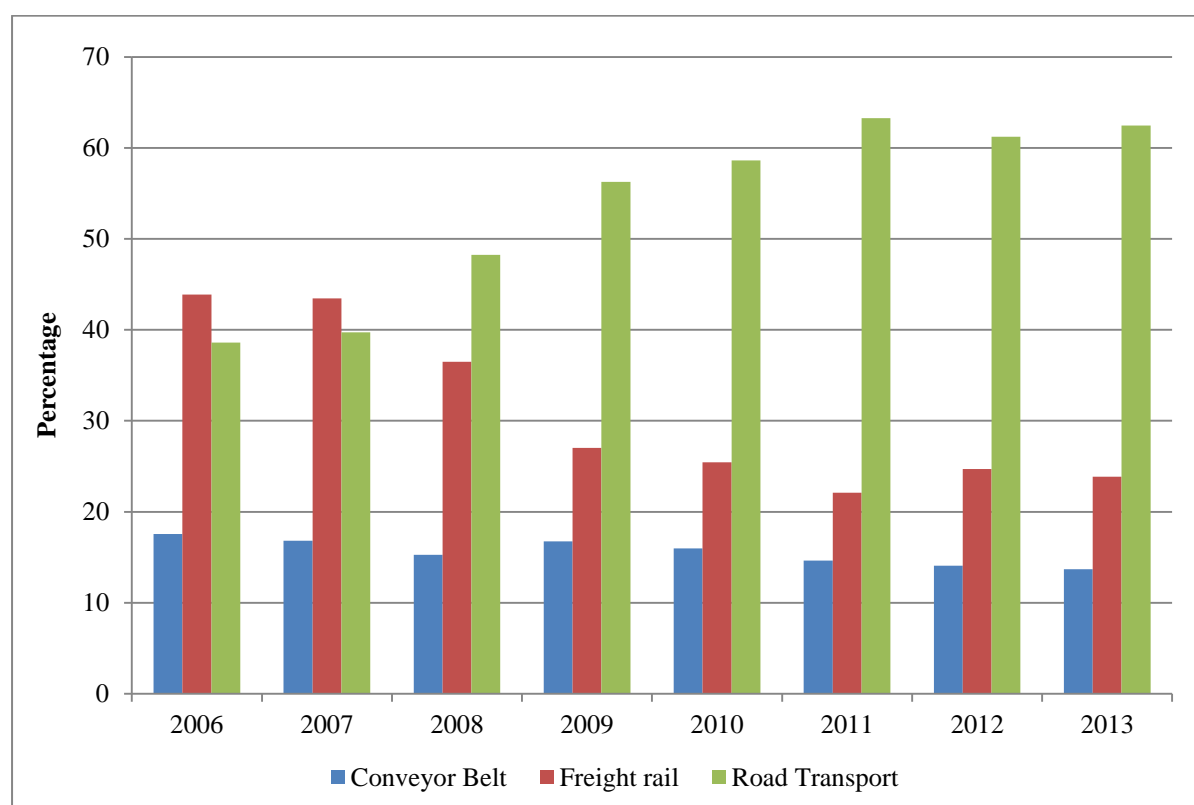


Figure 4.6: Wheat transport by component

Source: SAGIS (2013)

Another crucial element in the linkage between the primary and secondary industries is the storage capabilities of a specific country. Existing infrastructure in the form of silos needs to be in place for the successful and efficient operation of a value chain. In this regard, Figure 4.7 depicts the number of co-ops with registered silos, as well as the number of registered

wheat silos in South Africa from 1999/2000 to 2011/2012. As can be seen, the number of both silos and co-ops stayed relatively constant over the period, with 145 silos registered at 17 co-ops in 2013.

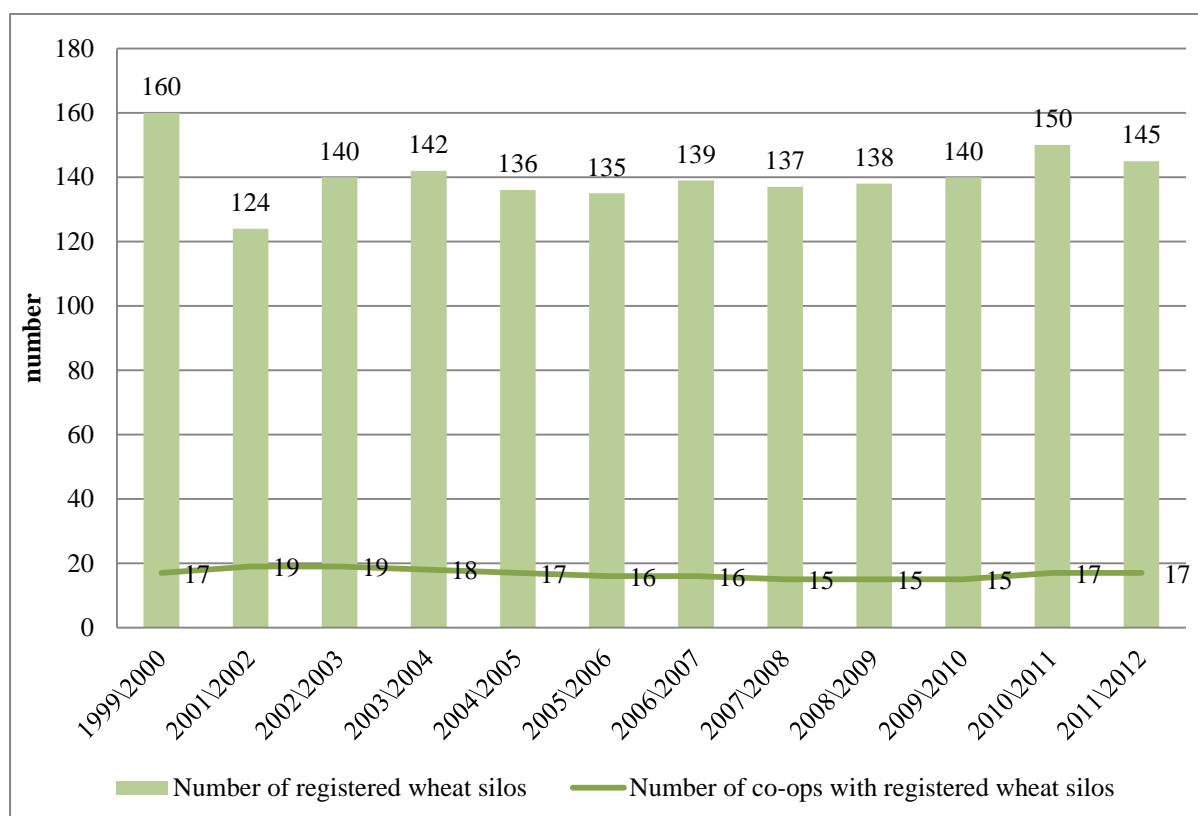


Figure 4.7: Number of wheat silos and associated co-ops

Source: SAFEX (2013)

4.3.3.2 The milling industry

The wheat milling industry converts raw wheat into wheat flour which is either sourced locally or from abroad. Wheat flour, which is a semi-processed product, can then be utilised by the baking sector or animal feed sector, or in wheat-based manufactured goods. In South Africa, wheat is mostly used for human consumption with the balance, estimated at less than 1 percent, used as animal feed (Mahomed, 2011).

As mentioned, prior to deregulation in 1997, the SAWI was controlled by the marketing system that administered the wheat, milling and baking sectors. Owing to greater price volatility and higher risks associated with an “open” market after 1997, the number of wheat

mills declined from 137 in 1997 to 65 in 2011 (Sosland, 2011). The majority of these mills are controlled by four major role players in the wheat milling industry. These are: Pioneer Foods (Sasko Milling), Tiger Milling, Premier Foods and Ruto Mills (a division of Foodcorp). In 2005, the four major wheat millers had an estimated 87 percent market share (Du Plessis *et al.*, 2005) but increased their market share by 10 percent to an estimated 97 percent in 2011.

Table 4.5 shows the number of employees, revenue and number of wheat mills associated with each of the major role players in the wheat milling industry. The milling division of Foodcorp, a wheat and maize operation with its mill situated in Pretoria, is the largest single wheat-milling complex in South Africa. The division supplies most of the flour within the Foodcorp Group as well as to a select customer base, including large multinational food companies, independent bakeries, and corporate and independent in-store bakeries (RCL Foods, 2013).

Table 4.5: Number of employees, revenue and number of wheat mills in the milling industry

Company	No. of employees	Revenue	No. of wheat mills
Foodcorp (Pty) Ltd	5 468 (group)	R 1,217m	1
Pioneer Foods (Pty) Ltd	11 524 (group)	R 15,731.3m	7
Premier Foods (Pty) Ltd	2 500 (group)	R 4,655m	8
Tiger Milling Ltd	9 022 (group)	R 19,554m	4

Source: Mahomedy (2011)

The tonnage of wheat that was milled in South Africa from 1998/1999 to 2008/2009 is depicted in Figure 4.8 (DAFF, 2010). From Figure 4.8 a definite upward trend in the amount of wheat milled is evident. According to the DAFF (2010), in 2008/2009 the milling industry produced on average 2.5 million tonnes of milled wheat which was converted into flour, with the overall yearly capacity estimated at 3.3 million tonnes annually (Sosland, 2011).

Products from milled flour include white bread flour, brown bread flour, whole wheat flour, cake flour, industrial flour and self-raising flour. The major markets for these products are wholesalers, industrial users and export markets in Botswana, Lesotho, Namibia and

Swaziland. Sosland (2011) stated that approximately 67 percent of this milled flour is used for bread and the raw product can easily be sourced either locally or internationally.

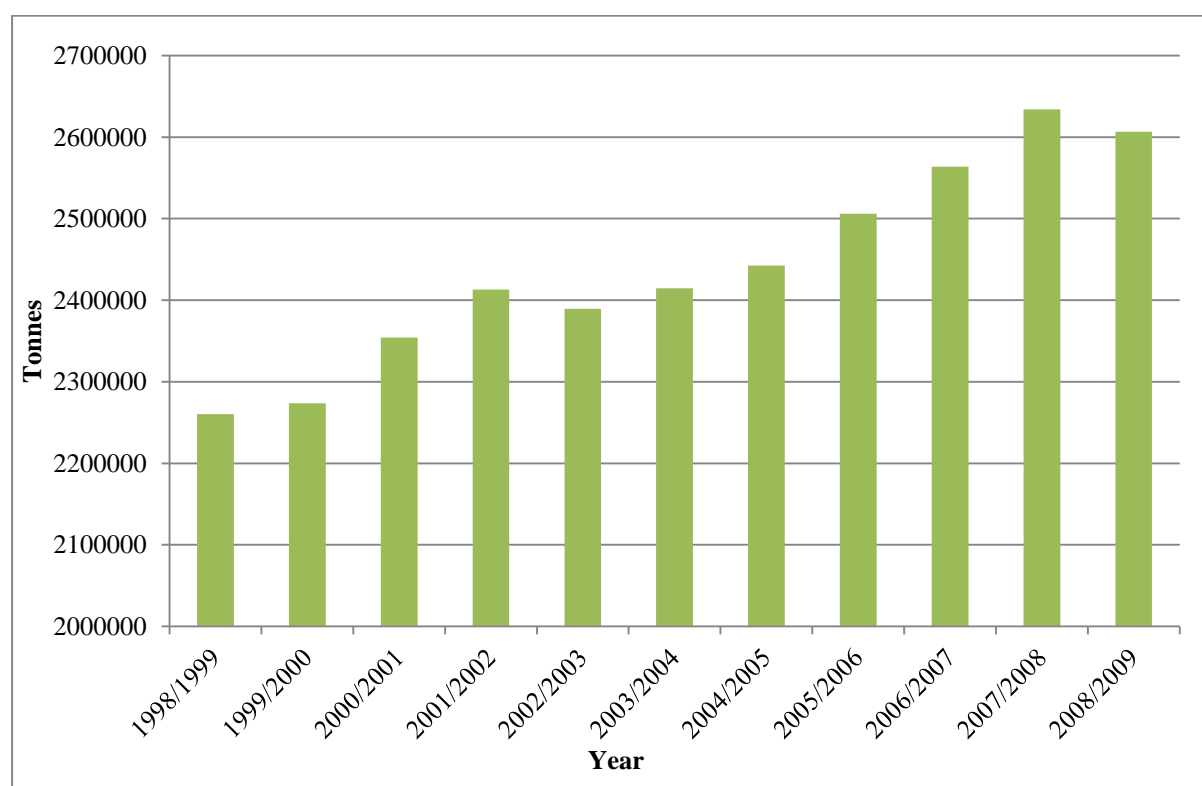


Figure 4.8: Tonnage of milled wheat in South Africa from 1998/1999 to 2008/2009

Source: NCM (2010)

4.3.3.3 The baking industry

The baking industry is the major client of the milling industry. According to the South African Chamber of Baking, there are five different types of baking units, namely plant, wholesale, industrial, in-store and other bakeries. A significant proportion of bakers are informal. The bakers produce mainly bread and other products like biscuits, pies, pizzas, etc. The plant bakeries are still popular, although there are a large number of retail bakeries which may impact negatively on the plant bakeries (DAFF, 2011). According to Erasmus and Cownie (2002), baking units in South Africa are estimated to number 7 905, giving rise to approximately 45 500 job opportunities. The Food Price Monitoring Committee report indicates that there are approximately 52 200 informal bakers who operate in non-licensed premises. In general, growth in the baking industry has taken place through the establishment of franchises and in-store bakeries.

According to Gebhardt (2013), one of the current problems facing the baking industry is the fact that the industry is dominated by a select few companies which collectively control 85 percent of the bread industry in South Africa. In 2013, the net worth of the bread industry in South Africa was estimated at R28.4 billion. The major bakeries representing the companies in question are Albany, Blue Ribbon, Sasko, Sunbake and BB Cereals.

Albany is the baking division of Tiger Brands and is the largest contributor to operating income in the baking and milling segment of the company (Tiger Brands, 2013). The year under review (2013) saw growth in production volume despite a general market decline. Notwithstanding considerable pressure on raw material, labour and distribution costs, Tiger Brands' bakery business showed a strong increase in operating income (Tiger Brands, 2013). In this regard, Albany generated an income of approximately R4 billion in 2013.

Blue Ribbon is the baking division of Premier Foods, producing over 500 million loaves of bread per annum from 16 bakeries situated in 9 provinces, as well as Lesotho, Swaziland and Mozambique. This makes Premier Foods the single largest supplier of bread in South Africa. The company's brands include Blue Ribbon, BB Bread, Mr Bread, Star, S.U.B. (Swaziland) and Just Baked (Premier Foods, 2013). In 2013, Premier Foods realised revenues of R9 billion.

Sasko, which represents the baking division of Pioneer Foods, manufactures a range of grain-based staple foods and is one of South Africa's largest bakery operations, with bakeries and depots located throughout the country. In 2013, Sasko reported revenues of approximately R10 billion.

Sunbake, which is the baking division of Foodcorp, is the fourth largest bakery group in the country. Foodcorp operates seven bakeries and distributes its products in four provinces in South Africa. In 2013, Foodcorp realised revenues of approximately R1.2 billion.

Assuming that the four major companies control 85 percent of the bread industry in South Africa, the market share of each company can be estimated based on the revenue generated by each company in 2013. This calculation, which merely gives an indication of what the market share might look like in the South African bread industry in 2013, is depicted in Table 4.6. As can be seen, Tiger Brands controls an estimated 14 percent of the bread market in

South Africa, while Premier Foods and Pioneer Foods are regarded as the market leaders with an estimated 31.8 and 35 percent market share, respectively. Foodcorp is a relatively small role player with an estimated market share of only 4.2 percent of the R28.4 billion bread industry in 2013. According to Gebhardt (2013), the other 15 percent of the bread market is controlled by other independent bakeries.

Table 4.6: Bread market share of major role players in 2013

Company (bakery)	Estimated revenue (2013) (R '000 000)	Estimated control of bread market in 2013
Tiger Brands (Albany bakery)	4 000	14%
Premier Foods (Blue Ribbon bakery)	9 000	31.8%
Pioneer Foods (Sasko bakery)	10 000	35%
Foodcorp (Sunbake bakery)	1 200	4.2%
Other	4 200	15%

4.3.4 Wheat consumption in South Africa

Consumption or demand for a product plays a critical role in price determination. The rapidly growing population in South Africa, coupled with the fact that more people have access to markets now than in the “apartheid” era, has given rise to a surge in demand for agricultural food products. The increasing consumption of meat as well as bread and grain products as sources of energy in a healthy diet is illustrated in Figure 4.9. As can be seen, the rise in expenditure on meat and bread and grain products since 2000 has been more dramatic than expenditure on other agricultural food products. The meat and bread industries must therefore be viewed as the agricultural industries with the strongest potential for expansion, which would boost greater food security and wealth creation in South Africa.



Figure 4.9: Private consumption expenditure on food in South Africa

Source: DAFF (2014)

Figure 4.10 illustrates the total and per capita consumption of wheat in South Africa. As can be seen, the per capita consumption of wheat stayed relatively constant from 1990 to 2011 at around 50kg per person per year. A rapidly growing population, however, resulted in the total demand for wheat increasing from approximately 1.5 million tonnes in 1990 to an estimated 2.4 million tonnes in 2011.

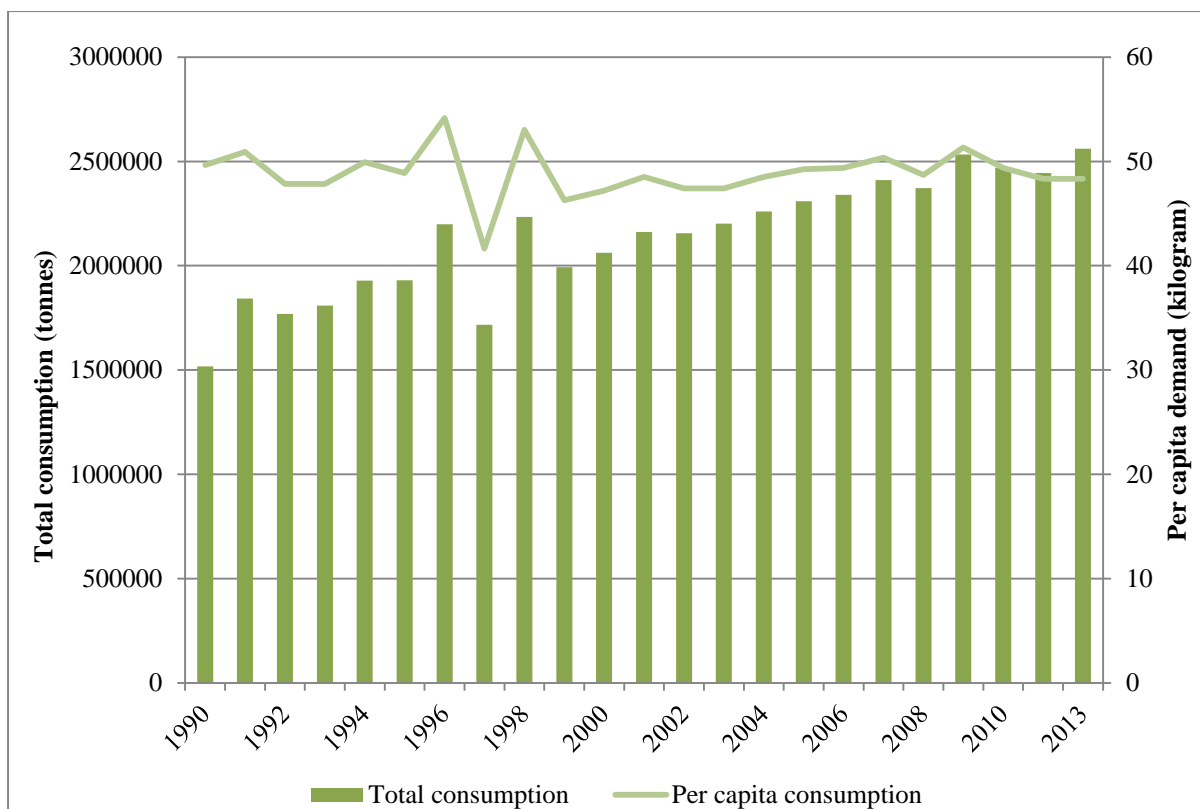


Figure 4.10: Total and per capita consumption of wheat in South Africa

Source: DAFF (2014)

4.3.5 South African wheat trade

It is essential to understand wheat trade and the influential role that it plays in terms of quality and price determination in the South African wheat industry. As mentioned, there was a growing demand for wheat and wheat products and to be able to sustain this demand, wheat production and/or wheat trade had to increase. From Figure 4.11, which depicts South African wheat imports from 1990/1991 to 2012/2013, it can be seen that wheat imports increased from 438 427 tonnes in 1990/1991 to an estimated 1.7 million tonnes in 2011/2012. This represents an overall increase in imports of 293.22 percent or an annual increase of 13.33 percent.

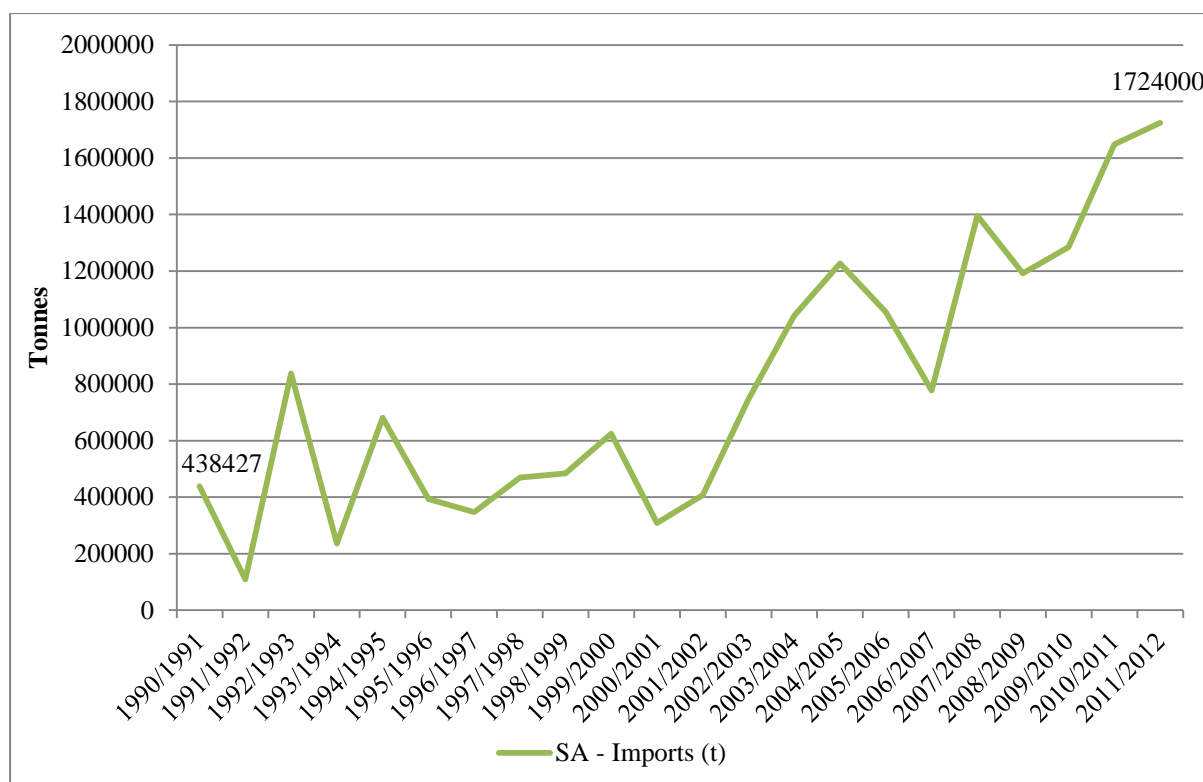


Figure 4.11: South African wheat imports from 1990/1991 to 2012/2013

Source: SAGIS (2013)

As can be seen, South Africa is a wheat-importing country and is highly reliant on international trends. An emphasis will therefore be placed on countries from which South Africa imported most of its wheat over the last two decades. Although fluctuating annually, the countries that had the greatest influence on the South African wheat market can be seen in Figure 4.12 which depicts the percentage of wheat imports to South Africa per country in 2012. It must be noted that countries such as India and China are major wheat-producing countries but due to high local demand are still considered to be wheat-importing countries. As shown in Figure 4.12, most of the wheat imported in 2012 originated in Argentina (37.84 percent), Brazil (16.04 percent) and Australia (14.37 percent). South Africa also considers the United States of America (USA), Russia and Germany to be major wheat trading partners.

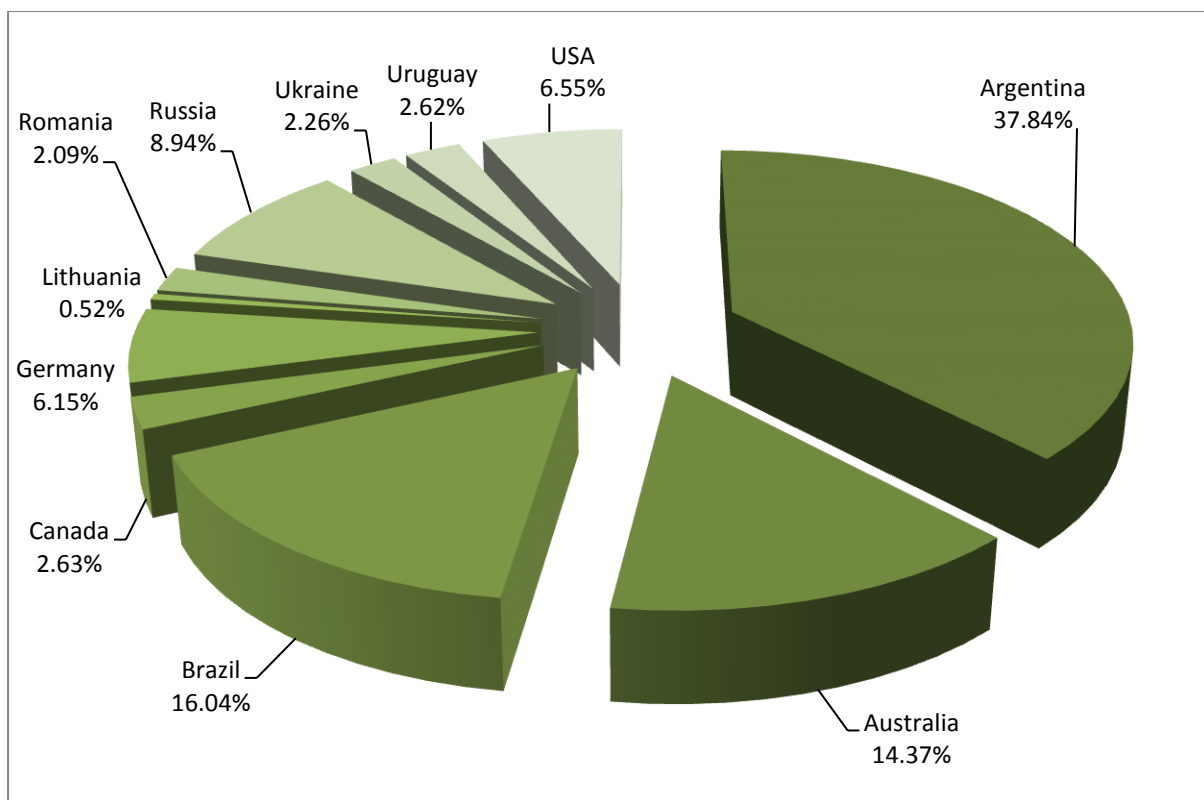


Figure 4.12: Percentage of wheat imports to South Africa per country in 2012

Source: SAGL (2013)

As can be seen in Figure 4.13, the value of Southern African Customs Union imports of wheat increased substantially from R633 million in 2000 to R4 346 million in 2011. It is thus clear that a large proportion of increased demand for wheat and wheat products was sourced from increased imports. It is, however, important to analyse the trends in wheat production to precisely determine the extent to which imports have replaced local production. If this is indeed the case, it will have a significant negative effect on the foreign exchange generated (Hawkins, 2010). According to Hawkins, the biggest losers in this case will be the rural communities in South Africa which could benefit from increased local production through job creation.

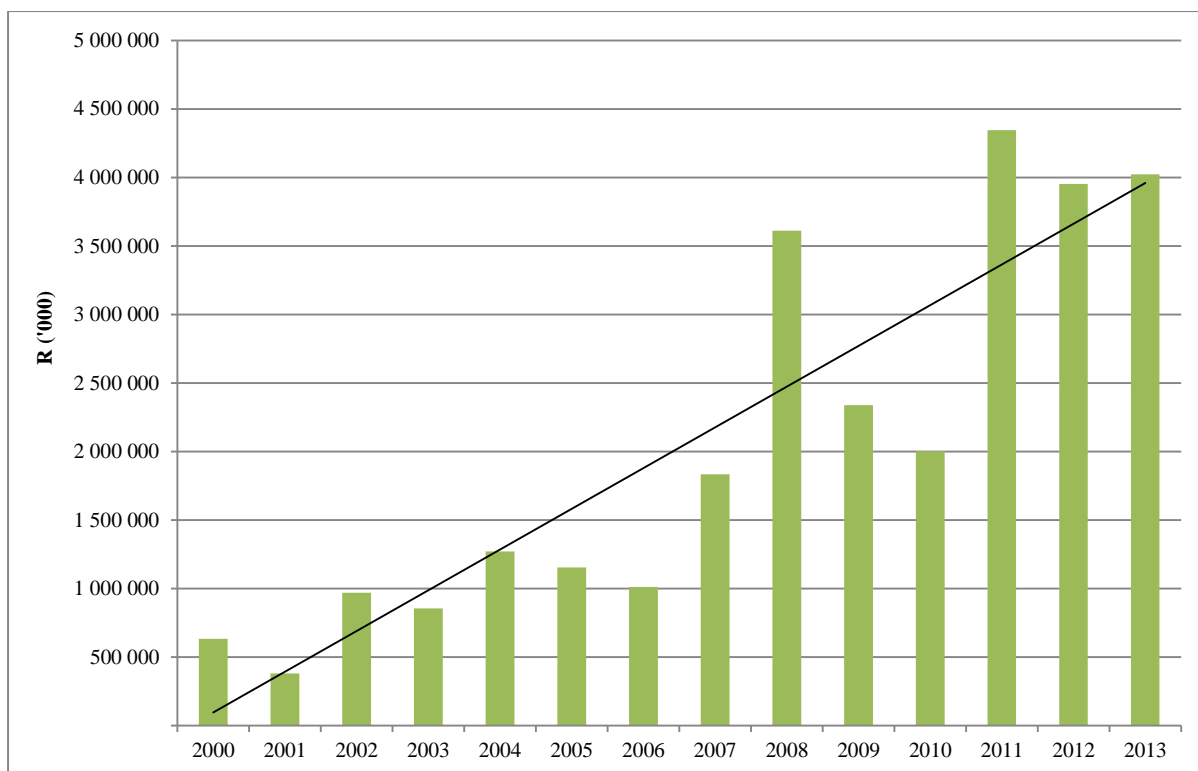


Figure 4.13: Value of the Southern African Customs Union imports of wheat

Source: DAFF (2014)

In Figure 4.14, the annual protein percentages of locally-produced wheat as well as imported wheat are illustrated. As can be seen, local protein content declined significantly from 2005/2006 to 2007/2008. This can be ascribed to many factors, of which climatic conditions are most likely to have had the largest influence. Protein content is very susceptible to seasonal variation in climatic conditions, such as rainfall and extreme heat. In 2006/2007, which was in the midst of the rapid decline in local protein percentages, imported wheat's protein content increased to its recent highest level of 12.32 percent. This is understandable because a certain percentage of protein is necessary for the baking process.

A similar pattern can be observed from 2007/2008 to 2008/2009 when locally-produced wheat's protein content increased to approximately 12 percent. Over the same period, imported wheat's protein content decreased to 11.2 percent. Since then, the protein content of both locally-produced wheat and imported wheat has stayed relatively constant.

It must be noted that imported wheat's protein content was calculated by means of a weighted average taking into account the amount of imports from each country.

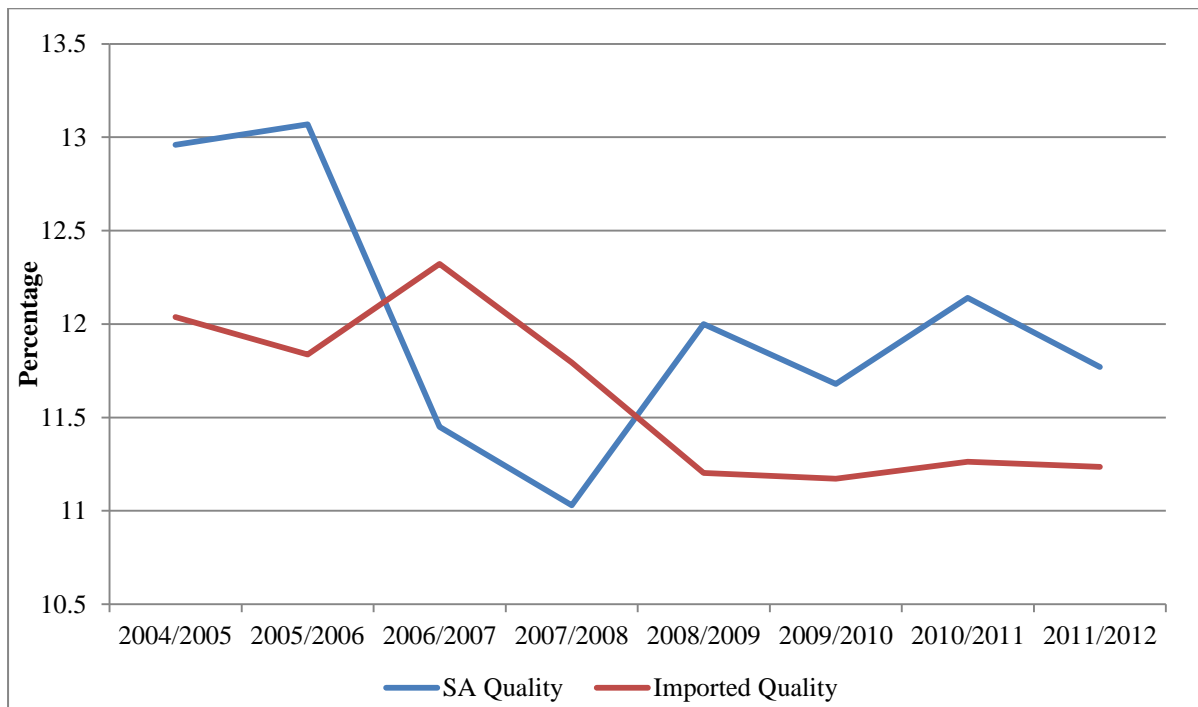


Figure 4.14: Annual protein percentage of local and imported wheat

Source: SAGL (2013)

Hectolitre mass is also regarded as one of the most important characteristics of wheat. This characteristic is therefore included in the grading regulations which ultimately play an essential part in price determination. When looking at the trends in respect of hectolitre mass (in kilograms) over the last eight years, a general upward trend of both the locally-produced and imported wheat can be observed (see Figure 4.15). The hectolitre mass of locally-produced wheat increased from 77.7kg in 2004/2005 to 80.7kg in 2011/2012. In the 2008/2009 production season, a lower than average hectolitre mass was experienced, which can be ascribed to local production conditions.

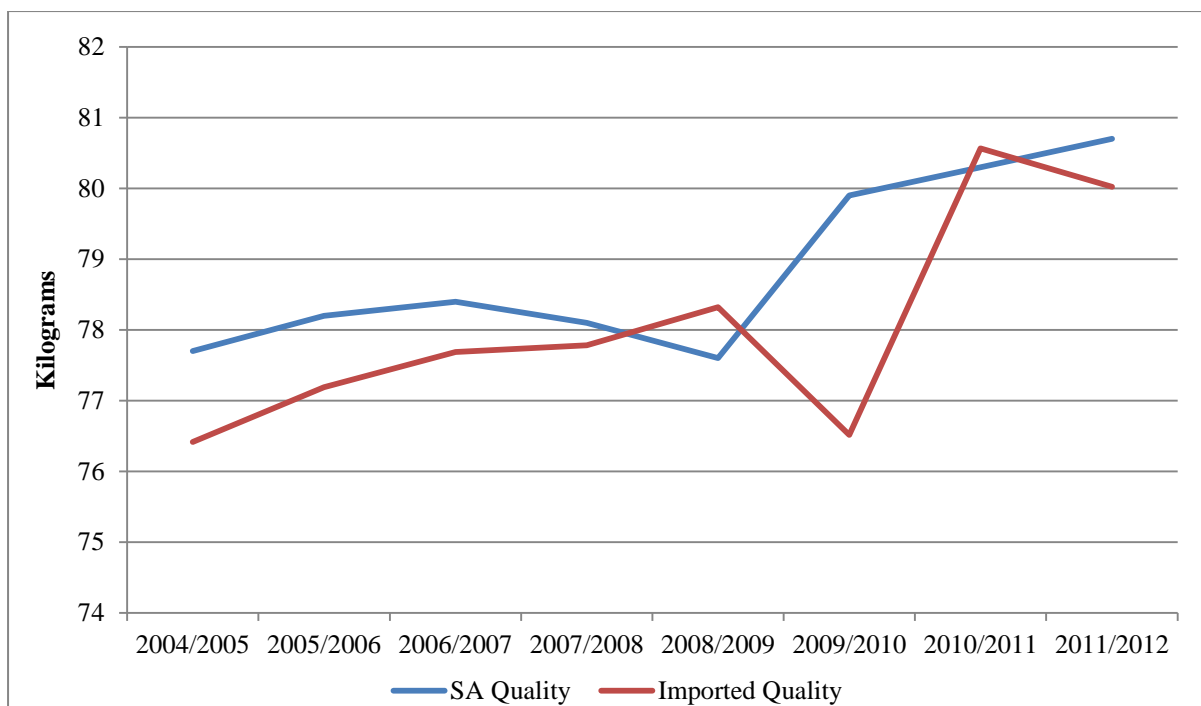


Figure 4.15: Annual hectolitre mass content of local and imported wheat

Source: SAGL (2013)

Falling number is the third characteristic of wheat that determines the grade of a wheat sample. As can be seen in Figure 4.16, the falling number of locally-produced wheat stayed relatively constant over the last eight years. However, imported wheat's falling number increased to a recent high of 426.99 seconds. The minimum limit of the falling number is 250 seconds for grades 1, 2 and 3 and both these trends are well above that minimum limit.

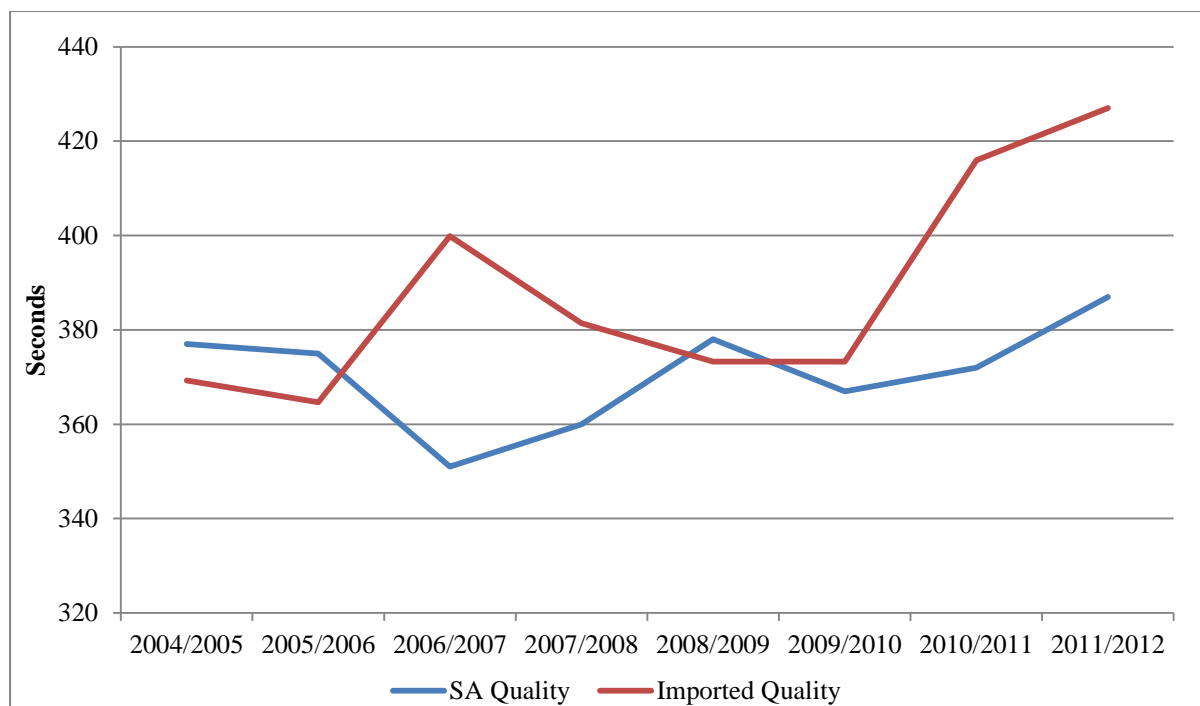


Figure 4.16: Annual falling number in seconds of local and imported wheat

Source: SAGL (2013)

4.4 Performance of the wheat producers in South Africa

The performance of producers (i.e. profit) is determined by income and costs which, as discussed in section 4.3, are dependent on a number of factors, including quality, prices and demand. The importance of a profitable wheat production sector in South Africa is summed up in the fact that wheat is currently the second most heavily-consumed field crop in South Africa (StatsSA, 2014) and together with the local wheat processing sector provides a large number of job opportunities. Similarly, the NAMC (2004) stated that the wheat industry in South Africa is of great economic importance as it contributes significantly to total gross value of production and serves as an important source of staple food.

4.4.1 Wheat production in South Africa

The decline in the number of hectares planted and the decline in overall production form the basis of the problem statement of this study, necessitating a thorough review. As mentioned, recent statistics indicate that wheat production has declined significantly in recent years. Figure 4.17 depicts the total wheat deliveries in South Africa as well as the linear average

from 1984 to 2015. As can be seen, total wheat deliveries in South Africa varied considerably, which can mostly be ascribed to uncontrollable factors such as climate, rainfall, hail, etc. However, when examining the linear trend, it is evident that total wheat deliveries in South Africa showed a decreasing trend during the period under review. Wheat deliveries in 2015 are estimated at 1 779 950 tonnes, with the highest deliveries (approximately 3.49 million tonnes) realised in 1988. More recent peaks in total deliveries were recorded in 1996 and 2001, with 2.57 million and 2.49 million tonnes, respectively.

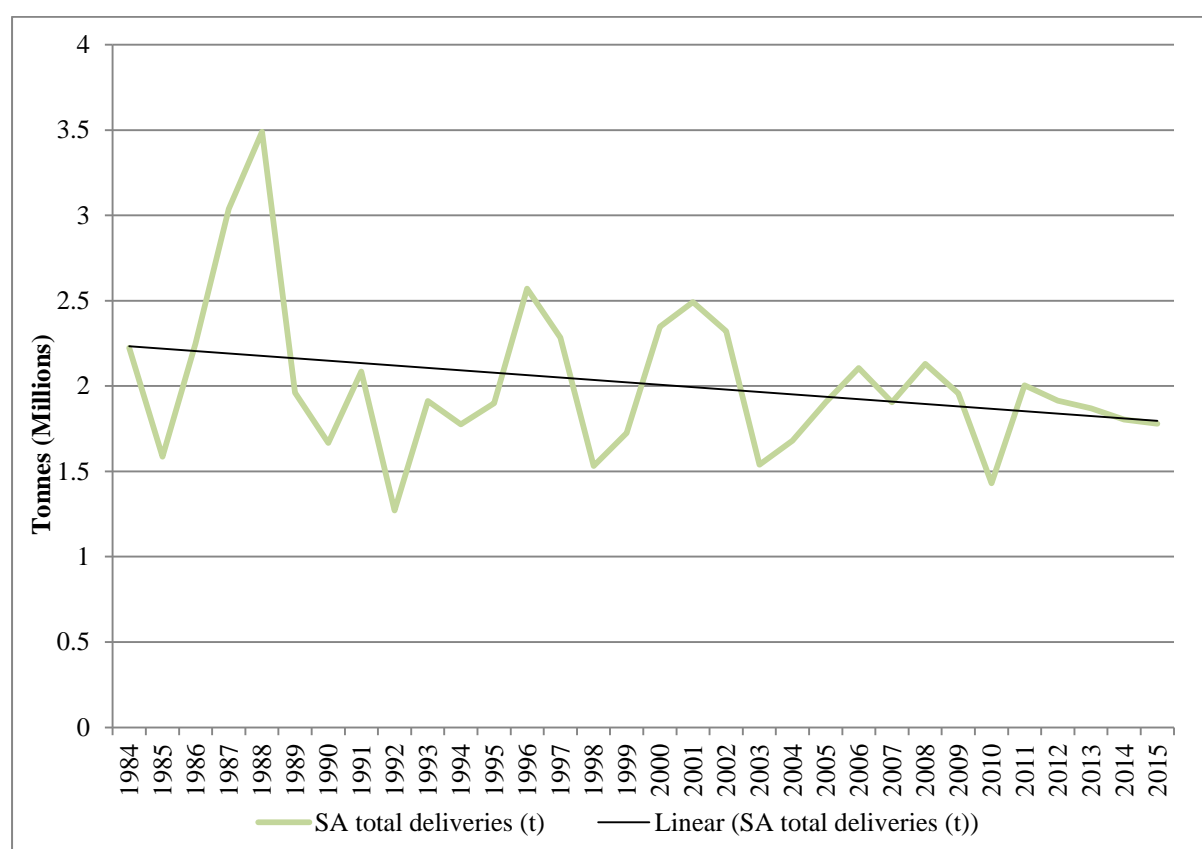


Figure 4.17: Total wheat deliveries in South Africa as well as the moving average from 1984 to 2015

Source: SAGIS (2015)

Figure 4.18 shows that the number of hectares utilised for wheat production in South Africa declined from 1.842 million hectares in 1984 to 468 000 hectares in 2015. This reflects a decline of approximately 75 percent or an annual decline of 2.33 percent. However, as mentioned previously, wheat yields in South Africa improved significantly from an average of 1.34 tonnes per hectare in the mid-80s (1984 to 1986) to an average of 3.21 tonnes per

hectare in 2010 and 2012². This represents an increase in productivity of approximately 139 percent from 1984 to 2012. Although this represents an average annual increase of 4.8 percent, the real improvement was realised from 2010 to 2015 when yields increased by 32.63 percent from 2.56 tonnes per hectare to 3.80 tonnes per hectare.

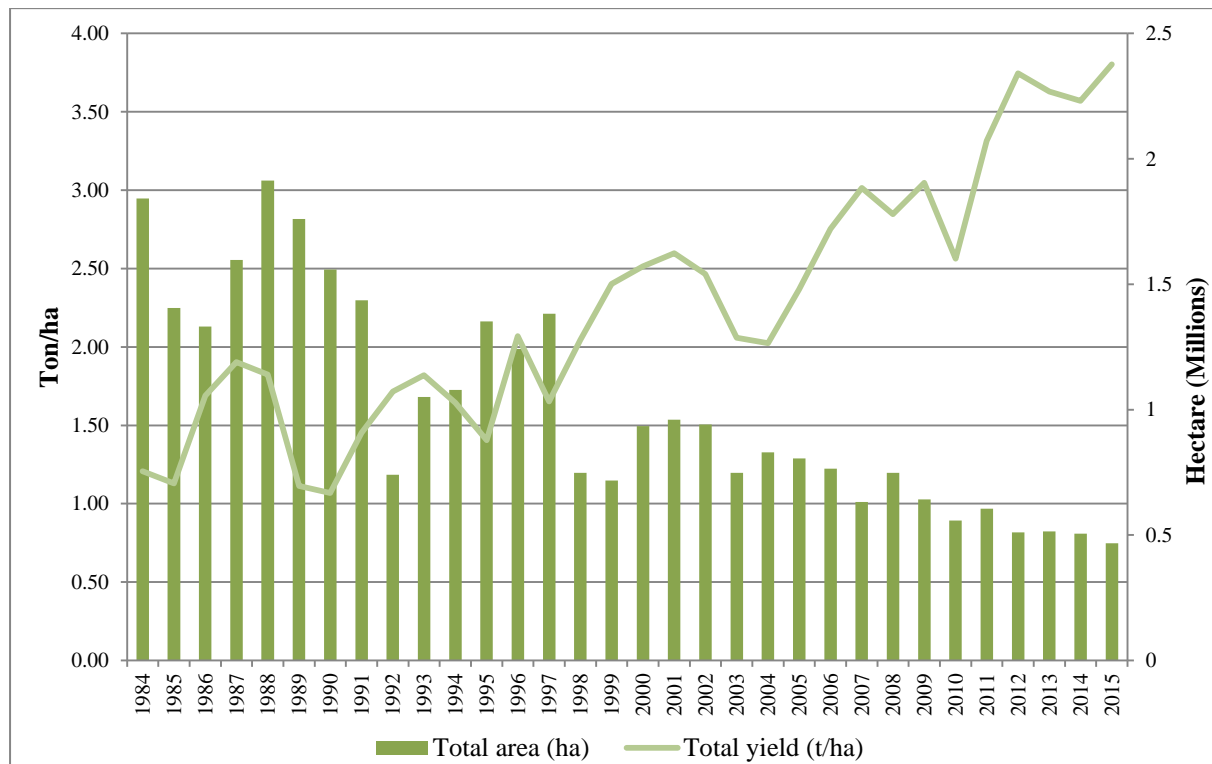


Figure 4.18: Total yield and total area dedicated to wheat in South Africa from 1984 to 2015

Source: SAGIS (2015)

Historically throughout South Africa, wheat has mainly been produced in three regions, namely the Western Cape (winter rainfall area), the Free State (summer rainfall area) and the Northern Cape (irrigation). These three regions combined accounted for approximately 80 percent of local production in the 2014/15 production season (see Figure 4.19). The North West recently became a larger wheat-producing region, with 9.34 percent of national production deliveries in 2014/15. This can be ascribed to the province's close proximity to Randburg where transport differential prices are determined. Most of the wheat produced in South Africa is bread wheat, while small quantities of durum wheat are produced in certain areas. The latter is mainly used for the production of pasta. The majority of wheat is

² An average period of three years was used in an attempt to reduce the effect of annual variations in uncontrollable factors, such as climatic conditions.

processed for human consumption (bread, rusks, biscuits, breakfast cereals, etc.) with only a small proportion used for seed and animal feed. Non-food uses of wheat include ethanol, absorbing agents, adhesives and industrial uses, such as starch on coatings (DAFF, 2011). Because the Western Cape, Free State and Northern Cape are responsible for the bulk of local production, this section will focus mostly on these regions.

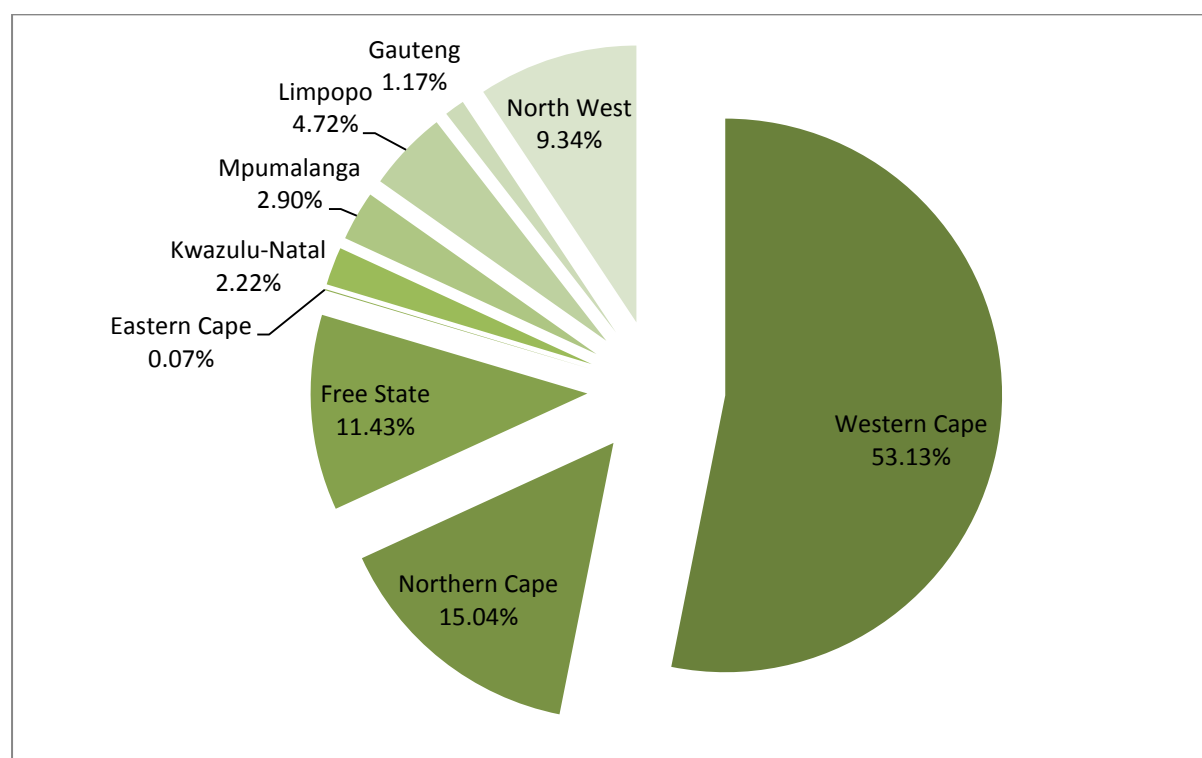


Figure 4.19: Percentage wheat producer deliveries per province in 2014/15 (Oct to Feb)

Source: SAGIS (2015)

4.4.1.1 Western Cape

Figure 4.20 depicts the production, area and yield of wheat in the Western Cape from 1989/90 to 2014/15. As can be seen, the area designated for wheat production in the Western Cape steadily declined over the period under review. Although fluctuating on an annual basis, yields nearly doubled from 1989/90 (1.62 tonnes per hectare) to 2013/14 (2.93 tonnes per hectare). This resulted in the total production in the province showing a generally rising trend.

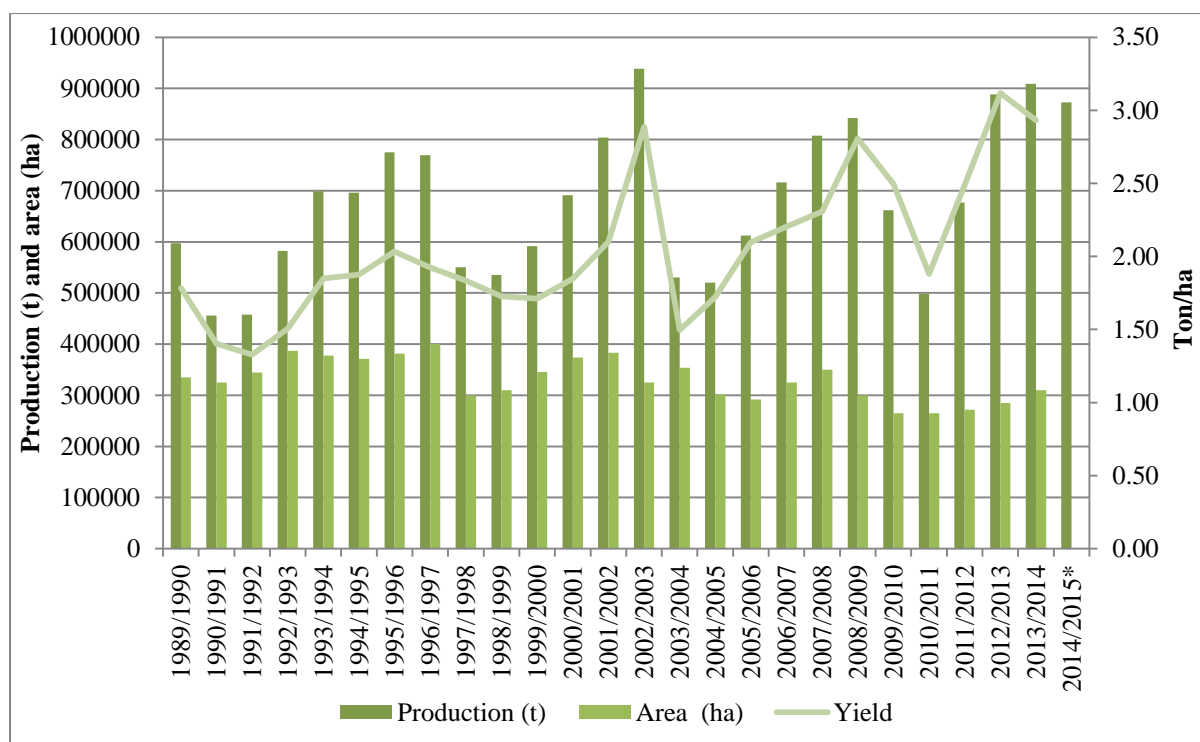


Figure 4.20: Wheat production, area and yield in the Western Cape from 1989/90 to 2014/15 (* from Oct 2014 to Feb 2015)

Source: SAGIS (2015)

From 1990 to 2013, the producer price index (PPI) for wheat increased by 589%. However, during the same period, the price index of intermediate inputs (including fertiliser, fuel, animal health and crop protection, maintenance, repairs and farm feed) increased by nearly 894 percent, according to DAFF (2014). Fertiliser and fuel contributed 13 and 15 percent, respectively, to total variable input costs, while farm feed and maintenance and repairs contributed 33 and 18 percent, respectively, to total variable input costs. Combined, these inputs accounted for 79 percent of total input expenses.

As a result, farmers are feeling more and more pressurised by the cost-price squeeze and this is impacting on the profitability and sustainability of South African wheat producers (Jooste, 2012). However, production costs cannot be held solely responsible for any profits or losses made by wheat farmers. The total income per hectare, which is calculated by multiplying the yield per hectare by the wheat price, also plays a key role in determining whether or not a farmer will make a loss or profit in a specific year.

Therefore, Figure 4.21 depicts the actual production costs per hectare, income per hectare and profits/losses from wheat from 2001 to 2012 in the Swartland region (situated in the Western Cape). As can be seen in Figure 4.21, six of the twelve years produced losses for farmers. This can be ascribed to the fact that prices received by these farmers were significantly lower than those received in other regions within South Africa as the transport differential must be taken into account. The price received by farmers in the Swartland region was R2 378 per hectare compared to R3 130 per hectare received by farmers in the Eastern Free State. To make up for low prices, farmers in the Swartland region need to realise higher yields if they want to achieve similar profitability to farmers in the Eastern Free State. However, with yields as low as those achieved in 2003, 2004 and 2011, significant losses were realised. These losses were inflated by a high transport differential for this region.

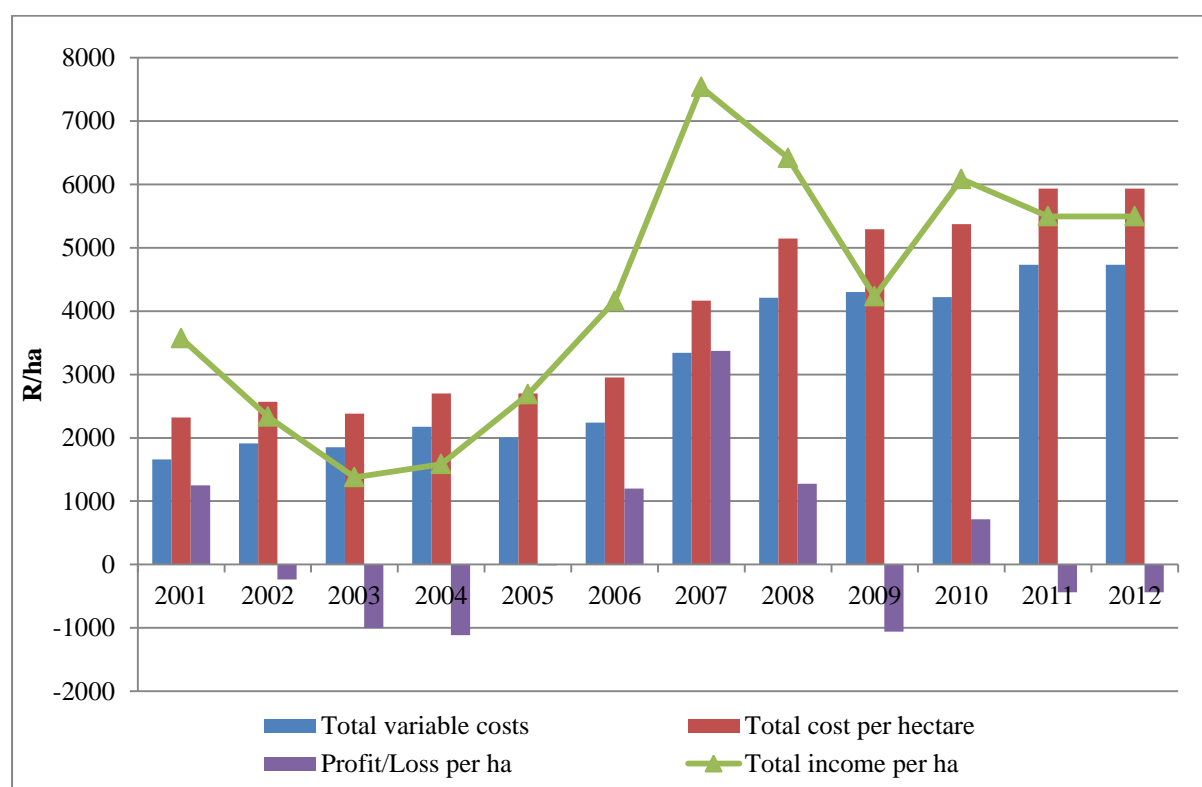


Figure 4.21: Swartland: Actual production costs per hectare, income per hectare and profits/losses from wheat from 2001 to 2012

Source: Grain SA (2014)

As can be seen in Figure 4.22, variable costs in the Southern Cape (which also falls under the Western Cape production region) increased from R2 417 per hectare in 2002 to approximately R5 400 per hectare in 2012. In order for farmers to make a profit, the price

and/or yield must increase at a similar or higher rate. Income per hectare was very erratic over the last few years, but with a relatively lower production cost in the region, losses were recorded in only five years. Similar to the Swartland, a spike in income was seen in 2007 in the Southern Cape, with good prices coupled with good yields. This resulted in high profits and strong performance in the industry in those specific years.

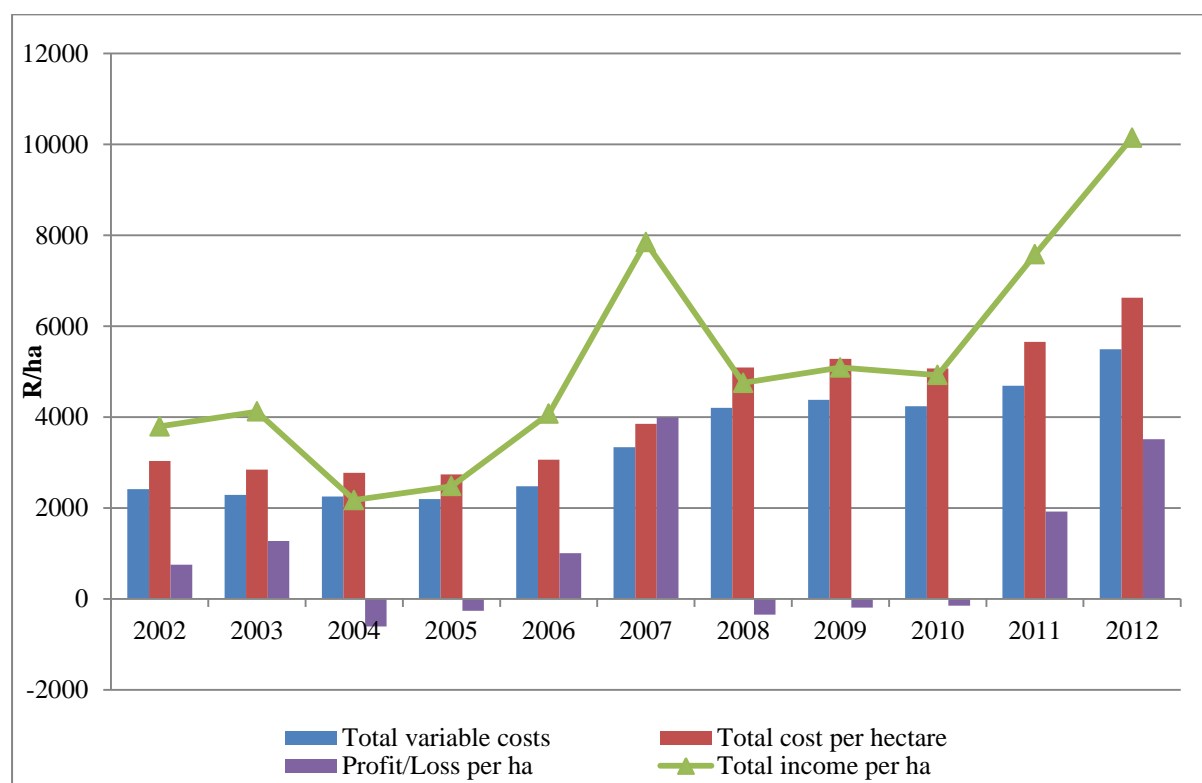


Figure 4.22: Southern Cape: Actual production costs per hectare, income per hectare and profits/losses from wheat from 2002 to 2012

Source: Grain SA (2014)

4.4.1.2 Free State

As can be seen in Figure 4.23, total wheat production in the Free State declined by 72.95 percent from 873 576 tonnes in 1989/90 to 236 239 tonnes in 2013/14. This can be ascribed to a significant decline in the number of hectares designated for wheat production. In 1989/90, approximately 1.1 million hectares were utilised for wheat production, declining to an estimated 90 000 hectares in 2013/14. This represents a decline of 92.31 percent over the period or an annual decline of 3.69 percent. This means that only 7.69 percent of the area that was planted in the Free State in 1989/90 was planted in 2013/14. The availability of more

profitable commodities is believed to be the main reason behind this significant decline in production of wheat in the Free State.

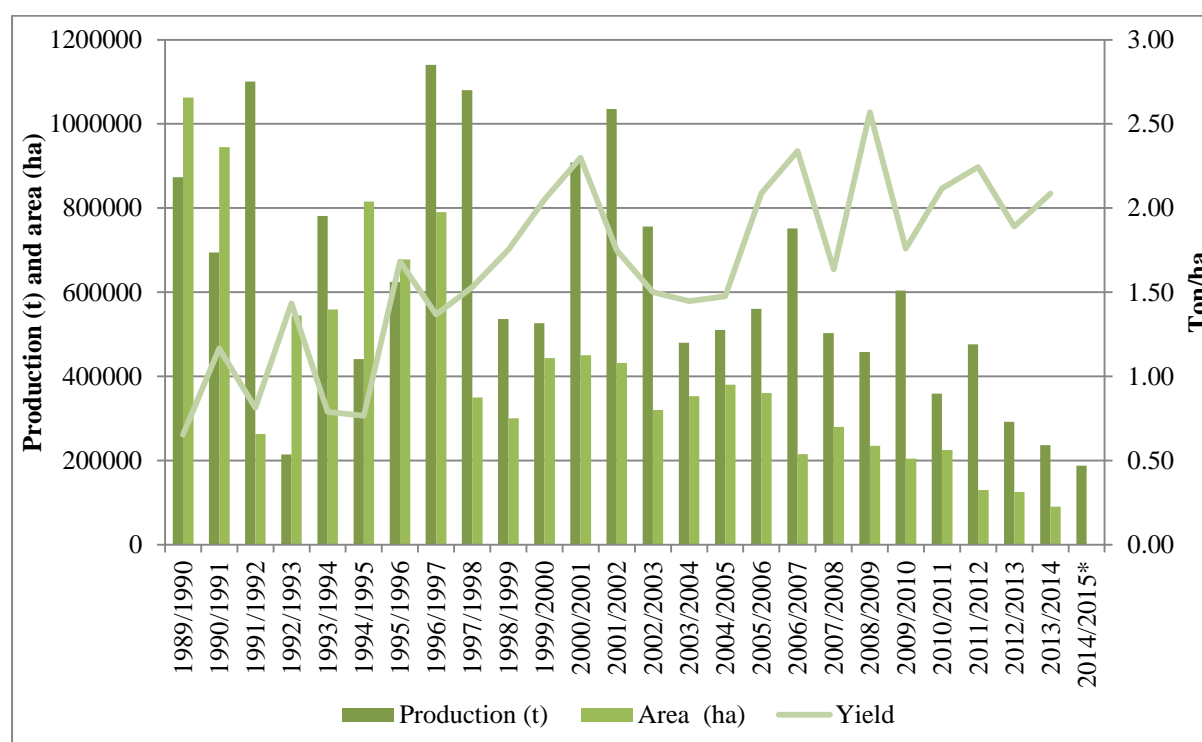


Figure 4.23: Wheat production, area and yield in the Free State from 1989/90 to 2014/15 (* from Oct 2014 to Feb 2015)

Source: SAGIS (2015)

Figure 4.24 depicts the actual production costs, yields and resulting profits or losses of wheat farmers in the Eastern Free State production areas. As can be seen, total variable costs increased from R2 116 per hectare in 2001 to approximately R6 600 per hectare in 2012. Increased demand for fertilisers, weed and pest control as well as seeds in 2008 prompted a spike in the production costs. However, as mentioned, production costs cannot be held solely responsible for any profits or losses made by wheat farmers. The total income per hectare also plays a large part in determining whether or not a farmer will make a loss or profit in a specific year.

As can be seen, an increase in commodity prices in 2007 coupled with a good yield resulted in higher-than-usual income in 2007 for wheat farmers. In 2012, a similar trend was seen, with the income per hectare exceeding the R8 000 per hectare mark. Again this can be ascribed to a higher-than-usual price coupled with higher-than-usual yields. Taking all these

factors into consideration, the performance of wheat farmers in South Africa can be calculated. Of the 12 years included in the analysis, 6 were profitable and 6 made losses. The performance of wheat production in the Eastern Free State is thus very erratic and highly dependent on yields and prices in a given year.

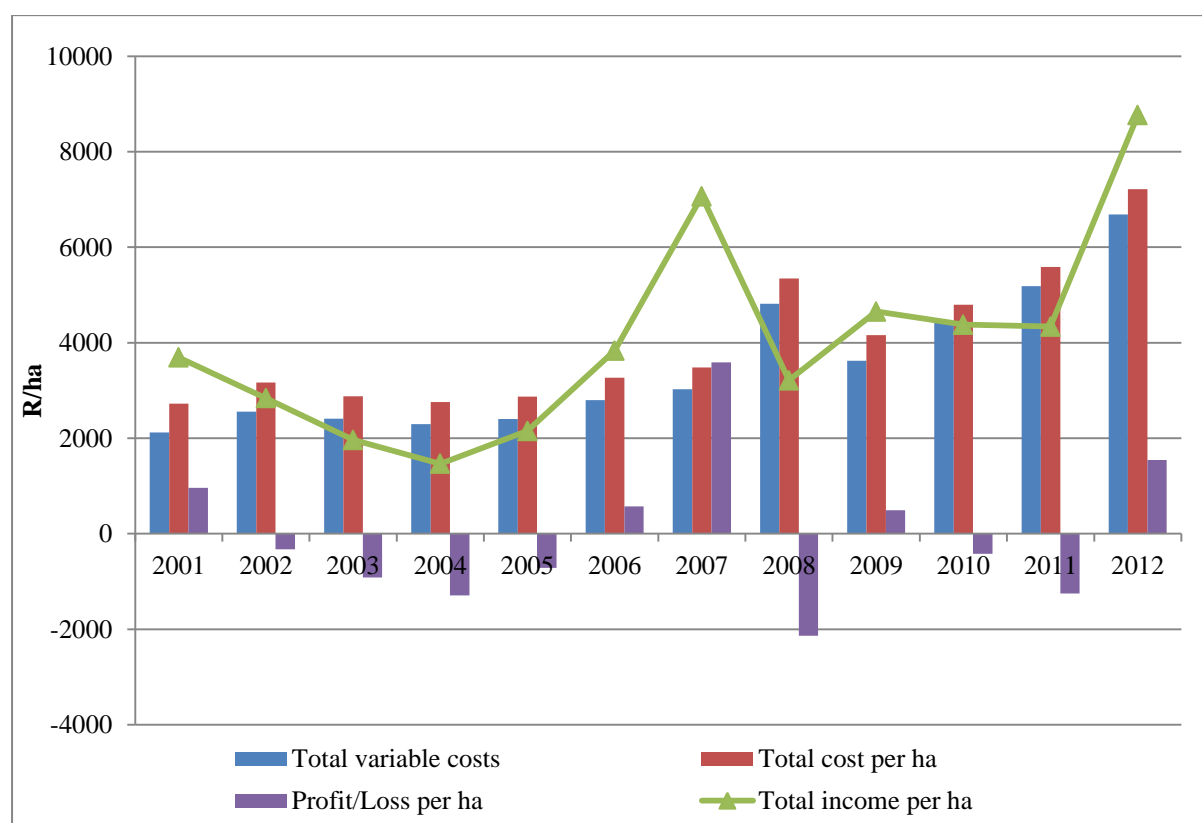


Figure 4.24: Eastern Free State: Actual production costs per hectare, income per hectare and profits/losses of wheat from 2001 to 2012

Source: Grain SA (2014)

4.4.1.3 Northern Cape

Figure 4.25 depicts the production, area and yield of wheat in the Northern Cape. As can be seen from the relatively higher yields compared with other regions, wheat in this region is mostly produced under irrigation. Similar to the other regions in South Africa, the area utilised for wheat production declined from 1989/90 to 2013/14. Production, however, increased on the back of increasing yields. In 2013/14, an estimated 339 776 tonnes of wheat were delivered at an average yield of 8.09 tonnes per hectare.

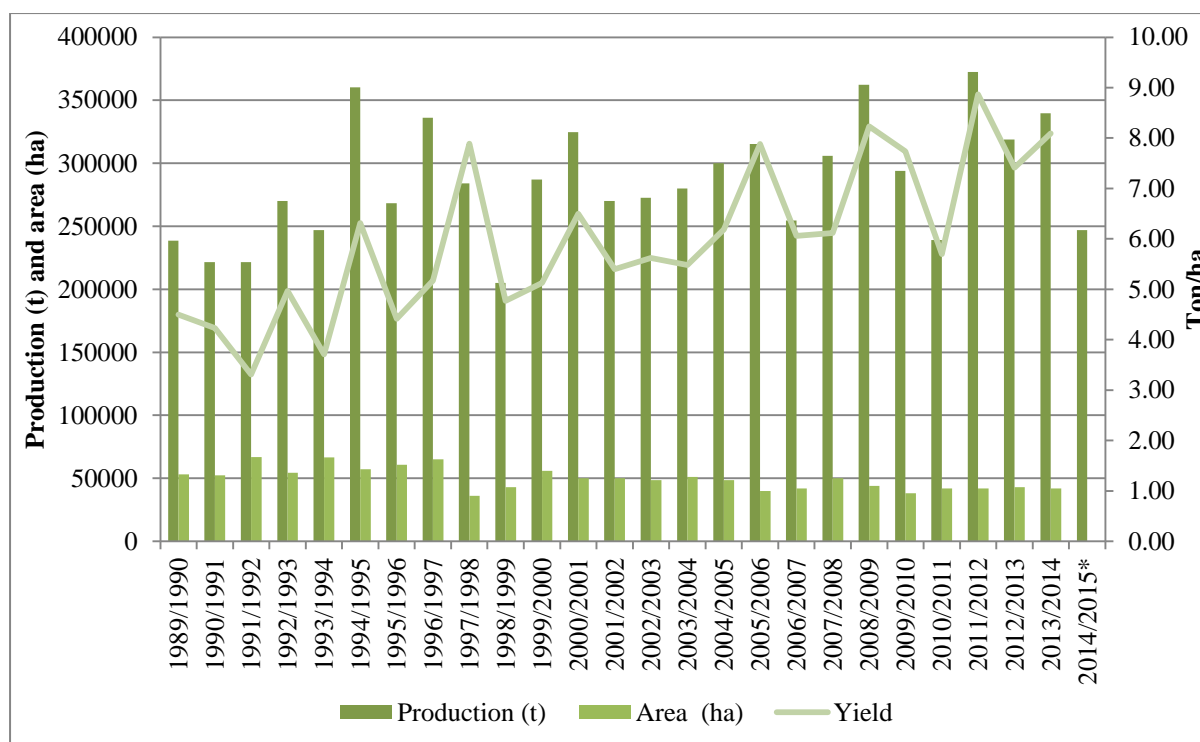


Figure 4.25: Wheat production, area and yield in the Northern Cape from 1989/90 to 2014/15 (* from Oct 2014 to Feb 2015)

Source: SAGIS (2015)

Figure 4.26 depicts the estimated production costs per hectare as well as the income per hectare from 2001 to 2012 in the Northern Cape irrigation areas. As can be seen, the estimated total costs per hectare are higher than those of dry land regions. However, constant higher yields, due to lower climatic risks, ensure that these regions more often than not realise profits. Yet the only substantial profit realised was in 2007 when prices and yields were unusually high. In 2012, a profit of approximately R3 000 per hectare was realised, which is relatively small—especially considering that each farmer usually plants a small number of hectares compared with those in the dry land areas. Relatively low profits compared to alternative crops result in farmers converting; hence the decline in the area designated for irrigated wheat production.

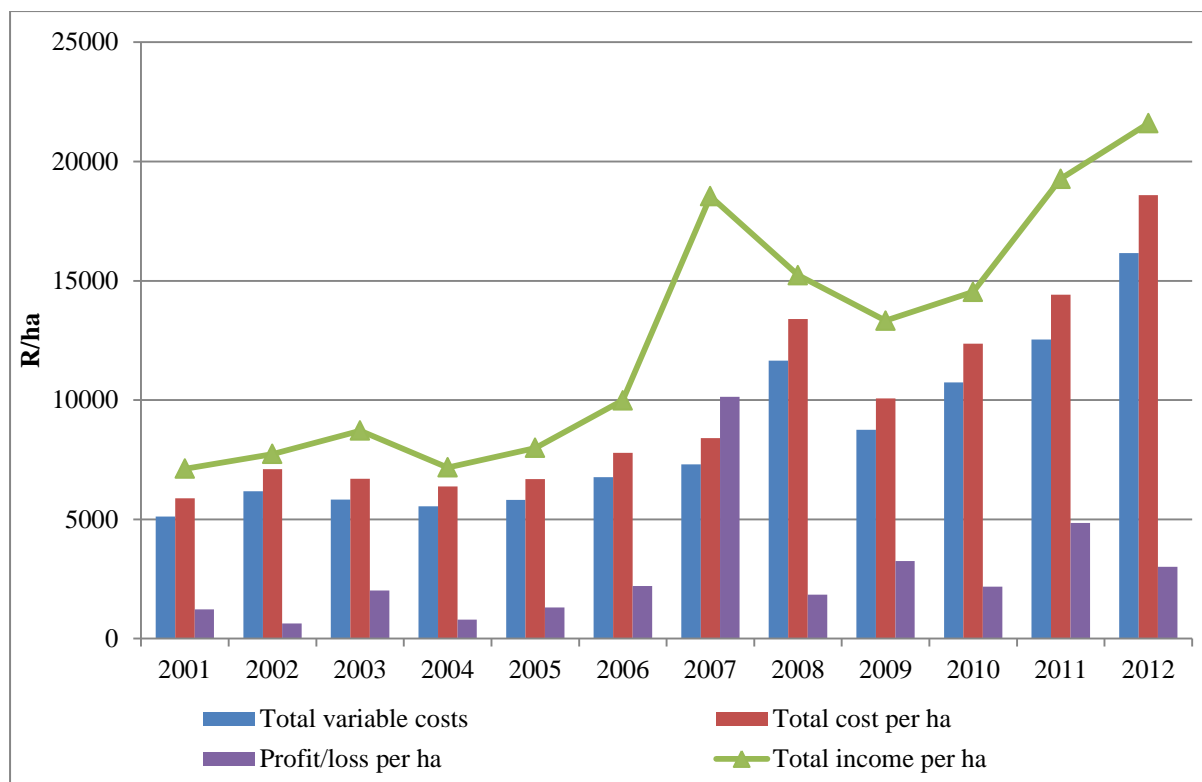


Figure 4.26: Northern Cape: Estimated production costs per hectare, income per hectare and profits/losses from wheat from 2001 to 2012

Source: Grain SA (2014)

4.5 Conclusion

According to Porter (1990), the past performance of an industry must first be determined if its competitiveness is to be analysed. This chapter therefore provided an industry overview—or, in other words, a situation analysis—of the SAWI. This analysis revealed numerous international and local market trends, together with impressions of the institutional environment in which the SAWI currently operates. From the analysis, numerous concerns come to the fore in terms of productivity patterns, especially in the primary wheat sector in South Africa. This, coupled with the current institutional environment of the SAWI, raises the question of what the current competitive status of each sector in the SAWI is.

Chapter 5

Hedonic Price Model

5.1 Introduction

As mentioned in earlier sections, the performance of an industry or business can be directly linked to the profitability of that industry or business, which in turn is dependent on the difference between revenues and costs. However, Van Zyl *et al.* (1993) stated that there is a network of uncontrollable and controllable factors that underpin a company's or sector's revenues and costs. Factors that can be controlled by producers to improve revenue and cut costs thus form the basis of producers' attempts to improve the profitability of their businesses. Other than forming cooperatives and improving production efficiency (produce more with less), input costs are fixed for most producers and can to a large extent not be controlled.

Although producers are price takers, they can positively influence yields and quality, thus improving revenue in a given year. Revenue can be defined by the relationship between product quantity and product price. The price obtained for the product thus plays an essential part in determining not only the revenue of the business but the profitability as well. Sekhar (2010) held a similar view. He stated that the way in which a market is structured is inextricably linked to the process of price formation, which to a large extent determines the profitability and thus the performance of an industry.

The other element that determines revenue and thus profitability—namely product quantity—is, according to Porter (1998), an important factor when measuring competitiveness. The recent decline in the production of wheat in South African can therefore be seen as a decline in the performance of the wheat industry. The fact that marginal land was taken out of production due to a declining number of hectares being utilised for wheat production meant

that the suitability of natural resources increased. This, in turn, increased the average annual yields or productivity of producers. So, although productivity increased in South Africa, it was not necessarily due to an increase in productivity of the cultivars planted. In fact, the declining production and number of hectares suggest that productivity on land traditionally utilised for wheat production would have stayed in decline or at best, stayed relatively constant.

Fossati *et al.* (2010) were of the opinion that the declining productivity can be ascribed to certain quality-related characteristics of wheat. Fossati *et al.* (2010) stated, for example, that quality characteristics such as protein content, which is regarded as one of the most important factors influencing wheat buying decisions in South Africa, are negatively correlated with yield and will consequently have a negative effect on productivity. Karaman *et al.* (2008) held a similar view, asserting that wheat has the defect of conversion (that is, yield declines as quality improves) as a general characteristic. When yield suffers in the face of quality improvements (as has been witnessed in Turkey, for example), the domestic demand for wheat in South Africa cannot be met by the available supply. The necessary quantities of wheat for the South African grain milling industry therefore have to be procured from foreign sources of supply (Karaman *et al.*, 2008).

Against this backdrop, the quality characteristics of South African wheat, the quality characteristics of wheat imported into the country, and the manner in which the quality characteristics of wheat determine the market price, are essential elements that need to be analysed.

In addition, Wilson (1989) stated that the performance of the global wheat industry is influenced by a unique set of factors, which are largely determined by quality-related price differentials. More often than not, commodities exhibit differences in quality, variety and physical attributes while other, market-related factors might also influence prices in a given year (Espinosa and Goodwin, 1991). The market's response to the presence and nature of these characteristics manifests in a price for a particular commodity being set. Differential prices are a reflection of the relative utility offered by a differentiated commodity's characteristics. Thus, a commodity's market price is often viewed as being derived from a combination of implicit (or hedonic) prices which are assigned to the individual characteristics of the commodity.

Understanding all the characteristics that influence the commodity's price in the marketplace is of fundamental concern to agricultural market participants as price can be the root cause of the industry's declining performance (Espinosa and Goodwin, 1991). Hedonic models are built on the premise that price is a function of all the characteristics that a product possesses. Hedonic models are therefore ideal mechanisms for precisely determining the factors that impact on the wheat price and consequently the competitiveness of the wheat industry (Wilson, 1989).

It is therefore important to identify and understand the factors that influence the price received by producers. In an effort to accomplish this, a hedonic price model, which has the ability to identify the factors that have a negative or positive influence on wheat prices in South Africa, was used.

5.2 Development of a theoretical hedonic price model

The development of a conceptual framework for this analysis was based on the work done by Espinosa and Goodwin (1991) who, in turn, built on the work carried out by Lancaster (1966) and Ladd and Martin (1976). According to these authors, the development of such a framework had to be based, first and foremost, on the view that each individual characteristic of wheat is an input in a productive process. Using this assumption, a product such as wheat is demanded by buyers because of the particular characteristics it possesses. The quality and the quantity of each characteristic are accordingly expressed as a function of the price paid for the associated wheat.

The starting point for developing a conceptual framework was the identification of a profit maximisation function $f_y(z)$. The first-order conditions of the profit maximisation problem yielded a hedonic price function of:

$$P_x = R_y \sum_{k=1}^m \left(\frac{\partial f_y}{\partial z_{ky}} \right) \left(\frac{\partial z_{ky}}{\partial x_y} \right) \dots\dots\dots (1)$$

Where:

P_x is the price of input x ;

R_y is the price of output y ;

$\frac{\partial z_{ky}}{\partial x_y}$ is the marginal yield of the k th characteristic in the production of y from input x ;

and

$\frac{\partial f_y}{\partial z_{ky}}$ is the value of the marginal product of characteristic k used in the production of y .

The $R_y \frac{\partial f_y}{\partial z_{ky}}$ term represents the marginal implicit price of the k th characteristic of the hedonic price.

According to Espinosa and Goodwin (1991), this equation states that the price paid for each input is equal to the sum of the marginal implicit prices of the characteristics possessed by the input, multiplied by the marginal yield of such characteristics. The equation can be simplified into a linear hedonic price function:

$$P_x = \sum_{k=1}^m B_k z_{kxy} \dots\dots\dots(2)$$

Where:

B_k is the marginal implicit value of the characteristic k ;

and z_{kxy} is the quantity of characteristic contained in each unit of input x that goes into the production function y .

According to the authors, if input prices are regressed in input characteristics, as measured by z_{kxy} , the effect that physical characteristics have on the prices paid for inputs can be determined, which will measure the marginal implicit values of the characteristics. Although buyers consider a large number of characteristics when purchasing wheat, the characteristics that are most relevant in the determination of prices in South Africa are illustrated by the primary factors in Table 5.1.

In addition, characteristics that directly measure the milling and dough properties of a wheat sample will also be viewed as a set of variables. These variables are not considered at the time of purchase and do not have a direct impact on wheat prices. However, it must be noted that these variables are certainly not independent of the characteristics that are typically taken into account in the determination of wheat quality. Espinosa and Goodwin (1991) were of the opinion that the traditional characteristics might inaccurately measure the end-use potential of a given wheat lot.

As a result, more factors that may improve the accuracy of the model should be included as an alternative implicit price model. These characteristics are represented by the secondary factors in Table 5.1. Additional factors that are taken into account when analysing whether or not a new cultivar can be released for commercial production in South Africa are included in Table 5.1 under Additional factors.

Table 5.1: Relevant factors in the determination of wheat prices in South Africa

Category	Characteristic
Primary factors	Origin of wheat (dummy variables)
	Protein content (Prot)
	Falling number (Fall)
	Hectolitre mass (Hect)
	Total percentage of defects (Defects)
Secondary factors	Buhler extraction percentage (Extrac)
	Colour KJ 76 (Colour)
	Peak time (Peak)
	Absorption (Absorp)
	Strength (Str)
	P/L value (Pl)
	Corrected volume (Vol)
Additional factors	Thousand kernel mass (kermass)
	Development time (develop)
	Farinogram stability (farstab)
	Alveogram stability (alvstab)
	Distensibility (distens)
	Exchange rate (excrate)
	World wheat production (wprod)

5.2.1 Discussion of data used

Data acquired for this analysis were obtained from the South African Grain Laboratory (SAGL) which publishes a comprehensive annual review of the quality of the season's wheat crop. This document includes a review of the quality of imported and locally-produced wheat. The review also reports on various measures of wheat quality characteristics and physical attributes. Such characteristics and attributes are reported as country averages for nine different wheat-producing countries, namely Argentina, Australia, Brazil, Canada, Germany, Ukraine, Uruguay, the United States of America (USA) and South Africa. A comprehensive cross-sectional time-series panel of observations of average wheat attributes

for each of the nine wheat-producing countries was collected for the period 2003/2004 to 2011/2012.

The monthly average of prices was calculated by using the “free on board” price for each region and incorporating the International Grain Council’s freight rate, current exchange rate, insurance charges, financing costs, discharging costs, import tariff and inland transportation costs. Monthly average data were converted into annual average data in line with wheat quality data obtained from the SAGL. All prices were calculated delivered at Randfontein, which is where the South African SAFEX price is determined, and were indexed with the International Grain Council’s wheat price index to convert them to 2011/2012 prices. This allowed the individual coefficients, which represent marginal implicit values of the characteristics, to be interpreted in 2011/2012 value terms.

Basic quality information produced by the SAGL was obtained for each wheat-producing region in all the years that actual imports were delivered to South Africa—that is, from 2003/2004 to 2011/2012. As a result, certain years from certain countries had no data available. Locally-produced and imported wheat is comprehensively tested by the SAGL on a yearly basis. This includes 16 quality-related tests.

All these quality-related results with their corresponding average annual prices were available for 58 cross-sectional time-series observations. A summary of the data is provided in Table 5.2. In order to improve the accuracy of the model and ensure that all factors contributed the same weight to the end result, the values were converted to unit-free values before the analyses were performed. This was accomplished by converting all the values to a minimum base value of 100.

Table 5.2: Summary of statistics for variables utilised in the analysis

Variable	n	Mean	Standard deviation
Price (R/ton)	58	3493.17	1763.65
Hectolitre mass (kg/hl)	58	78.98	1.84
Kernel mass (g)	58	35.47	3.59
Falling number (s)	58	382.98	60.60
Protein content (%)	58	11.98	0.86
Extraction (%)	58	73.65	1.34
Colour (KJ76)	58	-1.14	1.04
Peak time (min)	58	3.58	0.64
Absorption (%)	58	60.64	2.77
Development time (min)	58	2.99	1.24
Farinogram stability (min)	58	6.91	2.68
Corrected volume (cm ³)	58	810.47	68.80
Strength (cm ³)	58	38.74	8.40
Alveogram stability (mm)	58	99.53	17.54
Distensibility	58	75.93	20.33
P-L value	58	1.49	0.52
Total defects (%)	58	7.39	2.59
Exchange rate (R/\$)	58	7.35	0.84
World production	58	642.09	42.86

5.2.2 Application of the hedonic price model and key results

The application of the hedonic price model was performed in three steps. The first step was to include all the available variables, which are presented in Table 5.3. Although the regression, as presented in Table 5.3, looks relatively good at first glance, multicollinearity could have a seriously adverse effect on the accuracy of the model due to the large number of variables. Multicollinearity is the undesirable phenomenon of the correlations among the independent variables being strong. Multicollinearity increases the standard errors of the coefficients. Increased standard errors, in turn, mean that coefficients for some independent variables might be found not to be significantly different from 0. Without multicollinearity and with lower standard errors, these same coefficients might have been found to be significant and the authors might not have come to null findings in the first place (CHSBS, 2014). According to CHSBS (2014), the easy solution to this problem is to remove one of these variables from the regression model.

Table 5.3: Hedonic price parameter estimates: Step 1 of 3

Dependent Variable: PRICE				
Method: Least Squares				
Sample: 1 54				
Included observations: 54				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2171.789	545.7273	3.979623	0.0005
DAR	234.4217	29.40741	7.971518	0.0000
DAU	84.18961	22.06635	3.815294	0.0007
DB	246.3721	32.27074	7.634536	0.0000
DC	202.2889	21.13598	9.570832	0.0000
DG	208.9371	29.60209	7.058187	0.0000
DUK	286.3123	29.64808	9.657029	0.0000
DUR	249.4809	31.39861	7.945603	0.0000
DUS	213.2156	25.42169	8.387151	0.0000
ABSORP	-13.78799	3.244560	-4.249571	0.0002
ALVSTAB	0.128766	0.057343	2.245524	0.0331
COLOUR	0.517882	0.268946	1.925601	0.0647
DEFECTS	-0.012465	0.063481	-0.196366	0.8458
DEVELOP	0.197920	0.168253	1.176321	0.2497
DISTENS	2.312227	0.275009	8.407807	0.0000
EXCRATE	-0.865554	0.449337	-1.926293	0.0647
EXTRAC	0.995799	3.671087	0.271255	0.7883
FALL	1.050652	0.255610	4.110373	0.0003
FARSTAB	3.743168	0.644936	5.803936	0.0000
HECT	-11.86926	2.742151	-4.328450	0.0002
KERMASS	1.703102	0.699678	2.434123	0.0218
PEAK	-2.600410	0.422165	-6.159698	0.0000
PL	-0.442644	0.129592	-3.415670	0.0020
PROT	2.969974	1.623898	1.828916	0.0785
STR	-3.144728	0.392812	-8.005674	0.0000
VOL	-2.198545	1.130833	-1.944182	0.0624
WPROD	0.662065	0.993774	0.666213	0.5109
R-squared	0.953216	Mean dependent var		137.5993
Adjusted R-squared	0.908165	S.D. dependent var		71.99473
S.E. of regression	21.81747	Akaike info criterion		9.310152
Sum squared resid	12852.06	Schwarz criterion		10.30464
Log likelihood	-224.3741	Hannan-Quinn criter.		9.693689
F-statistic	21.15858	Durbin-Watson stat		2.146112
Prob(F-statistic)	0.000000			

In this case, PROT was highly correlated with seven independent variables, namely DC, ABSORP, ALVSTAB, DEVELOP, DISTENS, STR and VOL (see Table 5.4). To correct for multicollinearity, either PROT or all the other variables would need to be excluded from the

regression. In this instance, the regression that included only PROT explained more variance (higher adjusted R^2) than the regression that included all the other correlated variables and was considered to be the better regression.

Table 5.4: Correlations between PROT and independent variables

	PROT	DC	ABSORP	ALVSTAB	DEVELOP	DISTENS	STR	VOL
PROT	1.000000	0.656937	0.614852	0.670654	0.700649	0.602034	0.754564	0.797448
DC	0.656937	1.000000	0.344742	0.477914	0.471140	0.403639	0.490334	0.578051
ABSORP	0.614852	0.344742	1.000000	0.411552	0.577165	0.146474	0.659813	0.444983
ALVSTAB	0.670654	0.477914	0.411552	1.000000	0.754691	0.600610	0.666467	0.718204
DEVELOP	0.700649	0.471140	0.577165	0.754691	1.000000	0.703677	0.595567	0.836741
DISTENS	0.602034	0.403639	0.146474	0.600610	0.703677	1.000000	0.500760	0.809415
STR	0.754564	0.490334	0.659813	0.666467	0.595567	0.500760	1.000000	0.672782
VOL	0.797448	0.578051	0.444983	0.718204	0.836741	0.809415	0.672782	1.000000

Additionally, HECT and WPROD showed a high correlation with COLOUR, while WPROD and FARSTAB also had a high correlation with EXCRATE and PL, respectively (see Table 5.5). In order to avoid multicollinearity, COLOUR, EXCRATE and PL were excluded while HECT, WPROD and FARSTAB were included in the regression. The last three variables were included on the basis that they explained more variance (higher adjusted R^2) than the variables to which they were correlated.

Table 5.5: Correlations between additional independent variables

	HECT	WPROD	FARSTAB	COLOUR	EXCRATE	PL
HECT	1.000000	0.516755	0.124256	0.701079	0.303486	0.010800
WPROD	0.516755	1.000000	-0.333622	0.621783	0.598150	-0.087213
FARSTAB	0.124256	-0.333622	1.000000	-0.306375	-0.283805	0.721140
COLOUR	0.701079	0.621783	-0.306375	1.000000	0.412755	-0.306774
EXCRATE	0.303486	0.598150	-0.283805	0.412755	1.000000	-0.121171
PL	0.010800	-0.087213	0.721140	-0.306774	-0.121171	1.000000

As these correlated variables had to be removed from the model, it was assumed that the included variables would serve as a proxy for all the excluded correlated variables. Table 5.6 shows the included variables that served as proxies for excluded variables. In other words, these included variables that represented the excluded variables in the model.

Table 5.6: Included variables that serve as proxies for excluded variables

Included variables:	Excluded variables:
PROT	ABSORP
	ALVSTAB
	DEVELOP
	DISTENS
	STR
	VOL
FARSTAB	PL
HECT	COLOUR
WPROD	COLOUR
WPROD	EXCRATE
DEFECTS	
EXTRAC	
FALL	
KERMASS	
PEAK	

The results from excluding all the mentioned dependent variables are shown in Table 5.7. Since the problem of multicollinearity was eliminated in this regression, the parameters could be trusted. In addition, the regression had to be tested for any signs of heteroscedasticity and autocorrelation. Heteroscedasticity arises when the error terms do not have constant variances, thus leading to biased standard errors and, in turn, bias in test statistics and confidence intervals.

In this regression, the combination of the variables included explained 44.33 percent of the variance in price (this was represented by the adjusted R^2). However, the values of the adjusted R^2 and the R^2 were relatively far apart, which pointed to errors in the model. To improve the accuracy of this regression, insignificant variables can be eliminated. For example, a variable with a p-value above the critical value of 0.1 is regarded as insignificant, while a variable with a p-value lower than 0.1 is regarded as significant.

Table 5.7: Hedonic price parameter estimates: Step 2 of 3

Dependent Variable: PRICE				
Method: Least Squares				
Sample: 1 54				
Included observations: 54				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1497.019	770.5677	1.942748	0.0597
DAR	124.4107	45.90373	2.710251	0.0101
DAU	21.21171	35.80307	0.592455	0.5571
DB	97.88031	49.42526	1.980370	0.0551
DG	141.1847	46.00175	3.069116	0.0040
DUK	129.9568	55.63446	2.335904	0.0250
DUR	87.55093	56.76738	1.542275	0.1315
DUS	42.48154	40.30686	1.053953	0.2987
DEFECTS	-0.227360	0.115312	-1.971702	0.0562
EXTRAC	-6.912633	5.910602	-1.169531	0.2497
FALL	0.870824	0.569033	1.530359	0.1344
FARSTAB	-0.859838	0.229667	-3.743854	0.0006
HECT	-8.115259	5.053251	-1.605948	0.1168
KERMASS	-0.026221	1.504785	-0.017425	0.9862
PEAK	-1.128689	0.675887	-1.669939	0.1034
PROT	3.025827	1.557809	1.942361	0.0597
WPROD	1.467594	1.545122	0.949824	0.3484
R-squared	0.632350	Mean dependent var		137.5993
Adjusted R-squared	0.473367	S.D. dependent var		71.99473
S.E. of regression	52.24621	Akaike info criterion		11.00138
Sum squared resid	100997.7	Schwarz criterion		11.62754
Log likelihood	-280.0371	Hannan-Quinn criter.		11.24286
F-statistic	3.977457	Durbin-Watson stat		1.736906
Prob(F-statistic)	0.000260			

By eliminating the so-called insignificant variables (DUS, DAU, DUR, EXTRAC, PEAK and KERMASS) one by one, the regression, as presented in Table 5.8, was obtained. This model was significant at a 1 percent level with an F-statistic of 0.000019. As can be seen, the adjusted R^2 improved to 47.45 percent, meaning that the included variables explained more of the variation in price than the previous regression.

Additionally, the Akaike info criterion and Schwarz criterion improved, which indicates that the relative quality (trade-off between the model's goodness of fit and complexity) of the statistical model improved. There was also no trace of autocorrelation with a Durbin-Watson stat of 2.013555. From the above-mentioned test statistics, the regression presented in Table 5.8 can be regarded as the model that best fits the data. From this model it can be concluded that wheat originating in Argentina (DAR), Brazil (DB), Germany (DG) and Ukraine (DUK) had a meaningful impact on price variation, while percentage of defects (DEFECTS), falling number (FALL), farinograph stability (FARSTAB), hectolitre mass (HECT), protein content (PROT) and world production (WPROD) also made meaningful contributions to the variance in price.

Table 5.8: Hedonic price parameter estimates: Step 3 of 3

Dependent Variable: PRICE				
Method: Least Squares				
Sample: 1 54				
Included observations: 54				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	814.7125	418.2997	1.947676	0.0580
DAR	58.90149	26.17944	2.249914	0.0296
DB	96.04689	38.26566	2.510002	0.0159
DG	83.35738	26.74550	3.116688	0.0033
DUK	55.48017	37.30221	1.487316	0.1442
DEFECTS	-0.224674	0.091647	-2.451516	0.0184
FALL	0.885358	0.409977	2.159532	0.0364
FARSTAB	-0.728999	0.189124	-3.854601	0.0004
HECT	-11.17972	4.592090	-2.434560	0.0191
PROT	2.754036	1.051566	2.618986	0.0121
WPROD	2.557189	1.428298	1.790375	0.0804
R-squared	0.573702	Mean dependent var		137.5993
Adjusted R-squared	0.474562	S.D. dependent var		71.99473
S.E. of regression	52.18687	Akaike info criterion		10.92716
Sum squared resid	117109.2	Schwarz criterion		11.33233
Log likelihood	-284.0334	Hannan-Quinn criter.		11.08342
F-statistic	5.786831	Durbin-Watson stat		2.013555
Prob(F-statistic)	0.000019			

5.3 Conclusion

This chapter attempted to address one of the sub-objectives of this study, namely “to identify specific factors that can be influenced by a concentrated market and that will affect the performance and long-term competitiveness of the wheat production sector in South Africa”. To accomplish this, a hedonic price model was applied. Prices obtained by producers were used to determine the specific factors that influence the price and ultimately the competitiveness of the primary wheat industry in South Africa.

Results from the hedonic price model confirmed the current institutional environment which primarily determines prices by means of a grading system. The grading of wheat in South Africa and ultimately the price received are determined by the protein content (PROT), hectolitre mass (HECT), falling number (FALL) and the number of defects (DEFECTS), which were all identified as playing an influential role in price changes. Farinogram stability (FARSTAB) and world production (WPROD) levels were also identified as factors that will influence South African wheat prices.

The interesting part of the analysis, however, was the additional factors, i.e. dummy variables that have an influence on the wheat price in South Africa. Wheat acquired from Argentina (DAR), Brazil (DB), Germany (DB) and Ukraine (DUK) influenced South African wheat prices. The fact that South African wheat prices are determined by the import parity price means that wheat and the associated quality acquired from these countries ultimately determine local prices. The question is whether these qualities, which determine local wheat prices, are in line with the qualities prescribed to local producers. If this is not the case, the question must be asked why prescribed qualities are set at their current levels, which are often considered too high. Unjustified high prescribed qualities to producers can influence their performance negatively (through productivity and prices) which can be a contributing factor to the declining wheat production sector in South Africa.

Chapter 6

Wheat Quality Standards and their Potential Impact on Performance

6.1 Introduction

The fact that wheat has the defect of conversion (negative correlation between yield and quality) as a general characteristic means that the quality of cultivars prescribed to producers in South Africa will have a significant impact on the productivity of South African producers. As mentioned in previous chapters, productivity is an important aspect that determines the performance and ultimately the long-term competitiveness of the South African wheat industry.

The ultimate objective of this chapter is therefore to determine whether the qualities required for the release of new cultivars for commercial production are justified by the quality provided and demanded in the market environment.

To determine if the quality required for the release of new commercially-accepted wheat cultivars in South Africa will in fact have an impact on the productivity of the primary wheat industry, four comparisons have been developed to determine the impact of the criteria on the performance of the primary wheat industry.

These four comparisons, representing the quality demand of different marketing stages in the wheat industry, will be undertaken against the quality of the cultivars prescribed to producers. In an effort to quantify the impact on productivity (i.e. performance), the yields of existing cultivars will be compared to the yields of cultivars that exhibit the qualities demanded by each of the marketing stages.

6.2 Wheat quality prescribed to South African producers

As mentioned in Chapter 4, the Research Technical Committee (RTC) of the wheat industry is responsible for setting the criteria for the release of new wheat cultivars for commercial production in South Africa. Furthermore, as mentioned and depicted in Table 6.1, the Elands, SST806 and Kariega cultivars are used as the biological standards in the dry land Northern regions, irrigation regions and dry land Southern regions, respectively.

In an effort to determine the average standard that new cultivars are subjected to in order to be released for commercial production in each region, all the data that were available in respect of the three cultivars being used as biological standards, were included. In the case of the Elands cultivar, six years of data were available, while there were only four years of data available for the SST806 and Kariega cultivars. In other words, the standards as depicted in Table 4.3 show the average standards that a new cultivar must adhere to in order to be released for commercial production.

These quality standards will be compared to four different comparisons in an effort to understand whether or not these standards are justified. These four comparisons are:

- Wheat quality standards compared to wheat quality supplied;
- Wheat quality standards compared to wheat flour quality;
- Wheat quality standards compared to the quality of price determining wheat-importing countries;
- Potential higher yields if the criteria are relaxed.

Because quality and productivity are so closely intertwined in the wheat industry, it is assumed that these standards will be justified by the associated yields, productivity and current performance of wheat producers in South Africa. The opposite is, however, also true. If these quality standards are not justified by the demand in either of the marketing stages, the lack of yield, productivity and performance of wheat producers in South Africa are not warranted and modifications to the current criteria must be made.

6.3 Wheat quality standards compared to wheat quality supplied

The first comparison looks at wheat quality provided to buyers (millers, bakers, etc.) over a specific time period by analysing data obtained from the South African Grain Laboratory (SAGL). The quality of locally-produced wheat and imported wheat is used to simulate the wheat quality that is supplied to buyers over a specific period of time. The SAGL analyses local and imported wheat annually to determine the rheological and baking characteristics of all wheat in South Africa, which allow for comparison. In Table 6.1, the eight-year weighted average wheat quality is calculated by including the characteristics of local and imported wheat. Data from the first analysis performed by the SAGL were included to correct for seasonal variation due to external production factors.

In South Africa, wheat processors have the ability to control wheat flour quality through the quality of imported wheat. When circumstances in South Africa do not permit the production of high-quality wheat, buyers still have the option of importing higher quality wheat in order to obtain a desired level of wheat quality. The opposite is also true in that buyers can import relatively lower-quality wheat when local wheat quality is of a high standard in a specific production year.

The eight-year average wheat quality as shown in Table 6.1 is therefore regarded as an indication of the average wheat quality desired by wheat processors in South Africa. The wheat quality obtained from this analysis is compared with the biological standards set for each major production region in South Africa (Table 4.3).

Table 6.1: Annual weighted average of wheat quality of local and imported wheat

	Category	Min	Max	Total season demand								8-year weighted average
				2004/2005	2005/2006	2006/2007	2007/2008	2008/2009	2009/2010	2010/2011	2011/2012	
Kg/hl (clean)	P	-1.8		77.16	77.84	78.21	77.96	77.86	78.57	80.44	80.39	78.55
1000 kernel mass, g	S	-4	4	34.67	36.54	36.19	36.66	38.00	38.79	36.18	36.15	36.65
Falling number, sec	P	-15%		373.73	371.32	364.19	369.05	376.30	369.48	395.53	405.49	378.14
Protein (12% mb)	P	-1%		12.57	12.63	11.68	11.35	11.71	11.48	11.67	11.52	11.83
Buhler Extraction	P	-1.50%		73.94	74.84	74.80	74.79	74.66	73.29	74.05	73.50	74.23
Colour (KJ 76)	P		1	-0.81	-1.17	-0.86	-1.38	-1.42	-1.78	-1.65	-2.49	-1.45
Mixogram												
Peak time (SST 806)	P	-10%	20%	2.68	3.04	2.94	3.31	2.79	2.92	3.60	3.51	3.10
Peak time (Elands)	P	-25%	15%	2.68	3.04	2.94	3.31	2.79	2.92	3.60	3.51	3.10
Peak time (Kariega)	P	-25%	15%	2.68	3.04	2.94	3.31	2.79	2.92	3.60	3.51	3.10
Farinogram												
Absorption	P	-2.50%	2.50%	61.14	61.89	61.01	60.24	60.32	59.71	60.97	59.99	60.66
Development time, min	S	-25%	25%	4.09	4.12	3.18	2.94	3.36	2.94	3.84	3.30	3.47
Stability, min	S	-30%	10%	9.09	7.97	6.73	6.07	6.69	5.97	7.13	8.66	7.29
Baking test 100g												
Corrected volume, cm ³	P	-10%		871.79	865.85	816.87	801.86	842.38	805.05	790.47	797.93	824.02
Alveogram												
Strength, cm ³	P	-20%	20%	42.00	40.32	39.21	41.62	36.96	34.38	33.83	33.30	37.70
Stability, mm	S	-20%	20%	91.80	93.19	90.24	96.24	90.31	90.15	96.39	86.58	91.86
Distensibility	S	-10%	20%	103.23	92.53	94.69	91.58	85.89	77.03	69.81	81.42	87.02
P/L value	P	-25%	25%	1.11	1.24	1.05	1.25	1.24	1.29	1.60	1.21	1.25

When comparing the average wheat quality of local and imported wheat (see the South African wheat quality supplied column in Table 6.2) to the biological standards in each region as set by the RTC, a somewhat disturbing picture emerges. From Table 6.2, it can be seen that the quality provided to processors and the quality standards prescribed by the RTC are not in line. Table 6.2 shows the comparison between quality provided to processors (as was calculated in Table 6.1) and the biological standards in the three wheat production regions of South Africa.

Values marked in green are within the release criteria bracket and reflect values that are in line with quality provided to processors in South Africa. However, the values marked in red do not reflect the quality provided and can be considered to be too strict. Out of the 15 tests done by the SAGL, six values of the Elands cultivar fall outside the bracket, while eight and nine values are considered to be too strict in SST806 and Kariëga cultivars, respectively. For instance, with regards to the 1000 kernel mass test of Elands, the upper limit of 36.37 gram are less than the 8 year average quality in South Africa and thus falls outside the allowed deviation. However, the lower limit of 28.37 gram (green value) is still less than the 8 year average in South Africa and thus falls within the allowed deviation.

Based on these values, alterations to the existing tolerance levels are proposed for the identification of new commercial wheat cultivars in South Africa. Owing to regional differences in quality, different alterations are suggested for each of the three wheat production regions in South Africa (see Table 6.3). The values marked in red are the proposed brackets for new dry land Free State cultivars, irrigation cultivars and dry land Western Cape cultivars, respectively.

The proposed release criteria bracket for dry land Free State cultivars suggests that six of the 15 tolerance level brackets are widened to reflect quality provided to processors. It is further proposed that eight of the 15 tolerance level brackets for the release criteria for new irrigation cultivars should be altered, while nine out of the 15 tolerance level brackets for dry land Western Cape cultivars should be altered to reflect quality demand in South Africa.

Table 6.2: A comparison between wheat quality supplied and biological standards in the three wheat production regions in South Africa

	South African wheat quality supplied (8-year average) – Unprocessed wheat	6-year biological standard for Elands (dry land Northern Standard)	Release criteria bracket for Northern dry land cultivars (Elands)		4-year biological standard for SST806 (irrigation)	Release criteria bracket for irrigation (SST806)		4-year biological standard for Kariega (Southern Spring wheat)	Release criteria bracket for Kariega (Cape Spring)	
			Min	Max		Min	Max		Min	Max
Kg/hl (clean)	78.55	80.39	78.59		81.74	79.94		81.73	79.93	
1000 kernel mass, g	36.65	32.37	28.37	36.37	37.93	33.93	41.93	41.38	37.38	45.38
Falling number, sec	378.14	350.20	297.67		443.57	377.04		427.33	363.23	
Protein (12% mb)	11.83	13.02	12.02		12.46	11.46		12.48	11.48	
Buhler Extraction	74.23	75.54	74.41		77.16	76.00		75.33	74.20	
Colour (KJ 76)	-1.45	-2.20		-1.20	-2.99		-1.99	-3.13		-2.13
Mixogram										
Peak time (SST 806)	3.10				2.46	2.21	2.95			
Peak time (Elands)	3.10	3.07	2.30	3.53						
Peak time (Kariega)	3.10							2.75	2.06	3.16
Farinogram										
Absorption	60.66	63.17	61.59	64.75	62.01	60.46	63.56	62.45	60.89	64.01
Development time, min	3.47	5.58	4.19	6.98	5.46	4.09	6.82	5.92	4.44	7.40
Stability, min	7.29	9.93	6.95	10.92	7.56	5.29	8.31	10.87	7.61	11.95
Baking test 100g										
Corrected volume, cm ³	824.02	877.50	789.75		946.14	851.53		939.17	845.25	
Alveogram										
Strength, cm ³	37.70	44.54	35.64	53.45	40.86	32.69	49.03	43.78	35.03	52.54
Stability, mm	91.86	100.71	80.57	120.85	78.49	62.79	94.18	83.83	67.07	100.60
Distensibility	87.02	92.69	83.42	111.23	121.00	108.90	145.20	117.10	105.39	140.52
P/L value	1.25	1.27	0.95	1.58	0.67	0.50	0.83	0.75	0.56	0.94

Table 6.3: Proposed deviation from biological standards based on wheat quality supplied in South Africa of unprocessed wheat

	Current deviation allowed		Proposed bracket for dry land Northern Standard (Elands) based on SA quality supplied		Proposed bracket for irrigation cultivars (SST806) based on SA quality supplied		Proposed bracket for Cape Spring wheat (Kariega) based on SA quality supplied	
	Min	Max	Min	Max	Min	Max	Min	Max
Kg/hl (clean)	-1.8		-1.84		-3.19		-3.18	
1000 kernel mass, g	-4	4	-4.00	4.28	-4.00	4.00	-4.73	4.00
Falling number, sec	-15.00%		-15.00%		-15.00%		-15.00%	
Protein (12% mb)	-1.00%		-1.19%		-1.00%		-1.00%	
Buhler Extraction	-1.50%		-1.73%		-3.79%		-1.50%	
Colour (KJ 76)		1		1.00		1.54		1.69
Mixogram								
Peak time (SST 806)	-10.00%	20.00%			10.00%	26.18%		
Peak time (Elands)	-25.00%	15.00%	-25.00%	15.00%				
Peak time (Kariega)	-25.00%	15.00%					-25.00%	15.00%
Farinogram								
Absorption	-2.50%	2.50%	-3.97%	2.50%	-2.50%	2.50%	-2.87%	2.50%
Development time, min	-25.00%	25.00%	-37.79%	25.00%	-36.39%	25.00%	-41.33%	25.00%
Stability, min	-30.00%	10.00%	-30.00%	10.00%	-30.00%	10.00%	-32.93%	10.00%
Baking test 100g								
Corrected volume, cm ³	-10.00%		-10.00%		-12.91%		-12.26%	
Alveogram								
Strength, cm ³	-20.00%	20.00%	-20.00%	20.00%	-20.00%	20.00%	-20.00%	20.00%
Stability, mm	-20.00%	20.00%	-20.00%	20.00%	-20.00%	20.00%	-20.00%	20.00%
Distensibility	-10.00%	20.00%	-10.00%	20.00%	-28.08%	20.00%	-25.68%	20.00%
P/L value	-25.00%	25.00%	-25.00%	25.00%	-25.00%	87.21%	-25.00%	66.16%

The new, more relaxed criteria have been derived to determine if previously rejected cultivars could have been released for commercial production in South Africa or not. The yields of these cultivars are compared to the yields of already accepted cultivars to determine the difference in productivity and therefore competitiveness. A delicate balance between the optimal wheat quality and yields must be found, which will benefit the entire industry. This balance between quality and yield must ultimately be determined through consumer demand (Blakeney *et al.*, 2009).

Again it is important to distinguish between different regions within South Africa, as each region has its own cultivar that serves as a biological standard against the new cultivars released. Unfortunately, wheat breeders have few records on rejected cultivars or their yields. In order to compare apples with apples and to obtain more reliable information, yields of accepted cultivars that are produced in similar circumstances must be used for comparison purposes (Hawkins, 2014). Yields of accepted cultivars are published in a cultivar trials booklet annually. As a result, yields of “new” cultivars are compared to yields of cultivars that were determined in similar circumstances and are therefore deemed to offer the most appropriate form of comparison.

Looking at the dry land Free State region (using Elands cultivars as the biological standard), data for eight previously-rejected cultivars were available and compared to the suggested new criteria. Of the eight cultivars, one could have been accepted if the new proposed criteria were used. This specific cultivar (WNT 2005/2007) had an average yield of 3.43 tonnes per hectare in the 2006/2007 production season (Table 6.4). Comparing this figure to the yield of 2.7 tonnes per hectare (average yield of accepted cultivars in the Free State production region), a potential increase of 26.43 percent could have been realised if criteria had been relaxed.

Comparing rejected cultivars to the proposed new criteria in the Northern Cape irrigation areas, it was found that two cultivars (BSP09/17 and BSP07/11) would have been acceptable. Comparing the yields of these cultivars to the average yield of the accepted cultivars, an increase of 12.62 percent could have been achieved if the proposed criteria had been implemented in the northern irrigation areas (Table 6.4).

There are two cultivars that could have been accepted in the Western Cape production areas if the proposed criteria had been implemented, namely W11-02 and W11-04. Comparing the highest yielding “new” cultivar (W11-04) to the average yield in the Western Cape production regions, an increase of 7.04 percent could have been realised if the proposed new criteria had been implemented in the Western Cape (Table 6.4).

Assuming that 57 percent of dry land wheat with a potential yield increase of 7.06 percent is produced in the Western Cape and 24.3 percent in the Free State with a potential yield increase of 26.43 percent, are all produced under dry land practices, it can be assumed that wheat yields under dry land could have been increased by 12.80 percent if the proposed new criteria had been implemented. As mentioned, cultivar yields under irrigation, amounting to 18.7 percent of total wheat produced in South Africa, could have been increased by 12.62 percent if the proposed criteria for the release of the new cultivars had been implemented. The average increase in yield over all areas in South Africa is expected to amount to 12.80 percent.

Table 6.4: Potential increase in yield if criteria were relaxed

Region	Proportion of total production	Average yield of accepted cultivars	Yield of “new” cultivars	Potential increase in yields
	%	t/ha		%
Free State (dry land)	24.3	2.7	3.43	26.43
Northern Cape (irrigation)	18.7	7.34	8.27	12.62
Western Cape (dry land)	57	3.76	4.03	7.06
Average national increase	100	-	-	12.8

6.4 Wheat quality standards compared to wheat flour quality

In order to verify findings from the first comparison, a survey of existing wheat flour quality that is sold in South Africa was conducted. This was made possible through the assistance of the Small Grain Institute of the Agricultural Research Council which collected the wheat flour samples and conducted the analyses. Owing to the fact that flour has already undergone processing, certain tests are not possible to conduct. The tests that could be conducted include tests for protein content, mixograph peak time, mixograph absorption, farinograph absorption, farinograph stability, alveograph strength, alveograph stability, alveograph distensibility, alveograph PL-value and the baking volume. These tests are highlighted in

Table 6.5. Owing to an inability to conduct certain tests, such as hectolitre mass, kernel mass, falling number, extraction and colour, the eight-year average quality supplied to processors (see Figure 6.2) will be used. Similar to before, the flour quality obtained from the tests is compared to all three biological standards representing the major production areas within South Africa. As mentioned, these values are used for releasing new cultivars for commercial production.

Values marked in green are within the release criteria bracket and are in line with the quality provided to consumers in South Africa. Test values marked in red do not reflect the quality provided to consumers and can be considered to be too strict. Out of the 15 tests that were done by the SAGL, seven values of the Elands cultivar fall outside the bracket, while 10 values are considered to be too strict in SST806 and Kariëga cultivars, respectively. According to Blakeney *et al.* (2009), any classification and grading system must reflect both the demand from consumers and the ability of producers to achieve these standards. As has been proved, the quality demanded by consumers is not accurately reflected in the criteria for releasing new cultivars. Therefore, alterations to the existing release criteria for new wheat cultivars are essential if the competitiveness of the primary production sector in South Africa is to improve. Table 6.6 illustrates proposed alterations, based on the wheat flour quality demanded by consumers, to the existing criteria for the release of new wheat cultivars.

The proposed release criteria bracket for dry land Free State cultivars suggests that seven of the 15 tolerance level brackets must be widened to reflect quality provided to South African consumers. It is further proposed that 10 of the 15 tolerance level brackets for the release criteria for new irrigation cultivars be altered. This means that 10 existing tolerance levels are set too strictly and must be altered to reflect wheat quality demanded by consumers in South Africa. Nine out of the 15 tolerance level brackets for dry land Western Cape cultivars must be altered to reflect quality demanded by consumers in South Africa. Proposed alterations to the tolerance level brackets are depicted in Table 6.6. Unfortunately, due to the absence of additional data on rejected cultivars and their yield potentials, the same cultivars as identified in the first analysis (supply of unprocessed wheat quality) are also identified in this analysis. This means that this comparison, although a very conservative estimate, supports the potential wheat yield increase of 12.80 percent in South Africa if the proposed criteria had been implemented (see Table 6.4). Additional rejected cultivar data could have resulted in a higher estimated increase in yields.

Table 6.5: Comparison between unprocessed wheat qualities provided to consumers and biological standards in the three wheat production regions in South Africa

	South African quality provided (8-year average) coupled with existing quality on shelves	6-year biological standard for Elands (dry land Northern Standard)	Release criteria bracket for Northern dry land cultivars (Elands)		4 -year biological standard for SST806 (irrigation)	Release criteria bracket for irrigation (SST806)		4-year biological standard for Kariega (Southern Spring wheat)	Release criteria bracket for Kariega (Cape Spring)	
			Min	Max		Min	Max		Min	Max
Kg/hl (clean)	78.55	80.39	78.59		81.74	79.94		81.73	79.93	
1000 kernel mass, g	36.65	32.37	28.37	36.37	37.93	33.93	41.93	41.38	37.38	45.38
Falling number, sec	378.14	350.20	297.67		443.57	377.04		427.33	363.23	
Protein (12% mb)	10.80	13.02	12.02		12.46	11.46		12.48	11.48	
Buhler Extraction	74.23	75.54	74.41		77.16	76.00		75.33	74.20	
Colour (KJ 76)	-1.45	-2.20		-1.20	-2.99		-1.99	-3.13		-2.13
Mixogram										
Peak time (SST 806)	3.30				2.46	2.21	2.95			
Peak time (Elands)	3.30	3.07	2.30	3.53						
Peak time (Kariega)	3.30							2.75	2.06	3.16
Farinogram										
Absorption	62.60	63.17	61.59	64.75	62.01	60.46	63.56	62.45	60.89	64.01
Development time, min	4.50	5.58	4.19	6.98	5.46	4.09	6.82	5.92	4.44	7.40
Stability, min	8.30	9.93	6.95	10.92	7.56	5.29	8.31	10.87	7.61	11.95
Baking test 100g										
Corrected volume, cm ³	816.00	877.50	789.75		946.14	851.53		939.17	845.25	
Alveogram										
Strength, cm ³	50.90	44.54	35.64	53.45	40.86	32.69	49.03	43.78	35.03	52.54
Stability, mm (P-value)	128.30	100.71	80.57	120.85	78.49	62.79	94.18	83.83	67.07	100.60
Distensibility (L-value)	73.10	92.69	83.42	111.23	121.00	108.90	145.20	117.10	105.39	140.52
P/L value	2.00	1.27	0.95	1.58	0.67	0.50	0.83	0.75	0.56	0.94

Table 6.6: Proposed deviation from biological standards based on processed wheat quality in South Africa

		Current deviation allowed		Proposed bracket for dry land Northern Standard (Elands) based on SA wheat flour quality		Proposed bracket for irrigation cultivars (SST806) based on SA wheat flour quality		Proposed bracket for Cape Spring wheat (Kariega) based on SA wheat flour quality	
	Category	Min	Max	Min	Max	Min	Max	Min	Max
Kg/hl (clean)	P	-1.8		-1.84		-3.19		-3.18	
1000 kernel mass, g	S	-4	4	-4.00	4.28	-4.00	4.00	-4.73	4.00
Falling number, sec	P	-15.00%		-15.00%		-15.00%		-15.00%	
Protein (12% mb)	P	-1.00%		-2.22		-1.66		-1.68	
Buhler Extraction	P	-1.50%		-1.73%		-3.79%		-1.50%	
Colour (KJ 76)	P		1		1.00		1.54		1.69
Mixogram									
Peak time (SST 806)	P	-10.00%	20.00%			10.00%	34.30%		
Peak time (Elands)	P	-25.00%	15.00%	-25.00%	15.00%				
Peak time (Kariega)	P	-25.00%	15.00%					-25.00%	20.00%
Farinogram									
Absorption	P	-2.50%	2.50%	-2.50%	2.50%	-2.50%	2.50%	-2.50%	2.50%
Development time, min	S	-25.00%	25.00%	-25.00%	25.00%	-25.00%	25.00%	-25.00%	25.00%
Stability, min	S	-30.00%	10.00%	-30.00%	10.00%	-30.00%	10.00%	-30.00%	10.00%
Baking test 100g									
Corrected volume, cm ³	P	-10.00%		-10.00%		-13.76%		-13.11%	
Alveogram									
Strength, cm ³	P	-20.00%	20.00%	-20.00%	20.00%	-20.00%	24.58%	-20.00%	20.00%
Stability, mm (P-value)	S	-20.00%	20.00%	-20.00%	27.39%	-20.00%	63.47%	-20.00%	53.04%
Distensibility (L-value)	S	-10.00%	20.00%	-21.13%	20.00%	-39.59%	20.00%	-37.57%	20.00%
P/L value	P	-25.00%	25.00%	-25.00%	57.89%	-25.00%	199.79%	-25.00%	166.08%

6.5 Wheat quality standards compared to the quality of price determining wheat-importing countries

Results from the hedonic price analysis conducted in Chapter 5 revealed that wheat originating in Argentina, Brazil, Germany and Ukraine, together with other quality factors, had a meaningful impact on price volatility. As mentioned, South Africa is a net importer of wheat and prices are therefore determined by the import parity price, which is in turn derived from the price of imported wheat. This means that South African wheat prices are determined by the wheat imported from Argentina, Brazil, Germany and Ukraine, and these countries' associated qualities.

This view is supported by Hawkins (2014) who stated that the import parity price is determined by the wheat imported from the country with the lowest-priced wheat. Therefore, the average wheat quality from these countries is depicted in Table 6.7. One can rightfully debate that since these countries dictate our wheat price, their quality ultimately determines the price obtained by South African producers. In Table 6.7, the average quality of imported wheat from the mentioned countries is compared to the biological standards in each of the three production regions of South Africa. Values indicated in red fall outside the recommended bracket as they are considered to be too strict, while values in green indicate values that are in line with the existing criteria.

As is evident, 12 of the 15 test values are considered to be too strict for the Free State dry land cultivars and Western Cape dry land cultivars when compared to the new proposed criteria. In the case of irrigation cultivars, 11 of the 15 test values are considered too strict in comparison with the new proposed criteria.

Similar to the previous two comparisons, brackets for the release of new cultivars are proposed (see Table 6.8). These brackets are used to determine if rejected cultivars would have been accepted if wheat quality, as set by the RTC, was in line with imported wheat quality which determines local prices.

The proposed release criteria bracket for dry land Free State cultivars suggests that 12 of the 15 tolerance level brackets must be widened to reflect the quality of wheat that is primarily responsible for determining local wheat prices. It is further proposed that 10 and 12 of the 15

tolerance level brackets for the release criteria for new irrigation cultivars and dry land Western Cape cultivars, respectively, be altered. On this basis, proposed alterations to tolerance level brackets are depicted in Table 6.8.

Unfortunately, data on rejected cultivars are very limited. A conservative estimate from this comparison therefore indicates that at least the same cultivars as were mentioned in the previous two comparisons will again be accepted for commercial production. This comparison therefore supports the fact that yields could have been increased if the new proposed criteria had been implemented. Based on this analysis, yields could have been increased by an average of 12.80 percent in South Africa.

Table 6.7: Comparison between wheat qualities imported from countries having a meaningful impact on price and biological standards in the three wheat production regions in South Africa

	Average quality of wheat from countries that have an effect on SA prices	6-year biological standard for Elands (dry land Northern Standard)	Release criteria bracket for Northern dry land cultivars (Elands)		4-year biological standard for SST806 (irrigation)	Release criteria bracket for irrigation (SST806)		4-year biological standard for Kariega (Southern Spring wheat)	Release criteria bracket for Kariega (Cape Spring)	
			Min	Max		Min	Max		Min	Max
Kg/hl (clean)	78.51	80.39	78.59		81.74	79.94		81.73	79.93	
1000 kernel mass, g	36.20	32.37	28.37	36.37	37.93	33.93	41.93	41.38	37.38	45.38
Falling number, sec	373.48	350.20	297.67		443.57	377.04		427.33	363.23	
Protein (12% mb)	11.59	13.02	12.02		12.46	11.46		12.48	11.48	
Buhler Extraction	73.74	75.54	74.41		77.16	76.00		75.33	74.20	
Colour (KJ 76)	-0.67	-2.20		-1.20	-2.99		-1.99	-3.13		-2.13
Mixogram										
Peak time (SST 806)	3.69				2.46	2.21	2.95			
Peak time (Elands)	3.69	3.07	2.30	3.53						
Peak time (Kariega)	3.69							2.75	2.06	3.16
Farinogram										
Absorption	60.36	63.17	61.59	64.75	62.01	60.46	63.56	62.45	60.89	64.01
Development time, min	2.08	5.58	4.19	6.98	5.46	4.09	6.82	5.92	4.44	7.40
Stability, min	5.39	9.93	6.95	10.92	7.56	5.29	8.31	10.87	7.61	11.95
Baking test 100g										
Corrected volume, cm ³	749.44	877.50	789.75		946.14	851.53		939.17	845.25	
Alveogram										
Strength, cm ³	36.41	44.54	35.64	53.45	40.86	32.69	49.03	43.78	35.03	52.54
Stability, mm	107.89	100.71	80.57	120.85	78.49	62.79	94.18	83.83	67.07	100.60
Distensibility	61.27	92.69	83.42	111.23	121.00	108.90	145.20	117.10	105.39	140.52
P/L value	1.95	1.27	0.95	1.58	0.67	0.50	0.83	0.75	0.56	0.94

Table 6.8: Proposed deviation from biological standards based on imported wheat quality from countries having a meaningful impact on price

		Current deviation allowed		Proposed bracket for dry land Northern Standard (Elands) based on imported wheat quality		Proposed bracket for irrigation cultivars (SST806) based on imported wheat quality		Proposed bracket for Cape Spring wheat (Kariega) based on imported wheat quality	
	Category	Min	Max	Min	Max	Min	Max	Min	Max
Kg/hl (clean)	P	-1.8		-1.88		-3.23		-3.22	
1000 kernel mass, g	S	-4	4	-4.00	4.00	-4.00	4.00	-5.17	4.00
Falling number, sec	P	-15.00%		-15.00%		-15.80%		-15.00%	
Protein (12% mb)	P	-1.00%		-1.43		-1.00		1.00	
Buhler Extraction	P	-1.50%		-2.38%		-4.43%		-2.11%	
Colour (KJ 76)	P		1		1.53		2.32		2.46
Mixogram									
Peak time (SST 806)	P	-10.00%	20.00%			-10.00%	20.00%		
Peak time (Elands)	P	-25.00%	15.00%	-25.00%	20.20%				
Peak time (Kariega)	P	-25.00%	15.00%					-25.00%	34.18%
Farinogram									
Absorption	P	-2.50%	2.50%	-4.44%	2.50%	-2.66%	2.50%	-3.34%	2.50%
Development time, min	S	-25.00%	25.00%	-62.78%	25.00%	-61.94%	25.00%	-64.89%	25.00%
Stability, min	S	-30.00%	10.00%	-45.67%	10.00%	-30.00%	10.00%	-50.35%	10.00%
Baking test 100g									
Corrected volume, cm ³	P	-10.00%		-14.59%		-20.79%		-20.20%	
Alveogram									
Strength, cm ³	P	-20.00%	20.00%	-20.00%	20.00%	-20.00%	20.00%	-20.00%	20.00%
Stability, mm (P-value)	S	-20.00%	20.00%	-20.00%	20.00%	20.00%	37.46%	-20.00%	28.70%
Distensibility (L-value)	S	-10.00%	20.00%	-33.90%	20.00%	-49.36%	20.00%	-47.68%	20.00%
P/L value	P	-25.00%	25.00%	-25.00%	35.07%	-25.00%	192.41%	-25.00%	159.53%

6.6 Potential higher yields if the criteria are relaxed

When the release criteria are altered to reflect wheat demanded by the end user, a conservative average estimate of 12.8 percent increase in South African wheat yields can be realised. This statement is based on the findings from the previous three comparisons. However, according to the wheat breeders (Personal consultation, 2013), yields of newly-developed cultivars can be improved substantially if the focus is shifted slightly away from the unsubstantiated high-quality requirements (see previous analyses) towards a more balanced approach between yields and quality. Currently the focus of the wheat breeders is still on providing high-quality wheat rather than on a balance between quality and yields. The impact of reducing wheat quality to the current average market supply and demand requirements may thus be much higher than perceived.

In an attempt to simulate the possible impact on productivity, the yields of cultivars with lower-quality characteristics will be compared to the yields of the average commercial yield in each production region in the same production season. However, the yields of new cultivars are determined under more intensive production conditions in experimental farms and thus cannot be directly compared to commercial yields realised in each region. To avoid this problem, a fixed percentage of 20 percent difference between test result yields and commercial yields was used (personal consultation with wheat breeders, 2014). According to the wheat breeders, a 20 percent difference in test yields and commercial yields can be expected under normal circumstances. It must be noted, however, that this percentage change is merely a suggestion and many factors can influence the difference in yields.

Comparing the yields of the cultivars that can be accepted for commercial production if the criteria are relaxed in the Free State production regions, it is evident that the new cultivars realised a yield of 3.43 tonnes per hectare in the 2006/2007 production season. Subtracting the suggested 20 percent from this yield, it can be assumed that this cultivar would realise a yield of 2.75 tonnes per hectare, while the average yield in the Free State in that production season was 2.17 tonnes per hectare. Therefore, a potential increase in yield of 26.74 percent can be expected with more relaxed criteria (Table 6.9)

Comparing the yields of the “new” cultivars, less the suggested 20 percent in the Northern irrigation areas, to the average commercial yield, it can be seen that the average commercial

yield would have been higher. It would therefore be advisable to stay with current cultivars in this region.

Furthermore, comparing the average yield of 2.64 tonnes per hectare in the 2011/2012 production season in the Western Cape area to the average yields of “new” cultivars of 2.91 tonnes per hectare (calculated by subtracting 20 percent from 3.64 tonnes per hectare), it can be seen that a potential yield increase of 21.98 percent could have been realised if the criteria were more in line with the quality supplied and demanded in South Africa (Table 6.9).

Taking into account the number of tonnes produced in each region in the 2012/2013 production season, average increase in wheat yields of 19.03 percent across South Africa is expected if the criteria for new wheat cultivars in South Africa are relaxed.

Table 6.9: Potential higher yields if the criteria are relaxed and the focus is shifted to yield

Region	Proportion of total production	Average commercial yields	Yield of “new” cultivars (less 20%)	Potential increase in yields
	%	t/ha		%
Free State (dry land)	24.3	2.17	2.75	26.74
Northern Cape (irrigation)	18.7	6.84	6.48	0
Western Cape (dry land)	57	2.64	2.91	21.98
Average national increase	100	-	-	19.03

6.7 Conclusion

From the comparisons made in this chapter, it can be concluded that the criteria used to evaluate the release of new wheat cultivars are set too strictly, given the supply and demand requirements of wheat quality in South Africa. This statement is supported by the fact that far lower quality wheat is demanded by the end consumer. Based on the yields of cultivars that could have been accepted had standards been relaxed to within reasonable limits, wheat production could have been increased by 12.8 percent.

This result is supported by a comparison between the quality of supplied wheat (processed wheat) and the biological standards in each region. This comparison revealed that the same

cultivars (with higher yields and lower quality) would again be accepted for commercial production and that the possible implication thereof is an increase in local wheat production by 12.80 percent.

The third comparison, which was done to support the result of the first two comparisons, was to determine which countries have an effect on the local South African wheat price and therefore which wheat quality the local price linked to. As has been proved, South African wheat prices are determined by the quality of wheat imported from Argentina, Brazil, Germany and Ukraine. Similar to the previous two comparisons, data on rejected cultivars were limited which meant that the same cultivars, with a 12.80 percent higher yield, will again be accepted for commercial production in South Africa. All three of these comparisons therefore support the possibility of increasing yield by 12.80 percent through the simple relaxation of new cultivar regulations to be more in line with quality supply and demand requirements.

From the results of the sensitivity analysis, which compared the yields of the “new” cultivars (subtracting 20 percent yield) to the commercial yields in each production region, it was concluded that an estimated increase in production of 19.03 percent across South Africa can be expected by bringing the regulations for releasing new cultivars into line with quality and supply requirements.

It must, however, be noted that these are very conservative estimates and that the actual increase in yields due to lower quality could exceed the current estimates.

It can thus be concluded from these results that arrangements within the institutional environment (in this case the RTC) of the wheat industry are negatively impacting the productivity (i.e. competitiveness) of the primary wheat industry in South Africa, without concrete motivation. Therefore, it is proposed that a financial impact analysis be constructed to quantify the results obtained in this chapter. This will better illustrate the impact that the institutional environment of the wheat industry has on the competitiveness of the primary industry in South Africa.

Chapter 7

Financial Impact Analysis

7.1 Introduction

As discussed in the previous chapter, increased wheat yields are expected if the quality requirements for the release of new cultivars are adjusted to the supply and demand of wheat qualities in South Africa. Although these estimates were conservative, it was stated that wheat yields could increase by 12.80 percent across South Africa, and could even increase by as much as 19.03 percent if the focus of wheat breeders shifted slightly towards yields instead of quality. With reference to the main objectives of the study, an analysis must be conducted to determine the impact of policies, projects or programmes on the competitiveness of the South African Wheat Industry (SAWI). Therefore, quantifying the effect of the mentioned increased wheat yields can give an indication of the effect that the concentrated wheat market has on wheat producers in South Africa.

Mathematical programming has become an important and widely-used tool for analysing similar impact studies in the agricultural economics environment (Mills, 1984, as cited by Buysse *et al.*, 2007). The use of mathematical programming optimisation models, such as linear programming, can be seen as a communication-facilitating instrument for the various stakeholders in a changing policy environment—in particular, the farmer and the policy maker (Fernagut *et al.*, 2004, as cited by Buysse *et al.*, 2007). Linear programming in its simplest form is a method of determining a profit-maximising combination of enterprises which is feasible with respect to a set of fixed constraints (Hazell and Norton, 1986). As mentioned in Chapter 2, applying this approach on the farm level will give a good indication of the impact of the change in production. Furthermore, it is deemed necessary to make explicit allowance for the peculiar influence of time on the structure of the system under study. Of the many ways in which this may be achieved, dynamic linear programming (DLP)

provides a more adequate analytical description of whole farm situations over time than most other tools (Throsby, 1962). Louw *et al.* (2007) were of a similar opinion, stating that DLP is an extremely useful tool for simulating the farm system and analysing “what if” questions. As a result, Louw *et al.* (2007) developed a DLP farm-level model. The accuracy and complexity of the model developed by Louw *et al.* (2007) will result in a more accurate representation of the real world compared to a new model with limited resources. With the assistance of Louw, the model was adjusted for the purposes of this study. This chapter will provide a description of the model that was applied as well as the results obtained when simulating production increases on the performance of the SAWI.

7.2 Model description³

As mentioned, Louw and Van Schalkwyk (1998) developed a farm linear planning model in South Africa called OPTIMA. The objective of OPTIMA is to establish a holistic, user-friendly farm planning model to contribute to improved farm planning and extension and the formulation of agricultural policy. During 2000, this basic model was converted from spreadsheet to algebraic formulation. Louw *et al.* (2007) stated that within regional spatial modelling, the use of these DLP models has previously been limited by computer capacity and only during recent years has it become both possible and practical to embed several DLP whole farm models in a spatial framework and to solve these models within a reasonable time. According to the authors, this increased the capacity and flexibility of the model substantially. Louw *et al.* (2007) further stated that the DLP technique, which was used in this study, has been extensively used in other countries, especially the United States of America (USA), the European Union (EU) and South Africa. This modelling framework is probably the most comprehensive and the largest of its kind ever attempted with the use of DLP in a spatial context in South Africa (Louw *et al.*, 2007).

Risk management in agriculture has become an important part of the management function for primary producers, industry bodies and government alike. Analytical tools used as part of a framework to aid decision makers in formulating risk management strategies can be extremely useful. However, decision makers will only use these analytical tools if their value can be proven in terms of their ability to produce better decisions (Louw *et al.*, 2007). The

³ Section 7.2 relies heavily on the work done by Louw *et al.* (2007)

value of this model lies in the fact that it can calculate the Net Farm Income (NFI) that is generated by a specific set of activities and objectives through cash flow statements. The impact of higher yield on the NFI of farmers can thus be accurately estimated.

7.2.1 Theoretical model specification

In an effort to analyse the conversion from a conventional to an organic farming system over time, Acs *et al.* (2006) developed—similar to Louw *et al.* (2007)—a DLP model for a typical farm in the central clay region of The Netherlands. The general structure of the DLP model is summarised as follows (Hazell and Norton, 1986, as cited by Acs *et al.*, 2006):

$$\text{Maximise } Z = \sum_t \delta_t [(c_t x_t) - f_t] \dots\dots\dots (1)$$

Where:

$$\delta_t = (1/(1 + i))^{t-1}$$

$$A_t x_t \leq b_t$$

$$x_t \geq 0$$

Where:

Z is the discounted labour income;

t is the year;

i is the discounted rate;

x stands for the vector of activities;

c is the vector of gross margin or costs per unit of activity;

f is the vector of fixed costs per year;

A is the matrix of technical coefficients;

b is the vector of the right-hand side value.

Activities and constraints are included in each period (year) for all the relevant decisions, and many of them are duplicated from one year to the next (e.g. annual crop activities). The link between the years is provided by the conversion of the land area and the objective function (Acs *et al.*, 2006).

Although a basic knowledge of the model's theoretical background is necessary, Louw *et al.* (2007) stated that the first step in the development of a decision-making framework is to describe the system. In Chapter 3, a thorough overview of the "system" was provided. As mentioned, this study focuses its effort on the SAWI and the possible impact that concentration in the market may have on the release criteria and subsequently on the productivity and competitiveness of primary wheat producers. The model developed by Louw and Van Schalkwyk (1998) will be utilised to determine the exact impact that a decline in productivity of primary wheat producers in South Africa will have on the entire industry. The model will thus be developed based on a typical wheat farm in South Africa, with special reference to dry land and irrigated production practices.

Louw *et al.* (2007) stated that the second step in developing a decision-making framework is to develop a modelling framework based on the identified "system". This will enable decision makers to acquire a better understanding of how the system reacts to impulses from the outside. As this model was developed by Louw in 1998 and improved since then, the following section will give a brief description of the model and the methods that were implemented by the author to accomplish the above.

7.2.2 Basic modelling framework⁴

Similar to the model developed by Louw *et al.* (2007) to determine the effects of irrigated agriculture in the Northern Cape, a dynamic linear programming model was constructed for the purposes of this study. In this model, a typical farm unit in the dry land and irrigated wheat production areas of South Africa was used to simulate the possible effects of increased production on capitalised investment and net farm income. The basic structure and supporting theory of whole farm planning models and dynamic linear programming in particular were discussed in Chapter 2.

According to Louw *et al.* (2007), the first step in simulating a farm system should be to identify the objectives of the farm unit, the resource availabilities to reach these objectives, and alternative activities that could assist. The essential parts of a whole farm planning model are therefore depicted in Figure 7.1.

⁴ This section relies heavily on the work done by Louw *et al.* (2007)

In most cases, a farmer's principal objective is to make a decent living from farming activities. The approach would be to specify the farmer's basic or minimum consumption requirements and add these to the fixed costs of each period, thereby making financing of these requirements compulsory. Any surplus could then be reinvested in the business or invested off-farm, and the compounded (future) value of surplus, plus terminal values, could be maximised at the end of the planning period (Louw *et al.*, 2007).

The resource restrictions normally included in mathematical modelling (see Figure 7.1) are usually fixed, meaning that they can only be acquired at a cost (Louw *et al.*, 2007).

Farm activities represented in Figure 7.1 make use of scarce resources, while the DLP approach aims to optimise the use of resources through activities that will maximise farmers' objectives (in quantitative terms). The activities compete for the same resources to generate revenue to pay for operating expenses, interest on loans and household expenses. Any revenue surpluses are available as reserves which can earn interest (Louw *et al.*, 2007).

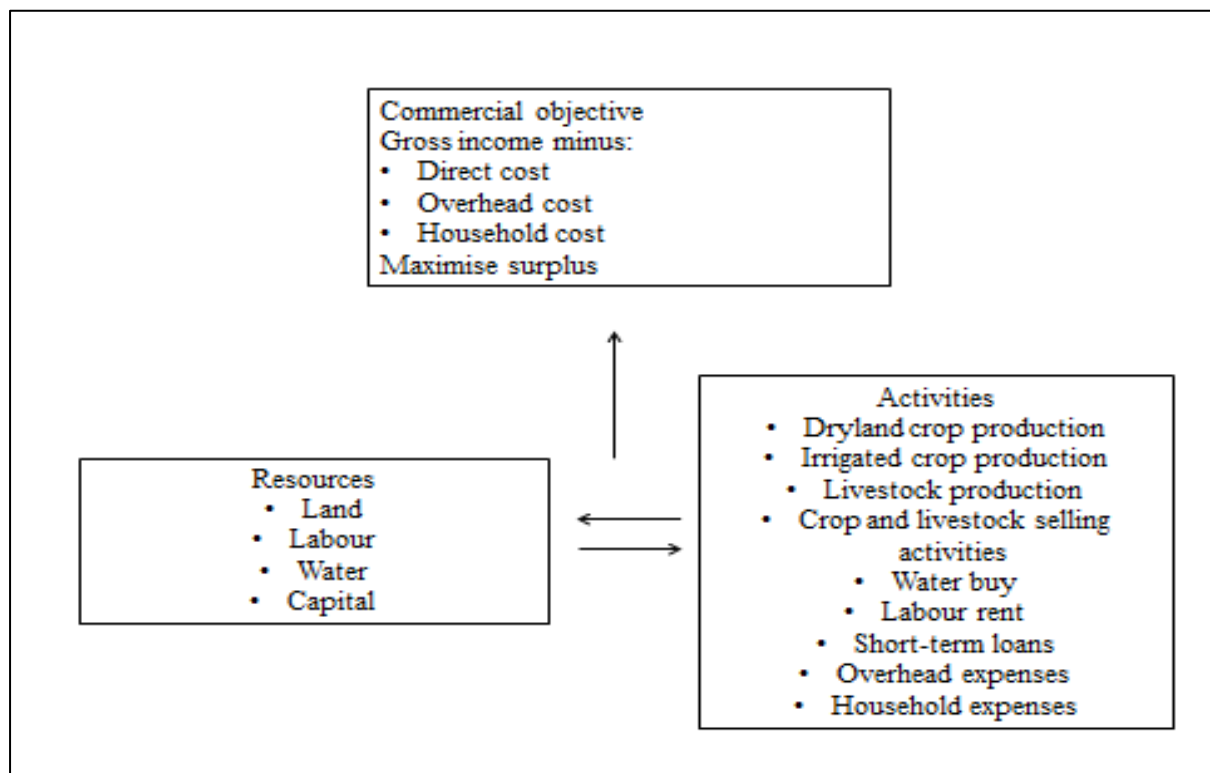


Figure 7.1: Typical farm DLP modelling structure

Source: Louw *et al.* (2007)

The model was developed in GAMS and is solved with the CPLEX solver. In an effort to give readers a basic knowledge of linear programming and GAMS, Louw *et al.* (2007) gave a condensed summary of the model in terms of the algebraic sets, database, variables, equations and objective function, which will now be briefly discussed. Sets are the algebraic notations used to refer to elements that will be used in the modelling framework. According to Louw *et al.* (2007), the sets as identified in Table 7.1 are standard for all the typical farm models.

Table 7.1: Typical farm model sets (Augrabies-Blouputs example)

Sets	Description	Elements (Augrabies-Blouputs example)
i	All enterprises included in model	Rwine, Wwine, Drygrape, Jiugrape, Tablegr, TablegrS, Citrus, Lucerne, Wheat, Peas, Maize, Oats, Cotton, Sheep, Hpveld, Lick, Lhay
ai(i)	All crops and livestock enterprises	Rwine, Wwine, Drygrape, Jiugrape, Tablegr, TablegrS, Citrus, Lucerne, Wheat, Peas, Maize, Oats, Cotton, Sheep
c(ai)	All crops	Rwine, Wwine, Drygrape, Jiugrape, Tablegr, TablegrS, Citrus, Lucerne, Wheat, Peas, Maize, Oats, Cotton,
cc(c)	Crops that cannot be used for animal feed	Rwine, Wwine, Drygrape, Jiugrape, Tablegr, TablegrS, Citrus, Peas, Cotton
veg(i)	Vegetable crops	Peas
g(c)	Grain crops	Wheat, Maize, Oats
fc(i)	Feed crops	Lucerne, Wheat, Maize, Oats, Hpveld
oj(ai)	Single-year crops	Wheat, Peas, Maize, Oats, Cotton
mj(ai)	Multi-year crops	Rwine, Wwine, Drygrape, Jiugrape, Tablegr, TablegrS, Citrus, Lucerne
Mjxl(ai)	Multi-year crops excluding lucerne	Rwine, Wwine, Drygrape, Jiugrape, Tablegr, TablegrS, Citrus
tga(i)	Converted Sultanas	TablegrS
p	By-products	Grain, Stubble, Pasture, Hay, Pmix, Gr1, Tabel, Tdry, Twine, Tjuice
v(i)	Natural veldt	Hpveld
t	All years	y1983*y2022
mt(t)	Modelling years	y2003*y2022
pt(t)	Past years	y1983*y2002
gsl	Growth stages	g01*g20
b	Irrigation technology	IrrigPV, IrrigDR, IrrigMC, IrrigSpr, IrrigFL
m	Inputs	Labour, Tractor, Water, Capital
w	Water sources	River, Canal
wp(w)	Pump water sources	River
d	Farm dams	Dams
a(ai)	Livestock enterprises	Sheep
ap	Livestock by-products	Live, wool
at(ap)	Terminating livestock at end of planning	Live
n	Nutrients	Bulk, TDN, TRP
fb(p)	Feed bank products	Grain, Hay
f(i)	Purchased feed	Lick, Hay
mo	Months	m1*m12
Dev	Motad deviation	Gm1*Gm100
gss(gsl)	Short term crops growth stages	G01
oh	Overheads	House, Overh, Labc, Ltax
s	Savings	Invest
L	Debt	Stloans

Source: Louw *et al.* (2007)

A database was developed by Louw *et al.* (2007) for each of the representative farm models. The databases are in Microsoft Excel and were developed in such a way that they can easily be updated and contain the following worksheets:

- All the farm data from the farm survey in one worksheet. These are used to calculate the coefficients for the total regional farm survey;
- One worksheet for each typical farm containing all the farm survey data for the farms which are included in the group of farms used to construct the typical farms (mainly farm structure, resource availability and overhead costs);
- Worksheets containing water, tractor and labour use for each crop;
- A worksheet with all the crop and livestock budget coefficients. These include yields, price and direct costs;
- A worksheet with the terminal value of long-term crops and of livestock at different growth stages;
- A worksheet with discount factors;
- A worksheet containing all the Motad data (risk data) for crops and livestock;
- Finally, there are worksheets for each typical farm linking all the data to data tables constructed in the GAMS code. After all data are updated, this worksheet is saved as a text file which can be read by the GAMS program.

According to Louw *et al.* (2007), the variables can basically be grouped into 10 types:

- Livestock production variables, including livestock numbers, growth in livestock numbers through reproduction, livestock sales and livestock purchases;
- Livestock product variables and sales;
- A minimum cost feed balancing model embedded in the DLP to ensure at least a basic nutritional value of livestock feed;
- Crop production variables and crop sales;
- Water, labour use variables;
- Rented input variables;
- Some variables to use in the water balancing equations;
- Overhead costs (including general overheads, household costs, labour, etc.);

- Variables that calculate the annual cash flows and end balances;
- Motad (risk) variables.

In order to give the reader some insight into the workings of the typical farm models, Table 7.2 depicts 20 of the 64 typical farm equations that are included in the model that was developed by Louw *et al.* (2007) (see Louw *et al.* 2007 for a detailed description of all the equations)

Table 7.2: Typical farm equations (20 basic equations)

Cost	Defines objective function
Land(b,mt,mo)	Land utilisation of irrigation technology b in year mt month mo
Croparea(mj,b,mt)	Sums LT crop area mj produced with irrigation technology b in specific year mt
Sultconv(mj,b,mt)	Balance Sultana production mj produced with irrigation technology b in year mt with availability
Sultanbal(mj,b,mt)	Total conversion may not exceed the specific area of grapes mj produced with technology b in year t
Sumprodl(I,p,mt)	Sum production of long term crop i product p in year mt
Sumprodst(I,p,mt)	Sum production of short term crops i product p in year mt
Sumreprod(a,mt)	Sums reproduction of livestock a in year mt
Sumlivenu(a,mt)	Sum livestock numbers a for specific year mt
MaxliveS(a,mt)	Limit livestock sale a in year mt
Sumlive(a,ap,mt)	Sum livestock sales numbers of animals a product ap in year mt
Sumwool(a,ap,mt)	Sum wool production of sheep a of product ap in year mt
Labtr(mt)	Labour use in period mt
Ownlabtr(mt)	Transfer own labour in year mt
Labrent(mt)	Labour rent in year mt
Tracuse(mt)	Tractor use in year mt
Tracrent(mt)	Tractor rent in year mt
WateruseM(mt,mo)	Total water use by irrigation crops in year mt month mo
MwateruB(mt,mo)	Monthly water use balance in year mt month mo
Awateru(mt)	Annual water use in year mt

Source: Louw *et al.* (2007)

All the equations can be grouped into 10 sets:

- Land availability and crop area balances;
- Equations that convert Sultana grapes to alternative uses;
- Crop and livestock product balances;
- Livestock numbers and livestock growth;

- Input (labour, water and tractor) balances;
- Equations that balance water availability from different sources with water usage;
- Equations that balance minimum cost feed ration specifications;
- Equations that force overhead costs into the solution;
- Equations that balance loans, investments and end balances;
- Trimming equations to force the observed crop and livestock activities in the base solution;
- Motad (risk) equations.

According to Louw *et al.* (2007), the objective function specifies that the end balance minus the sum of discounted expected MEAN outcomes minus a Risk Aversion Parameter (RAP) multiplied by Fischer's approximation of the standard error be maximised. Since the deviations from the mean in year mt are discounted, the SE is also discounted.

Alternatively, it is possible to maximise the annual cash flow instead of the end balance minus the Motad specifications, which was the case in this study. The objective function basically consists of the following code (Louw *et al.*, 2007):

```
Cost..
+ Endb
*+ sum(mt,Ancashfl(mt))
- SUM((c,b,mt),MEAN(c,mt)*crst(c,b,mt)*LUPB(c,b))
- SUM((a,mt),MEAN(a,mt)*LSTTOT(a,mt))
-rap*SE
=e= Z.
```

7.3 Application of the model through different farm model scenarios

The importance of analysing and applying the information recorded in cash flow statements to make sound farm-related business management decisions cannot be over-emphasised. A lack of cash flow is the stumbling block to many plans. Identifying periods with a potential cash flow surplus or cash flow deficit allows the manager to take advantage of opportunities as they arise or to plan for periods when cash is short (SMA, 2014). As a result, the model places specific emphasis on the effects of externalities on the cash flow statements on farm level.

In the process of adjusting the model for the purposes of this study, it was seen that differences in input structures between dry land and irrigated wheat production practices resulted in the model behaving differently under these two conditions. The model therefore had to make special reference to each of these conditions. To accomplish this, a dry land wheat farm model and an irrigated wheat farm model were used to simulate increased yields. Although different input structures are required for different dry land regions in South Africa, the effect on results obtained by the model proved to be minor. As a result, a dry land wheat-producing farm in the Moorreesburg area (Western Cape region) was used as an example to determine the effects of increased yields on dry land wheat-producing regions in South Africa. In an effort to determine the effects of increased yields on irrigated wheat production areas, an example of an irrigated wheat-producing farm in the Douglas area was used.

A typical dry land wheat farm in the Moorreesburg region of 1000 hectares was used to simulate the possible effects of increased yields, while a 256 hectare farm unit was used to simulate the effects of increased yields in the irrigated regions of Douglas. On these typical farm units, alternative commodities are also produced and the effect thereof is considered. In each of these cases, a base scenario with an unchanged yield, representing the current situation in the specific area, is compared to four additional scenarios, each representing a different yield increase. Table 7.3 provides a description of the wheat farm scenarios. As can be seen, the base scenario has no change in existing cultivar yields, but allows 50 percent upwards and downwards variation on areas cultivated.

The first scenario, which also represents the most likely scenario to occur if wheat quality standards were to be adjusted (see Chapter 6), assumes that wheat yields are increased by

12.80 percent in all wheat-producing regions in South Africa. The second most likely scenario, according to the motivation provided in Chapter 6, is the 19.03 percent increase in yields represented by Scenario 3, which allows for a 20 percent increase in wheat yields. Two additional scenarios, representing an increase in yield of 15 percent (Scenario 2) and 25 percent (Scenario 4) are included for comparison purposes.

Table 7.3: Description of wheat farm scenarios

Base scenario	No change to existing cultivar yields - 50% up and down variation allowed on base areas cultivated
Scenario 1	Similar to base with a 12.80% increase in yield
Scenario 2	Similar to base with a 15% increase in yield
Scenario 3	Similar to base with a 20% increase in yield
Scenario 4	Similar to base with a 25% increase in yield

7.4 Effects of increased yields on the performance of the wheat industry

As mentioned, the performance of an industry can be successfully determined from the profitability of the role players. Smith (2000) stated that agricultural producers are generally concerned about maximising the profitability of their operations while avoiding excessive financial risks.

According to Hofstrand (2009) and Van Zyl *et al.* (1993), profit comes from the difference between revenues and costs, and a sector or business can generate profit through productivity growth or price over-recovery, or both. The course that is taken, however, has important implications for the longer-term competitive position of a business or industry (Van Zyl *et al.*, 1993). A constraint in either productivity growth or prices can thus severely affect the performance and competitiveness of an industry. As proved, quality standards set by the RTC have negatively affected the productivity of wheat producers in South Africa. However, the impact of low productivity on the economy has not yet been quantified.

According to Louw, Van Schalkwyk, Grovè and Taljaard (2014), calculating the effect of decreased productivity on the NFI can directly measure the effect on the performance of the industry.

7.4.1 Changes in NFI

NFI accounts are designed to provide an annual measure of income returned to the operators of agricultural businesses from the production of agricultural commodities. The numbers are used to assess the state of the agricultural industry and to form the basis of various policy options (Statistics Canada, 2013).

The NFI of farm businesses is derived by subtracting operating expenses from farm cash receipts. It represents the amount of cash generated by the farm business that is available for debt repayment, investment or withdrawal by the operators (Statistics Canada, 2013). Table 7.4 depicts the expected increase in NFI on a dry land wheat farm unit of 1000 hectares. Under current conditions (base scenario), it is estimated that this specific farm unit will generate an NFI of approximately R17.8 million over a 20-year period, amounting to R17 807 per hectare over the period or R890 per annum.

As can be seen, the 12.80 percent increase in yield (Scenario 1) on dry land in South Africa resulted in NFI increasing from R17 807 per hectare to R25 911 per hectare over a 20-year period. This amounts to R1 296 per hectare per annum, representing an increase of 46 percent. As can be seen in Table 7.4, NFI per hectare increased from R17 807 to R30 333 with a 20 percent increase in yields, which represents an increase of 70 percent compared to the base scenario. Two additional scenarios (Scenario 2 and Scenario 4) are also included in the analysis for reference purposes. If yields were to increase by as much as 25 percent, NFI would increase from R890 per hectare per annum to an estimated R1 668 per hectare, representing an 87 percent increase in NFI.

Table 7.4: Expected increase in NFI under dry land conditions

	Base	Scen1	Scen2	Scen3	Scen4
	0% increase	12.8% increase	15% increase	20% increase	25% increase
Objective per farm unit (1000 ha) over a 20-year period	R17 810 000	R25 910 000	R27 270 000	R30 330 000	R33 360 000
Objective per ha over a 20-year period	R17 807	R25 911	R27 265	R30 333	R33 361
Objective per ha per annum	R890	R1 296	R1 363	R1 517	R1 668
Percentage deviation per ha		46%	53%	70%	87%

Table 7.5 shows the expected increase in NFI on an irrigated wheat farm of approximately 256 hectares due to increased yields. Similar to the case of the dry land regions, a base scenario is compared to four different scenarios, each representing different levels of increased yields (see Table 7.5). As mentioned, Scenario 1 with a 12.80 percent increase in yield is the most likely scenario to occur if the wheat quality standards were to be adjusted. As can be seen, the NFI per hectare over a 20-year period will increase from R21 516 to R28 106 under the assumption of Scenario 1. This amounts to R1 405 per hectare per annum, representing an increase in NFI of 31 percent. The NFI in Scenario 3 (second most likely scenario), representing an increase in yield of 20 percent, will increase from R21 516 to R30 555 per hectare over a 20-year period. This amounts to R1 528 per hectare per annum, representing an increase of 42 percent in NFI.

Table 7.5: Expected increase of NFI on irrigated land

	Base	Scen1	Scen2	Scen3	Scen4
	0% increase	12.8% increase	15% increase	20% increase	25% increase
Objective per farm unit (200 ha) over a 20-year period	R5 510 247	R7 255 125	R7 604 658	R8 454 686	R9 559 702
Objective per ha over a 20-year period	R21 516	R28 106	R29 357	R30 555	R30 406
Objective per ha per annum	R1 076	R1 405	R1 468	R1 528	R1 520
Percentage deviation per ha		31%	36%	42%	41%

7.4.2 National effects of increased wheat yields on the performance of the wheat industry

In order to gain a clear understanding of the extent of the impact of market concentration on the wheat producers, the total effect in South Africa must be determined. As depicted in Tables 7.4 and 7.5, the farm-level effects of decreased productivity were determined on a hectare basis. Multiplying this effect by the total hectares in each region will therefore determine the national effect. As can be seen in Table 7.6, the potential increase in NFI in the Free State that is generated by a 12.80 percent increase in yield amounts to R152 million per annum, while the effect is much larger in the Western Cape region at R358 million per annum. The increase in NFI in the Northern irrigation regions amounts to R95 million per annum. The combined effect in all these regions due to a 12.80 percent increase in yield is

estimated to be R606 million per annum or just over R12 billion over a 20-year period. To put this into context, the NFI generated by the entire agricultural industry in 2012/2013 amounted to R58 927.90 million rand. This means that the strict criteria enforced by the RTC resulted in the NFI generated by the entire agricultural industry shrinking by an estimated 1.03 percent.

As mentioned, Scenario 3, which represents a 20 percent increase in yield, is regarded as the second most likely scenario to occur. The effect of the 20 percent increase on NFI amounts to R236 million in the Free State, R553 million in the Western Cape and R130 million in the Northern irrigation areas per annum. The total effect thus amounts to an estimated R920 million per annum or approximately R18.4 billion over a 20-year period. If this increase in yield had, in fact, occurred, the NFI generated by the entire agricultural industry could have been 1.56 percent more.

Table 7.6: Effect of increased yields on NFI on a national scale

		Base scenario	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Region	Hectares	0% increase	12.80% increase	15% increase	20% increase	25% increase
Free State	377 000	R335 653 998	R488 422 399	R513 952 326	R571 785 782	R628 850 228
Potential increase in NFI in the Free State			R152 768 401	R178 298 328	R236 131 784	R293 196 230
Western Cape	884 000	R787 050 753	R1 145 266 314	R1 205 129 592	R1 340 739 075	R1 474 545 362
Potential increase in NFI in the Western Cape			R358 215 561	R418 078 839	R553 688 322	R687 494 609
Northern irrigation areas	289 800	R311 771 067	R407 257 335	R425 382 447	R442 735 303	R440 578 496
Potential increase in NFI in the Northern irrigation areas			R95 486 268	R113 611 380	R130 964 236	R128 807 429
Total	1 550 800	R1 434 475 818	R2 040 946 047	R2 144 464 365	R2 355 260 160	R2 543 974 086
Total potential increase in NFI in South Africa			R606 470 229	R709 988 547	R920 784 343	R1 109 498 268
Total potential increase in NFI in South Africa over a 20-year period			R12 129 404 586	R14 199 770 942	R18 415 686 850	R22 189 965 364

7.5 Conclusion

It was concluded in this chapter that the use of DLP provides a more satisfactory analytical description of whole farm situations over time than most other tools. A DLP farm model, as developed by Louw *et al.* (2007), was thus used to simulate the possible increases in yields that would most likely occur if the wheat quality requirements were relaxed (see previous chapter). Because this study is mainly focused on determining the effect on the performance of the wheat industry in terms of its profitability, results from the DLP farm model pertaining to NFI were analysed and discussed in this chapter.

Significant differences were seen when comparing the application of the model to a dry land situation and to an irrigated situation, respectively. As a result, two different analyses had to be performed to improve the accuracy of the model. For both these models, a base scenario—representing the status quo—was compared to four different scenarios, each representing different increases in yield. From the results it was seen that a 12.80 percent increase in yield generated a 46 percent and a 31 increase in NFI on dry land and irrigated land, respectively. A 20 percent increase in yield generated a 70 percent and a 42 percent increase in NFI on dry land and irrigated land, respectively.

The country-wide effect on NFI was estimated at R606 million per annum due to a 12.80 percent increase in yield or approximately R18.4 billion over a 20-year period. An estimated R920 million per annum or just over R12 billion over a 20-year period was estimated when yields were increased by 20 percent.

Knowing that these mentioned NFIs could have been realised by wheat producers and that the benefits could have found their way to a struggling wheat production industry certainly amplifies the need to give urgent attention to these factors. Moreover, considering the knock-on effects on factors such as job creation, the balance of payments and exchange rates, it prompts the question why government has not intervened as yet. Increasing the competitiveness of this industry is especially relevant since government policies focus on addressing welfare issues, including unemployment and food security, through the agricultural sector.

Chapter 8

Summary, Conclusions and Recommendations

8.1 Introduction

The importance of an efficient and sustainable South African wheat industry is highlighted not only in the fact that it plays a central role in food security, but also in the indirect contributions it makes towards the local economy through job creation, skills development, poverty alleviation, etc. Yet specific policies devised mainly during the apartheid era, coupled with changes over the last two decades, have drastically altered the structure of the agricultural environment which, in turn, has impacted the financial position of all role players in the industry—from the primary producer to the end consumer and everyone in between.

With the collapse of apartheid, the swift move towards deregulation was embraced by the new government, but instead of creating opportunities for competition in the wheat to bread chain, it created “opportunities for extortion” by entrenched monopolies. These distinctive “systems of regulation” profoundly altered agricultural development and gave birth to monopolistic powers in the milling and baking industries. The post-apartheid liberalisation, which was intended to generate a more competitive environment and break down these structures of power, served rather to cement monopoly control.

The effect of increased market concentration has already been felt in the South African wheat industry—most acutely when the Competition Commission proved the existence of a flour and bread cartel in 2007 and 2010, respectively. The question that needed to be answered in this study is: “has the high degree of market concentration in the South African wheat

industry influenced the clearly struggling wheat production sector in South Africa?” and if so, “what mechanisms have been used to influence the market?”

It was concluded that because wheat has a characteristic known as the defect of conversion (yield declines as quality improves), wheat quality and the associated wheat prices could be among the mechanisms used by the concentrated market to influence the market in its favour. Following on from this, the main question that this study has sought to answer is: “has the high degree of market concentration in the South African wheat industry influenced the performance of the wheat production sector in the country by prescribing certain quality standards?”, and in doing so, “are prices manipulated through quality-related factors?”

8.2 Objectives of the study

To be able to answer the main research question, three major objectives, based on Porter’s work, were formulated. They were:

- To determine the long-term competitiveness of the South African wheat industry in relation to its major global markets. Porter (1998) asserted that the definition of competitiveness as well as the way in which competitiveness is measured must first be determined. Only after these issues have been clarified can the globally competitive state of an industry be determined.
- To identify the factors constraining performance and their relative impact, and to determine the implications thereof for long-term competitiveness. According to Porter (1998), these factors must be identified and addressed if the competitiveness of an industry is ultimately to be improved.
- To establish how the long-term competitiveness of the SAWI can be improved given the enriched knowledge of the factors constraining performance.

By answering these questions it was possible to explain the role played by the economic environment, institutions and policies in the competitive success of the South African wheat industry. Answering these questions allowed the author to evaluate and determine the efficiency, effectiveness and sustainability of the industry.

Based on the three major objectives, five more specific objectives of the study were:

- To describe the theoretical basis of performance and the link to competitiveness;
- To determine the exact state of competitiveness of the SAWI compared to that of major trading partners by means of a Relative Trade Advantage (RTA) method;
- To identify specific factors that can be influenced by a concentrated market and that will affect the performance and long-term competitiveness of the wheat production sector in South Africa, using a hedonic price model;
- To determine the extent of the impact of a concentrated market on the economy in South Africa, using a dynamic linear programming model;
- To provide recommendations from the results with a view to enhancing the performance of the wheat production sector in South Africa.

8.3 Summary of the study

8.3.1 Main issues from literature

The first challenge faced in this study was to fully understand the concepts of performance and the link to competitiveness. It was evident from the literature that the performance of an industry can be measured most effectively by focusing on the profitability of that specific sector. Profitability, in turn, is determined from revenue (relationship between product quantity and product price) and costs (relationship between resource quantity and resource price).

Smith (2000) stated that there are both uncontrollable and controllable factors that underpin the profitability of an industry or business. Smith (2000) was of the opinion that within any class of wheat and across some wheat classes, production costs for any given producer are generally similar. Therefore, a producer's varietal choice is to a large extent determined by expected yields and prices for each variety at the time of marketing (Smith, 2000). Smith (2000) further stated that wheat quality and wheat yields are highly correlated—although negatively, which makes wheat quality and the demands for such quality essential considerations when one is evaluating factors impacting the profitability and performance of an industry. It was further concluded that an industry's performance, in terms of its

profitability, and the course that is taken to improve such performance ultimately determine the long-term competitiveness of that specific industry.

In addition, concentration had to be explained, as well as the possible effects thereof on performance and competitiveness. From the literature, it was concluded that concentration or consolidation involves the growth and merger of firms, which can have a negative or positive effect on a market system. From this statement, the possibility of either a positive or negative influence on the industry had to be considered.

However, specific methodologies to analyse the competitive state and determine which factors are influencing the performance of the industry, as well as methodologies to quantify the impact of the performance, were still unknown. Previous studies that attempted one or all of the above-mentioned methods were analysed and included in the literature review.

8.3.2 Global wheat industry overview

To gain a better understanding of the functioning and roles of different segments of the South African wheat industry, it was necessary to provide a thorough overview of the international environment which ultimately has a significant impact on the local environment within which producers operate.

In pursuit of a better understanding of this rapidly changing global environment, it was deemed necessary to identify who the major role players in the global wheat market are and what factors might influence their performance and competitiveness. An attempt was therefore made to identify the major role player in the global wheat market and give an overview of the structure of their local market. Furthermore, an effort was made to determine the resulting competitive state of these countries by making use of the Relative Trade Advantage (RTA) method. Specifically, the RTA was used to illustrate the current competitive status of the production segment of the South African wheat industry compared to other segments and international counterparts. From this analysis, it was clear that the competitiveness of the South African unprocessed wheat industry or production segment of the industry has declined in recent years. When the South African RTA index values were compared to those of peer countries, some concerns were raised with regard to the institutional environment in which the South African producers must operate. What was

evident from the results is that South Africa is the only country that has an uncompetitive unprocessed wheat industry alongside a competitive semi-processed wheat industry. This means that the institutional environment is structured in such a way that the secondary industry can import raw wheat at lower cost than it can source it locally, process it into wheat flour and export it mainly to African countries.

8.3.3 Structure, conduct and performance of the South African wheat industry

As mentioned, Porter (1990, 1998) stated that the roots of productivity and competitiveness lie in the national and regional environment for competition. The current institutional environment that creates or hinders competition in the wheat industry had to be thoroughly investigated. Although constrained by limited data on the midstream and upstream segments of the South African wheat industry due to on-going collusion investigations into the industry, a glimpse of what the industry might look like was provided. It was evident that this segment of the industry is dominated by a select four companies which collectively control an estimated 85 percent of the bread industry in South Africa, thus pointing to a high degree of market concentration. These four companies are also regarded as major role players in the midstream segment, meaning that there is a high degree of horizontal integration present in the industry as well. Therefore, one important finding from this section was that there are definite signs of market concentration which has increased over the last two decades.

From the literature it was found that the Research Technical Committee (RTC) for wheat in South Africa (representative of the wheat market) set strict criteria regarding the rheological and baking characteristics during the final stages of approval of potential wheat cultivars in the country. The main aim of the RTC is to guide wheat-related research in South Africa and is thus responsible for guiding wheat quality production by prescribing certain quality standards for commercial production in the country. A total of 17 tests are conducted on potential new cultivars to determine whether or not silos are allowed to accept the produce from producers. It must be mentioned again that these criteria do not constitute regulations, but merely a suggested framework for producers. But the reality of the situation is that these criteria are actually enforced, leading to the possibility that buyers will not be willing to accept producers' produce if the cultivar in question does not appear on the list of accepted cultivars.

To adjust for seasonal variations in quality, cultivars with desired quality characteristics are used as biological standards for new cultivars, and fixed variations from these standards are allowed. What was also evident in the industry structure overview is that South Africa has three distinct wheat production regions, which play a major role in quality variations and have three different cultivars that set quality standards in each region. The three main wheat production areas are the Western Cape with Kariëga as cultivar standard, the Free State with Elands as cultivar standard, and irrigation areas mostly in the northern parts of the country with SST806 as cultivar standard.

The fact that higher wheat quality will result in lower yields prompted the institutional environment of the industry to regulate not only wheat quality but also the productivity thereof. From this analysis, numerous concerns were raised over the performance-related trends of (especially) the production segment of the wheat industry in South Africa owing to wheat qualities being prescribed to producers. The second factor that needed attention was the influential role that the international industry plays in determining the local wheat price. Local wheat prices largely follow international trends and are determined by the lowest import parity price. The question that came to mind here was whether the quality of this price-determining wheat (i.e. wheat that determines import parity price) is in line with locally-prescribed wheat qualities. If this was not the case and in order to enable South African producers to compete on a level playing field, they would need to either be compensated for the higher quality or be allowed to produce lower quality that is linked to higher yields.

8.3.4 Factors influencing the competitiveness of the South African wheat industry

Specific factors affecting the performance of the global and local wheat industries are unique and are largely determined through quality-related price differentials. As a result, the study employed a hedonic price model which rests on the premise that price is a function of all the characteristics that the product possesses. By conducting a thorough literature review, it was revealed that hedonic models are the ideal mechanism to precisely determine the factors that have an impact on the price and thus performance of the wheat industry.

The conceptual framework for this analysis was based on the work done by Espinosa and Goodwin (1991) which stated that the price of a commodity is representative of the quality

and quantity of the characteristics it possesses. In the process of identifying the possible factors that can influence the wheat price in South Africa, a large number of characteristics were identified. However, the factors that directly determine prices include the origin of wheat, protein content, falling number, hectolitre mass and total percentage of defects. In total, 14 additional quality-related and non-quality-related characteristics of wheat were included in the analysis. However, none of them was found to be statistically significant.

The application of the hedonic price model spanned three different steps. The first step was to include all the above-mentioned variables. Unfortunately, correlations among some of the independent variables were strong, indicating multicollinearity among variables. This meant that the parameter of the variables could not be trusted. The second step was to exclude variables that are correlated with more significant variables. For instance, it was found that protein content was highly correlated with seven other independent variables. Using the regression that includes only protein content explained more variance (higher adjusted R^2) than using the regression that included all the other correlated variables (and was considered to be the better regression). Since the problem of multicollinearity was eliminated, the third step was to test for signs of heteroscedasticity and autocorrelation. Since there were signs of these errors within the model, which affected the accuracy of the model, insignificant variables were eliminated.

Results from the hedonic price model confirmed that grading factors, such as protein content (PROT), hectolitre mass (HECT), falling number (FALL) and the number of defects (DEFECTS), have a significant influence on price changes. This was expected, as these factors are primarily used to determine prices in the grading system of South Africa. Farinogram stability (FARSTAB) and world production (WPROD) levels were also identified as factors that influence South African wheat prices.

The interesting part of the analysis, however, was the additional factors, i.e. dummy variables, that had an influence on the wheat price in South Africa. Wheat acquired from Argentina, Brazil, Germany and Ukraine influenced South African wheat prices. The fact that South African wheat prices are determined by the import parity price means that wheat and the associated quality acquired from these countries ultimately determine local prices. This analysis therefore identified the quality of wheat that determined local prices. An analysis to

determine whether these price-determining qualities are in line with the qualities prescribed to local producers is needed.

8.3.5 Wheat quality standards and their potential impact on performance

Chapter 6 dealt with the potential impact of prescribed wheat quality on performance. The aim was to determine whether the prescribed qualities required for the release of new cultivars were justified, given the actual quality provided and demanded in the market environment. The fact that wheat yields and quality are negatively correlated meant that unjustified high quality prescribed to producers will have an unnecessary negative impact on their productivity, performance and competitiveness. To determine if this was in fact the case, four comparisons were developed.

The first comparison was to determine if the quality prescribed to local producers was reflected in the quality of unprocessed wheat supplied to processors in South Africa or, in other words, the quality demanded by consumers. In order to accomplish this, the wheat quality of locally-produced wheat and imported wheat was used to simulate the wheat quality that is provided to buyers over an eight-year period. This quality was compared to the prescribed quality to producers that was obtained from the cultivars that serve as biological standards, thus serving as the minimum quality that producers may deliver to silos. From this comparison, new and more relaxed criteria were derived and used to determine if previously-rejected cultivars could have been released for commercial production in South Africa or not. The yields of these cultivars were then compared to the yields of already-accepted cultivars to determine the difference in productivity and therefore competitiveness.

From the results of this analysis, it was concluded that wheat yields under dry land could be increased by 12.80 percent, while wheat yields under irrigation could be increased by 12.62 percent if the proposed criteria for the release of the new cultivars were implemented. The average increase in yield over all areas in South Africa is expected to amount to 12.80 percent.

In order to verify findings from the first comparison, a survey was conducted into existing wheat flour quality sold on the shelves in shops in South Africa. Similar to the first comparison, wheat quality prescribed to producers was used but compared to the quality of

flour sold in the supermarkets. The second comparison thus compared the processed wheat that was demanded by, and supplied to, South African consumers to wheat quality prescribed to producers. From this comparison, it was seen that there was an even greater disparity between locally-produced wheat quality and the quality of flour sold in the supermarkets. Owing to a lack of adequate data, the same cultivars as identified in the first comparison (supply of unprocessed wheat quality) were again identified, meaning that this comparison supported the potential wheat yield increase of 12.80 percent in South Africa. More data could, however, have meant that even higher yield increases could have been realised.

In the third comparison, results from the hedonic price model were used, which indicated that wheat originating in Argentina, Brazil, Germany and Ukraine made a meaningful contribution to the variation in price. This means that South African wheat prices were determined by the wheat imported from Argentina, Brazil, Germany and Ukraine, together with their associated qualities. This comparison therefore compared the average quality of imported wheat from the mentioned countries to the biological standards in each of the three production regions of South Africa. Again, even bigger disparities were observed, but could not be quantified due to a lack of data on yields of previously-rejected cultivars. This analysis therefore also supported the fact that yields could be increased by 12.80 percent in South Africa.

As mentioned, the expected increase in yields may be under-estimated. This—coupled with a shift in focus of wheat breeders towards a relatively lower quality and higher productivity—may result in even greater increases of yields for producers in South Africa. In an attempt to simulate the possible impact on productivity if this focus is shifted in the near future, the yields of cultivars with lower quality characteristics were compared to the yields of the average commercial yield in each production region in the same production season. Results from this analysis showed that a combined increase in wheat yields of 19.03 percent across South Africa can be expected if the quality requirements for the release of new cultivars are adjusted to the quality that is demanded by the processors and consumers in South Africa.

8.3.6 Financial impact analysis

One of the major objectives of this study was to quantify the impact of market concentration on the performance of the South African Wheat Industry (SAWI). In order to accomplish this,

a farm level, dynamic linear programming model was used. However, developing such a model for the purposes of this study, to the required level of accuracy, could take several years. This, together with the fact that this study's aim was not to develop the specific model but only to quantify the impact of market concentration on wheat producers in the SAWI, gave weight to the decision to apply an already-developed model in the study. The accuracy and complexity of the model developed by Louw *et al.* (2007) offer a more accurate representation than would have been the case if a new model, with limited resources, had been developed. With the chosen model, the main focus was to determine the changes in net farm income (NFI) due to changing yields on a dry land farm and irrigated farm model.

An irrigated wheat farm of approximately 256 hectares was used to determine the effect on NFI when yields are changed. A base scenario was compared to four different scenarios, each representing different levels of increased yields. Scenario 1 with a 12.8 percent increase in yield is the most likely scenario to occur if the wheat quality standards were to be adjusted. NFI per hectare over a 20-year period will increase from R21 516 to R28 106 if yields increase by 12.8 percent. This amounts to R1 405 per hectare per annum, representing an increase in NFI of 31 percent. The NFI in Scenario 3 (second most likely scenario), representing an increase in yields of 20 percent, will increase from R21 516 to R30 555 per hectare over a 20-year period. This amounts to R1 528 per hectare per annum, representing an increase of 42 percent in NFI.

As can be seen, the 12.8 percent increase in yield (Scenario 1) on dry land in South Africa resulted in NFI increasing from R17 807 per hectare to R25 911 per hectare over a 20-year period. This amounts to R1 296 per hectare per annum, representing an increase of 46 percent. NFI per hectare increased from R17 807 to R30 333 with a 20 percent increase in yields, representing an increase of 70 percent compared to the base scenario.

8.4 Strategies and recommendations

The contribution of this study lies in the fact that it provides evidence as to why the performance of the wheat industry has been declining over the last two decades. It also offers a basis for policy and decision makers to develop a framework for wheat, which will encourage more competition and a freer market in terms of quality standards. Furthermore, this study contributes to the body of literature on competitive behaviour by showing how

concentrated industries can use statutory bodies to manipulate markets for rent-seeking purposes. It also shows how these decisions impact on important aspects like the profits of role players in an industry.

According to the findings of the study, the current wheat market system does not incorporate the differences in quality between locally-produced wheat and imported wheat. The fact that the quality standards as set in the release criteria for commercial wheat are not in line with the quality demanded by the end user, has negatively affected the performance of the wheat producers in South Africa. Furthermore, the fact that local wheat prices are determined by inferior quality wheat means that producers are not being compensated for higher quality. This means that producers are not only receiving lower prices for their produce but are also penalised on yields. Drastic steps need to be taken to reduce the effect of market concentration on the performance of the producers, thereby ensuring more profitable and sustainable wheat production in the future.

According to Porter (1990), one of government's roles should be to create an enabling environment for companies to raise their aspirations and move towards higher levels of competitive performance. Because less government intervention and a more competitive environment have served rather to cement monopoly control in the market instead of increasing competition, incorporating more intervention in government policies with the sole purpose to improve competitiveness can serve as an efficient corrective measure to bolster the competitiveness of the industry.

The important role that quality plays in any wheat industry, especially in South Africa, means that quality cannot be disregarded. For improved competitiveness, though, it is crucial that the prescribed qualities are brought into line with the qualities demanded by the market. For South African producers to compete on a level playing field, government policies therefore need to put in place a framework that will allow producers to either be compensated for the higher quality wheat or be allowed to produce lower quality wheat that is linked to higher yields. Coupled with this, wheat quality that determines the import parity price must be linked to wheat quality prescribed to local producers. It is important that wheat prices are determined according to its quality and not its origin.

Implementing these policies will enable producers to receive a premium for higher-quality wheat with lower yields or to compete on the basis of increased yields while still providing a desired product. This would have been the situation had free market conditions existed. This will have positive knock-on effects for the entire South African economy in the form of, for example, job creation, poverty alleviation, skills development and food security.

On the basis of the above findings, it is recommended that a further study be conducted aimed at standardising the prices paid for imported and locally-produced wheat, which must be linked to quality. To achieve this, a score sheet can be developed with the sole purpose of determining the exact quality of a specific batch of wheat—irrespective of whether it is locally produced or imported. The score sheet must include the relative importance of all important characteristics which must be determined by all stakeholders in the wheat industry. Price differences can then be determined solely on the basis of the difference in quality and not the area where the wheat is produced.

Another recommendation flowing from the findings of this study is to allow local producers to produce wheat of a similar quality to that of imported wheat, or at least of a similar quality to that determined in Chapter 6 (quality demanded by the market). The main arguments in the past against such a practice were linked to the issue of storage capacity and/or specific requirements for baking processes. Using alternative forms of storage, such as silo bags and on-farm silos, is a possible solution to the problems encountered. Another argument against allowing lower quality wheat was based on processing abilities. However, the ability of millers to process wheat from all over the world (different qualities and cultivars) provides for the assumption that locally-produced wheat of a lower quality can then also be processed. Allowing producers to produce lower quality wheat will most likely result in wheat breeders focusing their efforts on improving wheat yields, which will improve the performance of the production segment significantly. Moreover, marginal potential land can then possibly be brought back into production, which could decrease South Africa's dependency on wheat imports. The possibility of producing softer types of wheat for pasta production must also be investigated. South Africa is still reliant on imports of these products and sourcing these products locally can have added benefits.

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Annexure A

Tests to determine the rheological and baking characteristics of wheat cultivars

Protein content

The protein content of wheat grain can vary from 6% to as much as 25%, depending on the growing conditions. Grain protein is a major contributor to the nutritional quality of wheat. In South Africa, grain protein of 12% and higher is preferable. The availability of nitrogen is the major determining factor for the protein content of grain (Blackman and Payne, 1987, as cited by Koen, 2006). Koen (2006) elaborated by stating that there is a strong negative relationship between the grain protein percentage and the grain yield. This is observed in the SAWI where the grain protein percentage increased significantly, while yields stayed relatively constant. Protein is thus a desirable component of hard wheat and is expected to exhibit a positive influence on wheat prices

Falling number

Falling number is the effect of α -amylase activity resulting in the degradation of starch into simple sugars. Screening for this activity is given a high priority in most breeding programmes because the majority of wheat products are adversely affected by this enzyme. In the classification of potential new cultivars in South Africa, falling number should be higher than 250 seconds and should not be more than 15% lower when compared to the biological standard (SAGL, 2010, as cited by Miles, 2010).

Hectolitre mass

A hectolitre mass of 74.00 kg/hl is required for bread-making purposes (Nel, Agenbag and Purchase, 1998; SAGL, 2010), but Koekemoer (2003) reported that a hectolitre mass of 76.00

kg/hl and higher would be preferable. South African cultivar release procedures allow a potential breeding line to exhibit a hectolitre mass of 1.8 units less than the hectolitre mass of the biological standard during the classification of potential breeding lines for commercial release as cultivars (SAGL, 2010, as cited by Miles, 2010). Therefore, hectolitre mass is expected to have a positive influence on wheat price.

Buhler extraction percentage

According to Miles (2010), the Buhler extraction percentage is the percentage of flour obtained from a given amount of wheat. The extraction rate is an important measurement because genotypes that yield a higher percentage of flour also provide higher profits to millers. A positive relationship is thus expected between the Buhler extraction percentage and wheat prices.

Colour

An important element in determining the milling characteristics of wheat is flour colour. Similar to flour yield, the flour colour is mostly determined by the type of genotype that is milled. However, environmental factors, genotype-environment interaction and the milling process itself can also cause variance in flour colour (Miles, 2010). Flour colour of a potential breeding line is allowed to be only 1 KJ (Kent Jones) unit higher than the biological standard (SGL, 2010, as cited by Miles, 2010). It is thus expected that wheat prices will decrease when flour colour increases, representing a negative relationship.

Peak time

Peak time, which is effected by means of a mixogram, represents the dough development time. It begins the moment the mixer and the recorder are started and continues until the dough reaches maximum consistency. This indicates optimum mixing time and is expressed in minutes. Mixing tolerance is the resistance of dough to breakdown during continued mixing and affects the shape of the curve. This indicates tolerance to over-mixing and is expressed as a numerical score based on comparison to a control (Wheatflourbook, 2013). Weak gluten flour has a shorter peak time and less mixing tolerance than strong gluten flour (Wheatflourbook, 2013). During the classification of new cultivars in South Africa, the

tolerance for peak time differs, depending on which quality standard is used, e.g. for Elands (Free State and dry land areas) and Kariëga (southern dry land areas), a mixogram tolerance of +15 percent to -25 percent is allowed. When compared to SST 806 (irrigation areas), a tolerance of +20 percent to -10 percent is allowed (SAGL, 2010, as cited by Miles, 2010).

Farinogram

Water absorption is the most widely used farinogram measurement and relates to the volume of water required to centre the farinograph curve on the 500-brabender unit (BU) line. This relates to the amount of water required for a flour to be optimally processed into end products. Peak time indicates the dough development time, beginning the moment water is added and continuing until the dough reaches maximum consistency. This gives an indication of optimum mixing time under standardised conditions. According to Miles (2010), the farinogram results are of utmost importance when a cultivar is released in South Africa. A water absorption percentage of between 62 and 64 is desirable. A tolerance of ± 2.5 percent is allowed for water absorption when comparing a potential new cultivar to the biological standard during cultivar classification (SAGL, 2010, as cited by Miles, 2010).

The farinogram stability time is the difference in time between the arrival time and departure time, and indicates the time the dough maintains maximum consistency and is a good indication of dough strength (Wheatflourbook, 2013). The mixing tolerance index (MTI) is the difference in BU value at the top of the curve at peak time and the value at the top of the curve five minutes after the peak. This indicates the degree of softening during mixing (Wheatflourbook, 2013).

Alveogram

The alveogram is a test that uses an alveograph to determine the gluten strength of dough by measuring the force required to blow and break a bubble of dough (Wheatflourbook, 2013). The alveogram test provides results that are common specifications used by flour millers and processors to ensure a more consistent process and product. The obtained graph from the alveograph provides information such as dough stability or dough tenacity (P-value), dough extensibility or distensibility (L-value), dough strength (W-value) and the ratio between P and L (P/L-value) (Miles, 2010). Although all these characteristics are important when

cultivars are released in South Africa, some of these tests, such as stability and dispensability, are regarded as secondary characteristics. The alveograph is well suited to measuring the dough characteristics of weak gluten wheat. Weak gluten flour with a low P-value and long L-value is preferred for cakes and other confectionary products. Strong gluten flour with a high P-value is preferred for breads (Wheatflourbook, 2013). During classification of a new cultivar in South Africa, the two most important alveogram tests that are considered as primary characteristics are the strength (W-value) and the ratio between P and L (P/L value). For these tests, a deviation of ± 20 percent is allowed for the W-value and ± 25 percent for the P/L value when compared to the biological standard (SAGL, 2010, as cited by Miles, 2010).

Corrected volume

Loaf volume, which is the final test for assessing the wheat bread-making quality, indicates the dough's capacity to retain gas during the fermentation process and is measured by rapeseed displacement (Shogren and Finney, 1984). Bread quality is determined by the quality and the quantity of all raw materials involved and the processing method being applied (Cauvain, 2003). Loaf volume is evaluated by the ability of the flour to produce large, well-shaped loaves and by the water-absorbing capacity of the flour (Kent, 1984). Hard wheat is preferable for bread-making purposes due to the higher water absorption capacity which results in increased bread yield and an increased shelf life (Blackman and Payne, 1987). In South Africa, loaf volumes of potential breeding lines should not be more than 10 percent less than loaf volumes of the biological standard during the classification of potential new cultivars (SAGL, 2010, as cited by Miles, 2010). Corrected volume is thus expected to have a positive influence on wheat prices.

Thousand kernel mass

Thousand kernel mass, as a method, measures the mass of the wheat kernel. It is used by wheat breeders and flour millers as a complement to the testing of weight, thereby better describing wheat kernel composition and potential flour extraction. Generally speaking, wheat with a higher mass can be expected to have a greater potential flour extraction (Wheatflourbook, 2013). Posner and Hibbs (1997) indicated that thousand kernel mass is a more reliable indicator for millers of expected flour yield than hectolitre mass, as they found a strong correlation between thousand kernel mass and flour yield. In South Africa, a

tolerance of ± 4 units is allowed for thousand kernel mass during classification of a new cultivar when the potential breeding line is compared to the biological standard (SAGL, 2010, as cited by Miles, 2010).