The factors that influence the price of sunflower in South Africa

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Dissertation submitted in partial fulfilment of the requirements for the degree *Master of Commerce* in Risk Management at the Potchefstroom Campus of the North-West University

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November 2008

Acknowledgements

This dissertation would not have been possible without the help, co-operation, and patience of numerous individuals. I wish to express my sincere gratitude to everybody who made valuable contributions towards this dissertation. In addition, I would like to take this opportunity to extend a special word of appreciation to the following individuals:

Professor Paul Styger for his resilience, guidance, suggestions, and assistance. Without his commitment this dissertation would have remained an idea.

Professor Andrea Saayman for her assistance and patience. Especially with respect to all the econometric work that was necessary for the completion of this dissertation.

Doctor André Heymans of Free State Maize who examined a draft of this dissertation, for the valuable comments and suggestions to improve this study.

My ever-encouraging mother and my father, who taught me the qualities of hard work, self-discipline, and self-confidence. I am deeply indebted to you.

My brother, two sisters, and their families whom I love and admire. You will always be in my prayers.

My colleague, Leanne Keel, for proof reading this dissertation. I truly appreciate your help.

Finally, to our Creator. He that provides us with the necessary mental capacity and strength to complete each task successfully and faithfully. Let Him be praised!

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Abstract

The factors that influence the price of sunflower in South Africa

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Sunflower seed is the third most important field crop in South Africa after maize and wheat. During the period of regulated marketing (1980s - 1990s) the Oilseed Board controlled the majority of the oilseed industry in South Africa. Prices were determined by domestic demand and supply, as well as the export pool prices that were derived by the Oilseed Board. Prices were fixed for a particular production season and producers were faced with a single-channel marketing scheme. However, this situation changed with the introduction of the Marketing of Agricultural Products Act (No. 47 of 1996 as amended). This legislation led to the deregulation of the South African agricultural industry and the abolishment of the Marketing Boards.

Since the deregulation of the oilseed industry in South Africa, the prices of sunflower products are determined under free market conditions (that is demand and supply). Sunflower products are formally traded on the Agricultural Products Division (APD) of the JSE Securities Exchange. This division is frequently referred to as the South African Futures Exchange (SAFEX).

This dissertation aims to examine the structure of the South African sunflower price with the aid of various economic theories and econometric modelling techniques. Furthermore, the specific objective of this dissertation is to develop a series of South African sunflower price models to identify the factors that influence the price of sunflower in South Africa (the general objective of this dissertation). These models can accordingly be utilised to make definite projections of the price of sunflower in South Africa.

Vector Auto-Regression Estimations, Vector Error Correction Models and *First-Order Autoregressive Models* are applied to monthly data (January 2000 – March 2007) to develop four different South African sunflower price models. The results of the different sunflower price models yielded a number of influential price factors that are categorised into macroeconomic, South African oilseed supply and demand, South African vegetable oil import and international oilcake/meal price factors.

The macroeconomic factors that influence the price of sunflower in South Africa are the Brent crude oil price per barrel, and the Rand/US-Dollar exchange rate. The South African oilseed supply and demand factors comprise the North-West Province rainfall, and the closing stock of sunflower in South Africa. The South African vegetable oil import factors that influence the price of sunflower in South Africa include the sunflower import parity price quoted by SAFEX, and South Africa's 750ml cooking oil price. The international oilcake/meal price factors are the Argentinean soybean meal price and the Argentinean sunflower meal price.

Although these sunflower price models are based on a South African specific case study, a number of generic shortcomings in the composition, significance and applicability of such models were identified during their development. Consequently, these shortcomings need to be considered and addressed in future agricultural price modelling studies.

Samevatting

Die faktore wat die Suid-Afrikaanse sonneblomprys beïnvloed

deur

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Sonneblomsaad is die derde belangrikste landelike gewas in Suid-Afrika na mielies en koring. Gedurende die gereguleerde bemarkingstydperk (1980s - 1990s) het die Oliesaderaad die oorgrote meerderheid van die bedrywighede van die oliesaad-industrie beheer. Pryse was vasgestel deur vraag en aanbod, sowel as die uitvoerpryse (d.i. pryspoele) wat deur die Oliesaderaad afgelei was. Pryse was ook bepaal vir 'n spesifieke produksie seisoen, en daardie pryse was slegs blootgestel aan 'n enkelkanaal-bemarkingskema. Die situasie het heeltemal verander met die bekendstelling van die Wet op Bemarking van Landbouprodukte (Nr. 47 van 1996 soos aangepas). Die wetgewing het gelei tot die deregulering van die Suid-Afrikaanse graanindustrie en die afskaffing van die graan Bemarkingsraad.

Sedert die deregulering van die oliesaad-industrie in Suid-Afrika word die pryse van sonneblomprodukte onder normale markomstandighede (d.i. deur vraag en aanbod) bepaal. Sonneblomprodukte word formeel verhandel op die Landbou Produkte Afdeling (LPA) van die JSE Sekuriteitebeurs. Die afdeling is meer algemeen bekend as die Suid-Afrikaanse Termynmark.

Die verhandeling se doelwit is om die struktuur van die Suid-Afrikaanse sonneblomprys te analiseer met behulp van verskeie ekonomiese teorieë en ekonometriese modellering tegnieke. Die spesifieke doelwit van die verhandeling is dus om die faktore wat die Suid-Afrikaanse sonnebomprys beïnvloed (wat die algemene doelwit van die studie is) te neem en 'n reeks Suid-

Afrikaanse sonneblomprysmodelle te ontwikkel. Die modelle kan dan gebruik om spesifieke vooruitskattings van die sonneblomprys in Suid-Afrika te lewer. Maandelikse data (Januarie 2000 – Maart 2007) is geanaliseer met behulp van *Vektor Outoregressies*, *Vektor Fout Korreksie Modelle* en *Eerste-Orde Outoregressiewe Modelle* om die Suid-Afrikaanse sonneblomprysmodelle te ontwikkel. Die resultate van die verskillende prysmodelle het 'n aantal faktore wat die sonneblomprys beïnvloed opgelewer en is kategories as die volgende faktore geïdentifiseer: makro-ekonomiese, Suid-Afrikaanse oliesaad vraag en aanbod, Suid-Afrikaanse plantaardige olie invoere, en internasionale oliekoek/meel pryse.

Die makro-ekonomiese faktore wat die Suid-Afrikaanse sonneblomprys beïnvloed is die Brent ru-olie prys per vat en die Rand/Amerikaanse Dollar wisselkoers. Die Suid-Afrikaanse oliesaad vraag- en aanbod-faktore is hoofsaaklik die Noordwes-Provinsie se reënval en die eindvoorraad van sonneblom in Suid-Afrika. Die Suid-Afrikaanse plantaardige olie invoer-faktore wat die sonneblomprys beïnvloed sluit die SAFEX invoerpariteitprys van sonneblom en die 750ml kookolieprys van Suid-Afrika in. Die internasionale oliekoek-/meelprys-faktore is die sojaboon meelprys van Argentinië en die sonneblom meelprys van Argentinië.

Alhoewel die sonneblomprysmodelle wat in die verhandeling ontwikkel is spesifiek 'n Suid-Afrikaanse gevallestudie is, het dit ook 'n aantal tekortkominge geïdentifiseer in die samestelling, invloed en die aanwending van soortgelyke modelle. Dié tekortkominge moet dan natuurlik oorweeg en aangespreek word in toekomstige landboukommoditeit-prysmodelle.

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List of Abbreviations

ADF……………………………Augmented Dickey Fuller
AFMA…………………………Animal Feed Manufacturers Association
AMD…………………………… Agricultural Markets Division
APD…………………………… Agricultural Products Division
AR……………………………… Autoregressive Model
ARCH………………………… Autoregressive Conditional Heteroskedasticity
ARG…………………………… Argentina
BFAP……………………………Bureau for Food and Agricultural Policy
BR……………………………… Bulgaria and Romania
BTL…………………………… Biomass-to-Liquid
CHI…………………………… China
CIF……………………………… Cost, Insurance and Freight
CIS……………………………… Commonwealth of Independent States
DDGS…………………………Dried Distillers Feed with Soluble
EFS……………………………Eastern Free State
ENSO………………………… El Nino/Southern Oscillation
ETBE…………………………Ethyl Tetra-Butyl Ether
EU-25………………………… European Union-25
FAME…………………………Fatty Acid Methyl Esters
FAPRI………………………… Food and Agricultural Policy Research Institute
FFV…………………………… Flex Fuel Vehicles
FOB……………………………Free on Board
GATT………………………… General Agreement on Tariffs and Trade
GRAINSA…………………… Grain South Africa
IOMP…………………………International Oilcake/Meal Prices
IPP………………………………Import Parity Price
IWMI…………………………International Water Management Institute
JSE……………………………… Johannesburg Stock Exchange
K………………………………… Potassium
LSE……………………………Least Squares Estimates
MEF…………………………… Macroeconomic Factors

MTBE............................Methyl Tertiary-Butyl Ether
N..................................Nitrogen
NAMC........................... National Agricultural Marketing Council
NW................................North-West
NW-FS........................... North-West – Free State
OLS............................... Ordinary Least Squares
P.................................. Phosphorus
ROW............................. Rest-of-the-World
SADC............................. South African Development Community
SAFEX........................... South African Futures Exchange
SAFEXSSP...................... SAFEX Sunflower Spot Price
SAFEXS1P...................... SAFEX Sunflower First Futures Price
SAFEXS2P...................... SAFEX Sunflower Second Futures Price
SAFEXS3P...................... SAFEX Sunflower Third Futures Price
SAGIS............................ South African Grain Information Service
SAOSD........................... South African Oilseed Supply and Demand
SARB............................. South African Reserve Bank
SASPM........................... South African Sunflower Price Models
SASSPM......................... South African Sunflower Spot Price Model
SASFFPM....................... South African Sunflower First Futures Price Model
SASSFPM....................... South African Sunflower Second Futures Price Model
SASTFPM....................... South African Sunflower Third Futures Price Model
SAVOI........................... South African Vegetable Oil Imports
SOM.............................. Soil Organic Matter
USA............................... United States of America
USDA............................. United States Department of Agriculture
VAR.............................. Vector Auto-Regression
VECM............................ Vector Error Correction Model
WRI............................... World Resources Institute

1

Introduction

1.1 Background

Over the past fifteen years there were major influential changes in the global sunflower market. These changes were characterised by the transformation of a highly regulated international industry to an essentially free one (SAGIS, 2006:28; Meyer, 2005:2). As a result, the overall economic policy in South Africa changed considerably in line with the international movement towards the deregulation and the liberalisation of the economy. This movement resulted in a more market-based approach to both agricultural and macroeconomic policy (Meyer, 2005:2; GRAINSA, 2007:28).

However, due to this new and vibrant agricultural environment, the role players in the sunflower sector and other commodity sectors were forced to continuously make decisions concerning their particular pricing, distribution, production and product policies. Subsequently, if all the policies are documented, there will be a definite criterion to signify the overall agricultural cropping progress. This criterion includes intrusive business control, strategic planning, and forecasting within various agricultural commodity sectors. It is against this background that commodity price modelling can play an extremely important role. For example, commodity price models can assist key agricultural players in their general decision-making (Townsend, 1997:138; SAGIS, 2006:28; Meyer, 2005:2; Van Schalkwyk, 2003:2).

Sunflower is considered to be one of the most vital field crops produced in South Africa. This is not only true regarding its input to the gross value of production for agricultural commodities, but also in terms of its value in the value-adding system of other commodities and products (Van Schalkwyk, 2003:2, SAGIS, 2006:28; GRAINSA, 2007:28). The majority of the demand for sunflower in South Africa originates mainly from the animal protein feed producers (that is for supplementary protein feed provisions) and from the demand for sunflower oil (that is for industrial and human utilisation). For example, one of the largest increases in the demand for protein feed rations is from the South African dairy industry, followed closely by the cattle and sheep industries (AFMA, 2007:25). These industries' demands for oilcake/meal are met by the importation of large quantities of the total oilcake/meal utilised in South Africa. Subsequently, soybean oilcake/meal represents the largest portion of the imported oilcake/meal in South Africa (Van Schalkwyk, 2003:28; GRAINSA, 2007:28; AFMA, 2007:25).

The steady increase in the importation of agricultural commodities and secondary products, accentuates the importance of the overall liberalisation of the international markets. The subsequent impact of the liberalisation of the international markets on the South African sunflower industry needs to be analysed and well understood. One of the major effects of these changes is that the local commodity prices follow the international commodity prices very closely (Townsend, 1997:138; SAGIS, 2006:28). This will have a substantial effect on a number of factors. Amongst others, these include the strong consumer demand for sunflower products and the substitution between the different oilseeds[1] and other food and feed products for decisive health, price and income reasons (Van Schalkwyk, 2003:2).

The price of each sunflower product is a function not only of its demand, but also of the price of every substitute commodity and service. Therefore, all the agricultural commodities' prices are linked to a certain extent in an interdependent system. Subsequently, a momentous change in the price of one agricultural commodity brings about influential shifts in the prices of other agricultural commodities (Townsend, 1997:138; SAGIS, 2006:28; Van Schalkwyk, 2003:2). The core direction of the change in the price of an agricultural commodity depends on the direction of the change in the demand for a related commodity. As a result, this direction is dependent on whether or not the related commodity is a substitute or complement product. For example, the change in the price of a substitute commodity and the change in the demand for that specific commodity are usually positively correlated (Van Schalkwyk, 2003:2; Meyer, 2005:2).

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[1] *Sunflower oil is one of the many vegetable oil products that make up the "oilseed complex." Other oilseed crops include soybeans, cottonseed, canola, industrial rapeseed, safflower, sesame seed, coconut and palm oil. These alternative oilseed product sources are competitive, although not perfect substitutes. However, changes in the supply/demand conditions and in the prices of any one of these oilseeds will tend to have crossover effects upon other oilseed product prices and subsequently the overall oilseed market (O'Brien, Stockton, and Belshe, 2001:3).*

Agricultural commodity price modelling is a procedural and complete technique that can present powerful analytical tools. It can subsequently be used to examine the complexity of a specific commodity market. However, commodity price models can generally be utilised for three basic levels of analysis. The first is for market analysis (for example the general prices of agricultural commodities), the second for policy analysis (for example the inflation rate and the repurchase rate of a country) and finally as a forecasting tool (Townsend, 1997:138; SAGIS, 2006:28; Meyer, 2005:2).

The continuous development of agricultural commodity price models and their applications have appeared in economic literature as a distinct area of economic research since the mid 1970s. These models add importance to better understand the movements in the prices, quantities demanded, and the quantities supplied of an assortment of commodities (Van Schalkwyk, 2003:2; Meyer, 2005:2). This divergent area of economic research has raised the attentiveness of economists and policy analysts all over the world. One should always remember and take note of a statement that Henri Theil (a great master of econometric modelling) made, that "*Models are to be used not believed.*"

1.2 Problem statement

1.2.1 General problem statement

The South African agricultural sector has experienced a long and wearisome history of state intervention. The Marketing Acts of 1937 and 1968 respectively provided the momentum for a period of sixty years that was characterised by the controlled marketing of the chief agricultural industries (Kirsten and Vink, 2000:25). Under the protection of "orderly marketing" a single marketing channel was established with agricultural co-operatives that acted as agents to the Marketing Boards (Meyer, 2005:3; GRAINSA, 2007:28). As a result, farmers received fixed prices for their assortment of products. This was irrespective of the transaction costs incurred due to varying distances to final destinations for the delivery of products. These farmers had full knowledge about the prices they would receive for their products at the beginning of each production season (Van Schalkwyk, 2003:2; Meyer, 2005:3; SAGIS, 2006:28).

Hence, domestic agricultural producers had to "compete" in a marketing environment that was partially isolated from the international agricultural markets. Subsequently, these domestic producers benefited from access to subsidised sources of credit, making their credit applications more affordable and less risky (Townsend, 1997:138; Meyer, 2005:3). This combination of guaranteed fixed prices, and the accessibility to affordable credit loans made it possible for South African farmers to cultivate marginal lands for the production of field crops. In retrospect, the continuation of this kind of behaviour raised concerns within the South African agricultural industry as to the productivity of the land, and the value of subsidiary crop production (Townsend, 1997:138; SAGIS, 2006:28; Meyer, 2005:3; Van Schalkwyk, 2003:2).

In the early 1980s there was a general decline in the use of commodity price controls with a determined swing towards a more market-based pricing approach. The General Agreement on Tariffs and Trade (GATT) negotiations enhanced the pressure for the elimination of quantitative import controls and the introduction of tariffs on agricultural commodities (Van Schalkwyk, 2003:2; Meyer, 2005:3). In June 1991 the Minister of Agriculture appointed the Kassier Committee of Inquiry into the Marketing Act. Between the release of the Kassier report and the promulgation of the new Marketing of Agricultural Products Act in 1996, approximately ten of the existing Marketing Boards were abolished (Kirsten and Vink, 2000:25; Townsend, 1997:138; SAGIS, 2006:28).

The Marketing of Agricultural Products Act of 1996 set out to avert rather than to promote undesirable interventions. The key objectives of the Act were to increase access to the international market, the promotion of efficiency in the marketing of agricultural products, and the enhancement of the feasibility of the agricultural sector (Kirsten and Vink, 2000:25). As a result of the abolishment of the Marketing Boards, South African farmers had to compete in an open economy with world markets that notably influence their domestic crop prices. As an end result, the South African agricultural industry is open to the elements of an uncertain environment that are influenced by the dynamic changes in the world economy (Townsend, 1997:138).

As a price taker it is predominantly critical for the South African agricultural industry to anticipate the future directions of the world markets. The main reason for this is that the health of the South African macro economy is dependent to a fair extent on the agricultural sector. However, the relationship between the South African economy and the agricultural sector is extremely complex and the consequential macroeconomic effects are not always well understood by decision-makers (SAGIS, 2006:28; GRAINSA, 2007:28).

1.2.2 Specific problem statement

The dynamic environment in which the South African producers of sunflower products function necessitates the understanding of the production (that is the supply) and the consumption (that is the demand) patterns of the products they produce (SAGIS, 2006:28). As a result, the sunflower sector is characterised by a deregulated market with uninformed producers and consumers whom are no longer protected by the Marketing Boards (GRAINSA, 2007:28). It is thus fundamental to identify the factors that influence the price of sunflower in South Africa and to determine the influence on the South African sunflower price if one of the identified factors changes.

1.3 Objectives of this study

1.3.1 General objective

The general objective of this dissertation is to identify the factors that influence the price of sunflower in South Africa. This information can be utilised to assess the potential outcomes of proposals made as part of future trade negotiations or simply to protect the South African producers and consumers. In addition, it will facilitate and better inform the decision making behaviour of South African producers and consumers in the face of changing economic policies, trade policies, and world markets.

1.3.2 Specific objective

The specific objective of this dissertation is to construct a series of South African sunflower price models (SASPM) with the aid of the influential factors identified in the literature study. These models can then be utilised to make projections of the prices of sunflower in South Africa. The SASPM can be implemented for fundamental policy analysis and for business decisions, which might have a noteworthy impact on the various sunflower prices. A range of "what if" questions can also be evaluated. These "what if" questions can be based on changes in the tariffs and world prices or the possible impact of a depreciation in the Rand/US-Dollar exchange rate on the price of sunflower. The SASPM can, furthermore, be used to give a best estimate about the likely outcome of a fastidious policy proposal. Consequently, the SASPM is designed to imitate the primary and secondary effects of policy changes (for example to model the repercussions for major macroeconomic aggregates).

1.4 Demarcation of this study

This dissertation is based on historical monthly data and includes 87 data points that stretches from January 2000 - March 2007. This is due to the limited availability of suitable agricultural demand and supply data for the 2007/08 production season on completion of this study.

1.5 Chapter outline

This dissertation is organised into six chapters. *Chapter 1* is the introduction to this dissertation. It consists of the background, the general and specific problem statements, and the general and specific objectives of this study.

Chapter 2 is a broad spectrum discussion on the cropping of sunflower. This chapter includes the history of the sunflower plant and the growth and development of the sunflower. A section is devoted to the planting and fertility needs of the sunflower which includes soil requirements and cultivation, yield potential, selection of the sunflower seed cultivar, planting date, row width, plant density, planting techniques, and the macro nutrient requirements of the sunflower plant. Sections are also dedicated to the control of weeds and pests of the sunflower plant and the harvest and storage of sunflower. The final section examines the utilisation of sunflower products by the livestock, snack/fast food, and industrial industries.

Chapter 3 examines the international sunflower market. The first part of this chapter is dedicated to the global sunflower industry, the regional production of sunflower (seed, oil, and oilcake/meal), and the regional consumption and trade of sunflower (seed, oil, and oilcake/meal). The second part examines the global futures market fundamentals including an overview of the futures market and the factors that are responsible for price differences in an agricultural commodity market.

Chapter 4 provides a study of the South African sunflower market (that is the development of sunflower in South Africa and the sunflower seed, oil, and oilcake/meal production and consumption in South Africa). The second part of this chapter examines the South African

Futures Exchange (SAFEX) and specifically the futures contracts of sunflower seed with reference to the formation of sunflower seed prices in the South African market.

Chapter 5 of this dissertation comprises the empirical study. The first part of this chapter is divided into the related agricultural studies section and the data properties section. The data properties section details the source and frequency of the data, standardisation of the potential factors' data, and the stationarity of the variables' data. The second part is the econometric study, which describes the preliminary and final regression methodologies and the development of the different South African sunflower price models.

Chapter 6 is the conclusion and recommendations for this dissertation. The conclusion section is a start-to-finish overview of the factors that influence the price of sunflower in South Africa and the development of the different sunflower price models in South Africa. The recommendation section discusses some of the adjustments and/or improvements that can be made in future agricultural price modelling studies. An appendix section follows this chapter.

2

Sunflower Cropping

2.1 Introduction

Chapter 2 will support the identification of the variables that are required to construct a series of models that can provide an approximation of the present and the future prices of sunflower in South Africa. To explain and forecast the changes in the demand and supply of sunflower in South Africa, a fundamental understanding of the South African sunflower cropping industry is required. As a result informative questions and answers are essential in the identification process of the factors that influence the different prices (that is spot and futures prices) of sunflower in South Africa.

This chapter consists of a general discussion on the South African sunflower cropping industry. It is a compilation of three principle parts and a conclusion section. The first part (sections 2.2 and 2.3) of this chapter examines the history of the sunflower plant and the sunflower plant's growth and development. The second part (sections 2.4 and 2.5) discusses the planting and fertility needs of the sunflower plant and the control of weed, insects and diseases that threaten the cropping of sunflower. The third part (sections 2.6 and 2.7) inspects the harvest and the storage methods of sunflower seed and the universal utilisation of sunflower products.

2.2 History of the sunflower

The history of the sunflower (*Helianthus annuus*) is indeed remarkable. The wild sunflower is native to North America, but the commercialisation of the plant took place in Russia (Schneiter, 1997:35; Wikipedia, 2006:14; Putnam, Oplinger, Hicks, Durgan, Noetzel, Meronuck, Doll, Schulte, 1990:18). It was only fairly recently that the sunflower plant returned to North America to become a cultivated crop. The American Indians were the first people to domesticate the sunflower into a single headed plant with a variety of seed colours including black, white, red and black/white striped (Schneiter, 1997:35; Sauer, 1993:18). Subsequently, sunflower was one of the most common crops among American Indian tribes throughout North America. Evidence suggests that the plant was cultivated by Indians in present day Arizona and New Mexico around 3000 BC. Some archaeologists suggested that the sunflower may have been domesticated before maize, and was utilised in a number of ways by the various American Indian tribes (Myers, 2005:13). For example, the sunflower seed was crushed or pounded into flour for cakes, mush or bread and some tribes mixed the meal with other vegetables such as beans, squash and maize. The sunflower seed was also cracked and eaten for a snack. However, there are references of tribes that squeezed the oil from the seed and utilised it in the making of bread (Putnam *et al.*, 1990:18; Schneiter, 1997:35; Sauer, 1993:18).

Some of the non-gastronomic uses of the sunflower plant include purple dye for textiles, body painting, and other decorations. Various parts of the plant were used medicinally (that is the oil of the seed was used on the skin and hair) and the dried stalk was used as building material (Schneiter, 1997:35; Putnam *et al.*, 1990:18; Sauer, 1993:18). The sunflower plant and the sunflower seeds were a common necessity in numerous ceremonies across the Americas (Wikipedia, 2006:14; Myers, 2005:13). This North American plant was taken to Europe by Spanish explorers some time around 1500 AD. The plant became pervasive throughout present day Western Europe mainly for decorative and medicinal uses, but in 1716 an English patent was granted for the squeezing of oil from sunflower seed (Putnam *et al.*, 1990:18). As a result of this and the influential policies of Peter the Great[2], the sunflower plant became very popular as a cultivated crop in the 18th century (Schneiter, 1997:35, Wikipedia, 2006:14).

The plant was initially used as an ornamental flower in Europe, but 1769 literature mentions that the sunflower was also cultivated for oil production (Schneiter, 1997:35; Myers, 2005:13). By 1830, sunflower oil was manufactured on a commercial scale and the Russian Orthodox Church increased its popularity by forbidding most oil foods from being consumed during Lent. Sunflower was not on the Church's forbidden list and, therefore, gained in immediate popularity as a "religious" foodstuff (Wikipedia, 2006:14; Putnam *et al.*, 1990:18). As a result, by the early 19th century Russian farmers were growing over 810,000 hectares of sunflower seed.

[2] *Peter the Great ruled Russia and later the Russian Empire from 1682 until his death (1725), jointly ruling before 1696 with his weak and sickly half-brother, Ivan V. Peter carried out a policy of Westernisation and expansion that transformed the Tsardom of Russia into the Russian Empire, a major Eurasian power (Wikipedia, 2006:14).*

During that time two specific types of sunflower plant had been identified, namely the type for oil production and a large variety of types for direct human consumption (Schneiter, 1997:35; Myers, 2005:13; Sauer, 1993:18). Comprehensive government research programs were implemented in Soviet Russia and V.S. Pustovoit[3] developed a very successful agricultural research program at Krasnodar. Since then the sunflower oil contents and sunflower yields increased significantly. Today the most prestigious sunflower scientific award is known as *The Pustovoit Award* (Schneiter, 1997:35).

According to Putnam *et al.* (1990:18) the Russian sunflower seed found its way into the United States of America (USA) in the late 19th century. By the end of 1880 the seed companies were advertising the "Mammoth Russian" sunflower seed in catalogues. This particular seed name was still being offered in the USA and in South Africa in 1970, nearly 100 years later (Sauer, 1993:18). A likely source of this seed's movement to North-America may have been Russian immigrants and the first commercial use of the sunflower crop in the USA was silage feed for poultry (Sauer, 1993:18).

In 1926 the Sunflower Growers Association of Missouri participated in what was likely to be the first processing of sunflower seed into oil in the USA (Schneiter, 1997:35). Canada started the first official government sunflower production program in 1930 and the basic agricultural material utilised came from Mennonite (that is immigrants from Russia) gardens (Wikipedia, 2006:14). The area planted spread because of the increased oil demand. During 1946 Canadian farmers built a small crushing plant and subsequently, the area planted (that is the amount of hectares) spread into Minnesota and North Dakota (Putnam *et al.*, 1990:18). In 1964 the Government of Canada licensed the Russian sunflower cultivar called *Peredovik* and this seed produced higher crop yields due to the higher oil content (Schneiter, 1997:35).

The area planted in South Africa increased with the commercial interest in the production of sunflower oil. The sunflower was hybridised in the middle seventies to provide additional yield, oil enhancement, and disease resistance (Sauer, 1993:18). The USA's area planted escalated in

[3] *In 1912, V.S. Pustovoit began his research work on field crops in the Kuban region. Pustovoit was an outstanding breeder, a Lenin and State Prize winner, a member of the USSR Academy of Sciences and the Lenin Academy of Agricultural Sciences. He identified the technique of multiple individual selections from strains and intervarietal hybrids assessed for their offspring quality, with the subsequent induced and regulated transpollination of the best numbers (Wikipedia, 2006:14).*

the late 1970s to over 2,023,500 hectares because of a strong European demand for sunflower oil. This European demand had been stimulated by Russian exports of sunflower oil in the previous decades (Schneiter, 1997:35; Wikipedia, 2006:14; Putnam *et al.*, 1990:18). However, during this time animal fats (for example beef tallow for cooking) were negatively impacted by cholesterol concerns and the Russians could no longer supply the rising demand. Subsequently, the European companies looked to the fledging USA industry to supply in their rising demand (Sauer, 1993:18; Wikipedia, 2006:14).

South Africa became part of the global sunflower market in the late 1980s and its area planted increased on a seasonal basis (USDA, 2006:13). There are a fair number of minor reasons for the rapid increase in the production of sunflower seed. However, one of the major reasons is better understanding of the growth and development of the sunflower plant in South Africa. As a result it is essential to understand the basic needs of the sunflower plant to increase its production (for example the yield of the sunflower).

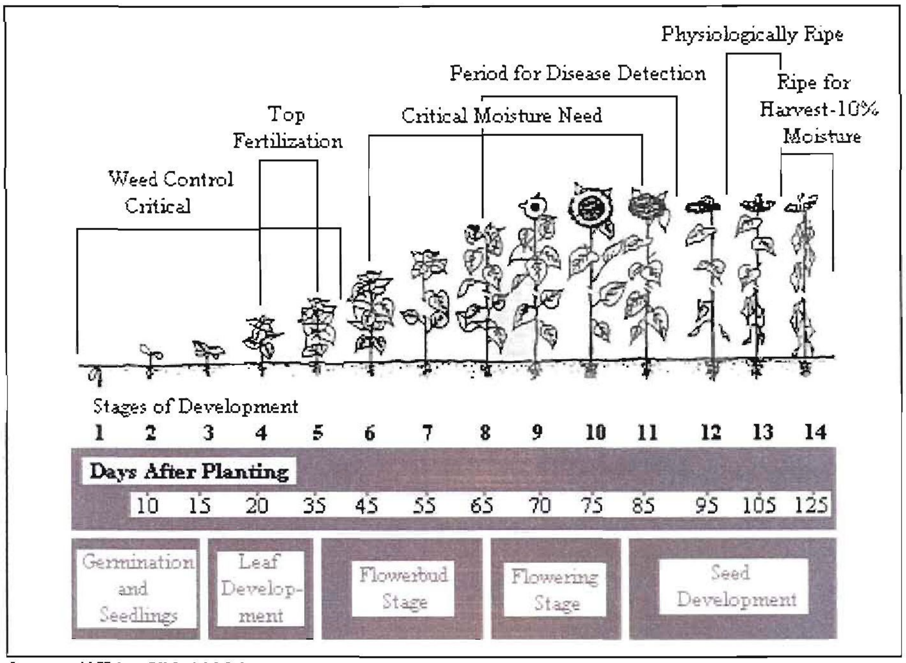
2.3 Growth and development

The sunflower is a broadleaf plant that emerges from the soil with two large cotyledons. Emergence will take four to five days when planted approximately 25 millimetres deep in warm soil, but will take a few days longer in cooler soils or when planted deeper (Wikipedia, 2006:14; Putnam *et al.*, 1990:18). Crusting of the soil can make it difficult for the large seedlings to push through the soil. However, the South African sunflower cultivars grow rapidly and produce large rough leaves. If sunflower in South Africa are planted in the early summer, they will be in full bloom after about two months, and will be fully grown approximately a month later (Myers, 2005:13; Schneiter, 1997:35; PANNAR, 2007:2).

The different development stages and associated crop management inputs of the sunflower plant are shown in Figure 2-1. This includes the germination, leaf development, flowering, and seed development stages. The management inputs like weed control, fertilisation, moisture, disease control, ripeness, and harvesting are indicated within a specific timescale. The current South African sunflower plant varieties can reach an average of roughly 1.8 metres in height. However, they vary between 1.5 and 2.1 metres depending on the planting date and soil conditions. After they have reached their full height and bloom, the heads on the commercial

South African cultivars will turn downwards. They are designed as such to make it harder for the birds to eat the seed (Myers, 2005:13; Putnam *et al.*, 1990:18).

Figure 2-1 Sunflower plant's development stages



Source: KZN-AGRI, 2006:8.

A large field of sunflowers in bloom is a remarkable sight. Numerous farmers comment on the pleasure they and passers-by get from seeing the flowers' yellow petals following the rays of the sun. Each sunflower head (inflorescence) is actually composed of two types of flowers. Firstly, what appear to be yellow petals around the edge of the head are actually individual ray flowers. Secondly, the face of the head is comprised of hundreds of disk like flowers which each form into a seed (achene). Although some studies have shown that bee pollinators provided a minor boost in the yield of sunflower seed production, commercial sunflowers are self-compatible for pollination (Myers, 2005:13; Wikipedia, 2006:14; PANNAR, 2007:2).

Sunflowers' heads turn with the sun (that is they track the sun) early in their development stage, but later the sunflowers' heads will continue to face East before facing downwards. Subsequently, some of the South African farmers like to plant their rows North and South. This is done to ensure that the heads can lean into the row space rather than "bashing" against an adjacent plant, causing some seed to fall and be wasted (Sauer, 1993:18; PANNAR, 2007:3).

To encourage the accurate planting techniques and to prevent the wasting of sunflower seed, section 2.4 will discuss the planting and fertility needs of the sunflower plant.

2.4 Planting and fertility needs

2.4.1 Soil requirements

The sunflower plant adapts comparatively well to a wide variety of soil types, but usually sunflower cultivation is limited to soils where the clay percentage varies between 15-55% (KZN-AGRI, 2006:1; PANNAR, 2007:2). At present the major planting areas for sunflower are in soils with a clay percentage of less than 20%. In South Africa a shortage of water is the main factor limiting the crop production (PANNAR, 2007:2). It is, therefore, vital that the available water is utilised to the best advantage of the plant. Especially in the more arid Western areas it is essential that as much water as possible has to be stored in the soil profile before planting (KZN-AGRI, 2006:1; PANNAR, 2007:2). This is to limit the chance of failure.

The sunflower plant has a deep and finely branched tap-root system that can utilise water from the deeper soil layers (that is in some cases deeper than 2 metres). As a result, the crop often performs well (that is even during a dry season) in deeper soils or in soils with a definite water table. Because of the sunflower plant's unique water utilisation pattern and its root system, the shallow soils that are found mainly in the Eastern areas of the Free State (for example Estcourt and Kroonstad) and other duplex soils are suitable for the farming of sunflower (PANNAR, 2007:2). The sunflower's tap-root system is capable of utilising water from the clay horizons of these soils. However, the potential for high yields in these soils is limited (KZN-AGRI, 2006:1).

2.4.2 Yield potential

From a farm management point of view it is essential to make a reliable assessment of the yield potential with effective planning in mind. The plant density, cultivar and especially the fertilisation programme cannot be planned unless the yield potential has been accurately determined (PANNAR, 2007:2). Table 2-1 provides a guideline (that is the soil depth and the rainfall for a certain soil) for the determination of the yield potential.

Table 2-1 Yield potential for loam soils

Soil Depth (mm)	Annual Rainfall (mm)		
	500	550	650+
40-60	1000 kg/ha	1200 kg/ha	1500 kg/ha
60-80	1300 kg/ha	1500 kg/ha	1900 kg/ha
80+	1300 kg/ha	1600 kg/ha	2200 kg/ha

Source: KZN-AGRI, 2006:2; PANNAR, 2007:2.

The slower sunflower cultivars require an annual rainfall of 650 – 850 millimetres. For the shorter, quicker types 500 – 650 millimetres is sufficient, but superior yields can be achieved with 300 – 400 millimetres of rain during the growing season. The feared *Sclerotinia* disease (that is head rot) develops under high rainfall conditions and thus the drier, warmer areas (with a rainfall of ±650 millimetres) with low humidity are preferred (PANNAR, 2007:2). The yield potential has been determined for loam soils and, therefore, the cultivar selection is very important.

2.4.3 Selection of the sunflower cultivar

The choice of the sunflower cultivar is an important aspect in the production process of sunflower seed. Its effect is time and again underrated, but by choosing the appropriate cultivar is one way of ensuring higher profits at no extra cost (KZN-AGRI, 2006:2; PANNAR, 2007:4). From a production point of view the disease resistance and the quality do not play a major role. For this reason the yield and the yield reliability[4] are by far the most important criteria when cultivars are evaluated (KZN-AGRI, 2006:1; Myers, 2005:13).

Another important aspect of the choice of a sunflower seed cultivar is the oil content, because the price is determined accordingly. High oil content goes hand in hand with the low fibre content (PANNAR, 2007:4). The high oil types have a fibre content of ±16% (that is the colour of the high oil type seed is a dull grey black with many fine stripes) while those with a low oil content contain ±26% fibre (that is the colour of the low oil type seed is black or striped with a shiny appearance) (KZN-AGRI, 2006:1; Myers, 2005:13; PANNAR, 2007:4). When a sunflower seed cultivar has been identified, the seed requirements should be determined for optimum yield, hence optimum production.

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[4] *The yield reliability of a cultivar at a certain yield potential is the minimum yield that will be achieved by that cultivar in nine out of ten cases. It takes the yield disposition, average yield, and the risk of a cultivar into account (KZN-AGRI, 2006:2).*

2.4.4 Sunflower seed requirements

Sunflower seed is graded according to its size[5] in order to simplify the planting process. The general seed requirements will depend on the sunflower seed size and the envisaged plant population (PANNAR, 2007:5). The estimated hectares that can be planted with 25 kilograms of sunflower seed at the various plant populations per hectare are discussed in Table 2-2.

Table 2-2 Summary of planted sunflower seed

Class	Kernels per Kg**		Plant Population per Hectare						
	Total	Less 20%*	20 000	25 000	30 000	35 000	40 000	45 000	50 000
4	22 000	17 600	22.0 ha	17.6 ha	14.7 ha	12.6 ha	11.0 ha	9.8 ha	8.8 ha
3	17 250	13 800	17.3 ha	13.8 ha	11.5 ha	9.9 ha	8.6 ha	7.7 ha	6.9 ha
2	13 500	10 800	13.5 ha	10.8 ha	9.0 ha	7.7 ha	6.8 ha	6.0 ha	5.4 ha

Source: PANNAR, 2007:5.
Note. * Subtracted 20% as a result of losses at or shortly after planting.
** The number of kernels per kilogram may vary, depending on the cultivar

The cultivars also vary with regard to the amounts of seed they produce of the various kernel sizes. Genetically there is no difference between small and large kernels, but the larger kernels are preferred on soils with a high clay content and that compact easily. Due to the fact that a larger kernel produces a larger seedling it is important (that is under the above circumstances) if the desired plant population is to be obtained (PANNAR, 2007:5).

2.4.5 Soil cultivation

Production stability can be enhanced by the utilisation of cultivation practices that limit the moisture stress as far as possible. The point of departure in the preparation of the soil should be to utilise the rainfall and soil moisture to a maximum and decreasing the runoff losses. This is especially in the case for soils with a low infiltration rate (KZN-AGRI, 2006:3; PANNAR, 2007:3). These losses can be limited to a great extent by applying the correct soil cultivation practices. Primary practices, such as ploughing with a mouldboard plough or chisel plough are suitable. However, the objective of this cultivation practice is to break up the limiting layers, destroy the weeds, provide a suitable seedbed, and to break the soil surface. This is to ensure maximum rainfall infiltration as well as to prevent wind and water erosion (KZN-AGRI, 2006:3; Myers, 2005:13; PANNAR, 2007:3).

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[5] *Number 2 sunflower seeds are the largest and number 5 sunflower seeds are the smallest. The majority of the sunflower seed available is sized as either 3 or 4 (PANNAR, 2007:5).*

Sunflower is usually cultivated in rotation with maize or sorghum. The benefits from the dense mulches of these crops shield the soil against the impact of raindrops. The impact of raindrops Subsequently, seals the surface and reduces the penetration rate. However, mulches of maize and/or sorghum may enhance some other pests and diseases on the sunflower plant (Wikipedia, 2006:14; Putnam *et al.*, 1990:18; PANNAR, 2007:7). The compaction of the soil can be a serious problem (that is in sandy soils) and if the compaction is not broken, the crop cannot utilise the full water capacity of the soil profile. This is primarily because the roots cannot enter the compacted layer (PANNAR, 2007:3). As a result, the root development of the previous crop should be examined through the use of profile pits. Generally in dry years the root development of the sunflower plant will be seriously hampered where compaction exits (Myers, 2005:13). To aid the sunflower plant's roots in its development, it is crucial to plant the sunflower during the appropriate season.

2.4.6 Planting date

Normally sunflower can be planted from the beginning of November until the end of December in the Eastern areas, and until mid-January in the Western areas. However, when choosing the best planting date a number of factors should be taken into consideration. These factors include the onset and last dates of frost, soil temperature, moisture requirements of the crop, rainfall patterns, and the risk of bird damage (KZN-AGRI, 2006:3; Myers, 2005:13; Schneiter, 1997:35). High average soil temperatures during the planting season usually lead to poor emergence in the warmer Western areas with its sandy soils. This is a major factor that often leads to a reduced stand (PANNAR, 2007:3). For example, at Viljoenskroon in the North-Western Free State, soil temperatures as high as 45 °C have been measured in sandy soil at plant depth during December. In these parts planting should rather be done before mid-November when the soil temperatures are not as high, or when a period of cooler weather is expected (KZN-AGRI, 2006:3; PANNAR, 2007:3).

2.4.7 Row width

The cultivar and the cultivation of the land are crucial to the general yield of the sunflower plant. However, the influence of row width on sunflower yield is quite small (KZN-AGRI, 2006:3; Myers, 2005:13). Row widths of 900 - 1,000 millimetres are predominantly used, but wider rows can also be utilised. Where other crops (for example maize) are planted in rows of 1,500 millimetres or even 2,100 millimetres, sunflower can also be planted productively in these row widths (that is in order to fit the farm equipment). Wide row spacing is only suitable for yield potentials lower than 1,500 kg/ha (KZN-AGRI, 2006:3; Putnam *et al.*, 1990:18). Row width is not a key factor that might influence the yield of the sunflower, but the plant density on the other hand is another story.

2.4.8 Plant density

A correct and uniform plant density with sunflower is the basis of an appropriate yield. Although the plant is able to compensate by head size and number of seeds per head, a very low plant density (for example less than 20,000 plants/hectare) often limits the yield (KZN-AGRI, 2006:4; Putnam *et al.*, 1990:18; Myers, 2005:13). At a low plant density heads are forming that are too large, that dry out unevenly and eventually weaken the harvesting process. However, larger sunflower heads have serious seed setting problems. For instance, a sunflower head of 300 millimetres produced only 19 grams of seed (that is a 20% seed setting) compared to the 54 grams of seed of a 160 millimetres head (that is a 80% seed setting) (Putnam *et al.*, 1990:18; PANNAR, 2007:3). Guidelines for plant density (that is the potential kilograms per hectare and the plants per hectare) are given in Table 2-3 and for seed requirements (that is the seed size and the amount of plants per hectare) in Table 2-4.

Table 2-3 Plant density at different potential yield levels

Potential Yield	Sunflower Plant Density
1,000-1,200 kg/ha	25,000-30,000 Plants/ha
1,200-2,000 kg/ha	30,000-35,000 Plants/ha

Source: KZN-AGRI, 2006:4, PANNAR, 2007.3.

Plant densities higher than 30,000 plants per hectare should be avoided at yield potentials below 1,200 kg/ha. This is because the higher rate of water utilisation often causes water stress and that ultimately leads to poor yield or even crop failure (KZN-AGRI, 2006:4; PANNAR, 2007:3). A high density of 55,000 plants per hectare and more causes a higher occurrence of lodging.

Table 2-4 Sunflower seed requirements

Seed Size	Plants per Hectare		
	25 000	30 000	35 000
4	1.42 kg/ha	1.71 kg/ha	1.99 kg/ha
3	1.81 kg/ha	2.17 kg/ha	2.54 kg/ha
2	2.32 kg/ha	2.78 kg/ha	3.24 kg/ha

Source: KZN-AGRI, 2006.4.

It is essential that sunflower plants be spaced evenly and the accuracy of the planter determines whether an even plant density will be achieved or not. The South African grading system follows the USA's grading system closely and, as previously mentioned, number 2 sunflower seeds are the largest, while number 5 seeds are the smallest (Myers, 2005:13; PANNAR, 2007:3). The test weight of sunflower will vary because of different seed sizes, but the typical test weights for oilseed sunflowers are 12.7-14.5 kg/bu.[6]

2.4.9 Planting depth and planting techniques

Sunflower seeds are usually planted at relatively shallow depths (that is a depth of 25 millimetres) and in soils with reasonable high clay content. However, in sandy soils the sunflower seeds can be planted at an average depth of up to 50 millimetres (KZN-AGRI, 2006:4, Myers, 2005:13). For the planting process of sunflower seed the importance of a good planter cannot be over-emphasised. A planter should be able to space the seeds evenly, have a good depth control mechanism, and should be equipped with press wheels (KZN-AGRI, 2006:4, Myers, 2005:13; PANNAR, 2007:5). Sufficient contact between the seed and the soil is essential and for this purpose the use of press wheels are necessary. During germination sunflower plants are particularly sensitive to compacted soil. Subsequently, the press wheels of the planter should only exercise light pressure on the soil to avoid compaction (Myers, 2005:13).

2.4.10 Macro nutrients

Compared to other grain crops the sunflower plant utilises the nutrients in the soil exceptionally well. The main reason for this is the finely branched and widespread root system of the sunflower plant (PANNAR, 2007:6). The roots absorb the nutrients that cannot be utilised by other crops. Subsequently, the sunflower plant normally reacts well to nitrogen (N) and phosphorus (P) fertilisation, where there is a substantial deficiency of these elements in the soil (KZN-AGRI, 2006:5). It is, therefore, essential that any fertilisation programme for sunflower

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[6] *The US Bushel is defined as 8 gallons. However, unfortunately these are gallons of dry measure, not the liquid gallons which most Americans are more familiar with. Basically the two are not the same. Nor are they the same as the Imperial gallon. The US bushel was originally defined as the volume of a cylindrical container 46.99 centimetres in diameter and 20.32 centimetres deep or approximately 54.62 cubic metres (LLT, 2006:22).*

1. *One bushel (for example maize) = exactly 56 pounds = approximately 25.401 kilograms.*
2. *One bushel (for example wheat) = exactly 60 pounds = approximately 27.215 kilograms.*

should be based on a soil analysis. Such a soil analysis will not only lead to more appropriate fertilisation levels, but can also significantly limit unnecessary fertilisation costs (PANNAR, 2007:6). Sunflowers appear to be tolerant of soils with a pH[7] down to 5.5. If the pH is below a specific level (that is 6.0) liming should be considered to improve the nutrient availability in the soil (Putnam *et al.*, 1990:18). Starter fertiliser for sunflower plants will usually be beneficial in the cool soils of early spring and should not be placed in direct contact with the seed (Sauer, 1993:18). Table 2-5 confirms that the sunflower plant removes relatively large quantities of nitrogen, phosphorus and potassium (K) out of the soil.

Table 2-5 Nutrient removal by the sunflower plant

Plant Component	Production	Nitrogen	Phosphorus	Potassium
	(Kilograms per Hectare)			
Seed	1 000	25.8	1.9	8.5
Stems and Leaves	6 000	41 2	5.2	87.6
Whole Plant	7 000	67.0	7.1	96.1

Source. PANNAR, 2007:7.

It is clear from Table 2-5 that the sunflower plant is a fairly heavy consumer of nitrogen, but the majority of the sunflower plant's nutrients are contained in the leaves and stems. Consequently, if the whole plant is ensiled relatively large quantities of N-P-K are removed from the soil. This is due to the low nutrient "consumption" of the sunflower seed (see Table 2-5). Nutrients will have to be replaced in the soil in some way or another. Specific recommendations of the 3 elements (that is N-P-K) are subsequently based on the general fertility of the soil (Putnam *et al.*, 1990:18; PANNAR, 2007:6).

2.4.10.1 Nitrogen

As a result of a shortage of nitrogen in the soil, the sunflower plant's growth rate decreases dramatically. The main leaves will turn to a pale green colour and the lower leaves will die off (KZN-AGRI, 2006:5; Wikipedia, 2006:14; Putnam *et al.*, 1990:18; PANNAR, 2007:7). However, to solve the problem of a nitrogen shortage, animal manure or a legume crop cover can reduce or eradicate the need for N-fertiliser (Myers, 2005:13). Fertilisation guidelines (that is the target yield in kilograms per hectare and the nitrogen in kilograms per hectare for the different soil types) for nitrogen are indicated in Table 2-6.

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[7] *It is a number that represents the degree to which a substance (that is soil) is acidic or alkaline. The pH is neutral at 7.4. The higher the pH is, the more alkaline the substance is. A pH below 7.4 signifies a more acidic substance (Longman, 1993:769).*

Table 2-6 Nitrogen fertilisation of sunflower

Target Yield	N-Guideline	
	Turf	All Other Soils
(Kilograms per Hectare)		
1 000	0	0-15
1 500	0-15	25-35
2 000	40-50	60-70

Source: Wikipedia, 2006:14; Putnam *et al.*, 1990:18.

2.4.10.2 Phosphorus

A shortage of phosphorus is characterised by the retarded growth of the sunflower plant. In exceptional cases serious necrosis[8] can be detected on the tips of the lower leaves (Putnam *et al.*, 1990:18). The fertilisation guidelines (that is the soil phosphor in milligrams per hectare and the target yield in kilograms per hectare) for phosphorus are given in Table 2-7. One of the factors that should be taken into consideration when planning a P-fertilisation programme is that an attempt should be made to build up the phosphorus content of the soil over time (KZN-AGRI, 2006:6). The optimum soil P-level for sunflower is about 10 mg/kg. However, at a higher level the crop will probably not respond to P-fertilisation (Myers, 2005:13; PANNAR, 2007:7).

Table 2-7 Phosphorus fertilisation of sunflower

Soil P (mg/ha)		Target Yields (kg/ha)		
Ambic 1	Bray 2	1 000	1 500	2 000
2.0	7.0	11.0	16.0	21.0
4.0	10.0	9.0	14.0	18.0
6.0	12.0	8.0	12.0	16.0
8.0	15.0	7.0	11.0	15.0
10.0	18.0	6.0	9.0	12.0
12.0	21.0	3.0	5.0	10.0
14.0	24.0	0.0	4.0	8.0

Source: KZN-AGRI, 2006:6; PANNAR, 2007:7.

2.4.10.3 Potassium

Although sunflower plants consume large quantities of potassium from the soil, only a small number (that is approximately 13%) of the potassium absorbed is utilised in the production of sunflower seed (PANNAR, 2007:8). The remaining 87% are utilised in the development of the sunflower plant. K-fertilisation in South Africa is usually unnecessary because South African soils generally have adequate quantities of this nutrient (KZN-AGRI, 2006:6; Myers, 2005:13). Table 2-8 signifies the relationship between the potassium and phosphorus levels in the soil.

[8] *The term is used to indicate the death of a piece of bone, tissue or plant material (Hawkins, 1991:544).*

The combination of potassium and phosphorus has a positive influence on the oil content of the sunflower seed that is produced during a specific production season (PANNAR, 2007:7).

Table 2-8 Potassium fertilisation of sunflower

Soil Potassium Analysis (mg/kg)	Phosphorus Administer (kg/ha)
20.0	27.0
40.0	20.0
60.0	14.0
80.0	11.0

Source: PANNAR, 2007:8.

2.4.10.4 Molybdenum and boron

Shortages of boron and molybdenum often limit the growth and yield of sunflower in the Eastern parts of South Africa. However, to avoid the different problems concerning these two elements sunflower farmers should apply a fertiliser that contains boron. Subsequently, they have to ensure that their seeds are treated with molybdenum (PANNAR, 2007:9). Local seed companies usually treat their seed with molybdenum. If no soil analysis is available, 50 - 100 kg/ha of a 3:2:1 (25) fertiliser mixture applied at planting is adequate for a yield potential of 1,000 - 1,500 kg/ha (KZN-AGRI, 2006:6). Table 2-9 indicates the boron recommendations for the three main soil types and the amount of boron that is necessary for the maximum yield per soil type.

Table 2-9 Boron recommendations on various soil types

Soil Type	Quantity Boron	Product	
		Solubor (20.5%)	Borax (11.3%)
	(Kilograms per Hectare)		
Sand	1.0	5.0	9.0
Sandy Loam	2.0	10.0	18.0
Heavy Clay	3.0	15.0	27.0

Source: PANNAR, 2007:9.

Boron fertilisation by means of soil sampling is unreliable. Subsequently, a leaf analysis is recommended to rectify a possible boron shortage in young sunflower plants. A sample of young plants should be tested for these trace elements (PANNAR, 2007:8). The young sunflower plants (of about one month old) must be cut off just above the ground for sampling purposes. If the boron content in the plant is less than 60 mg/ha, a foliar application should be applied before the critical flowering period to rectify the boron shortage in the plant (PANNAR, 2007:8).

Succeeding the soil fertilisation and the planting of the seeds, it is important to control the pests and diseases that may lower the yield potential per hectare of the sunflower plant. Section 2.5 is a brief examination of the largest production stability threats of the sunflower plant.

2.5 Weed control, insects and diseases

Proficient weed control is a vital requirement for high sunflower yields. Naturally it is achieved by a good combination of mechanical and chemical practices. Young plants are very sensitive to strong weed competition and cannot develop fast enough to form a full shade covering that can smother weed seedlings (Myers, 2005:13; Schneiter, 1997:35). It is, therefore, necessary to realise that the first six weeks after planting is a very critical period for the sunflower crop. The average yield can be increased significantly through mechanical and chemical weed control during this time (KZN-AGRI, 2006:7; Myers, 2005:13).

2.5.1 Mechanical weed control

Mechanical weed control can be incredibly efficient provided it is done in time and with care. The purpose of mechanical weed control is not to damage the crop, but with mechanical weed control this frequently happens (Schneiter, 1997:35; PANNAR, 2007:10). Reassuringly, chemical weed control can be successfully combined with mechanical methods and cultivation practices, bringing about better weed control. A farmer must cultivate the soil before the sunflower plant is too high for the equipment, otherwise the plants will be damaged. Hence, to prevent any damage to the roots of the sunflower plant the cultivation must be shallow (that is less than 75 millimetres) (KZN-AGRI, 2006:7).

In addition, a farmer must throw loose soil onto the row. This will help to smother the weeds that germinate in the row. As a result, the smaller weeds will die off easily when the dry soil is hoed. However, it is very important to hoe during the hottest part of day when the sunflower is wilted. A wilted sunflower plant reduces the occurrence of stem breakage and contributes to the supply of sunflower seed (PANNAR, 2007:10).

2.5.2 Chemical weed control

The use of herbicides has many advantages and the most important one is that effective weed control can be applied during the wet periods when mechanical weed control is virtually impossible (KZN-AGRI, 2006:7). If the sunflower is cultivated in a crop rotation with maize, the weeds can be controlled more effectively in both the crops as the grass and broadleaf herbicides can be utilised to succeed each other continuously. As a result sunflower should be grown in rotation with other crops like maize and/or sorghum, because the risk of diseases and weeds will increase with mono-cropping (KZN-AGRI, 2006:7; PANNAR, 2007:12).

The yield and quality advantage is often measured in a follow-up maize or sorghum crop (KZN-AGRI, 2006:7; Sauer, 1993:18). However, the farmers should take note that some herbicides do have a long residual period and may damage the follow-up crop in a rotation system. It is, therefore, imperative to strictly follow the instructions on the herbicide labels. Therefore, by using high quality rotation practices (for example not to plant sunflower in a field more than every three to four years) the farmer can notably reduce the likelihood of diseases in the production of sunflower (Myers, 2005:13; PANNAR, 2007:12).

2.5.3 Insects and diseases

Even though there are a number of insects and diseases that may attack a sunflower plant, the results are often not serious enough to have noteworthy negative effects on the yield (Putnam *et al.*, 1990:18; Schneiter, 1997:35). Soil insects such as cutworms, dusty surface beetles, and ground weevils may cause some damage to the emerging seedlings. However, heavy infestations of worms are only on rare occasions present at the seedling stage. As the sunflower plant grows, there are many insects that feed on the sunflower foliage (for example grasshoppers and caterpillars) and they seldom do any significant economic damage to the crop and the harvest (Putnam *et al.*, 1990:18; PANNAR, 2007:11).

The biggest risk stage (that is the stage to be scouting for insect pests) is once the flower bud has begun to develop (that is the pod bearing stage). There are specific insects that attack the stem right below the flower head and it can cause the whole head to fall off. Fortunately, this is not too common in South Africa (Myers, 2005:13; Wikipedia, 2006:14). Although a vast number of diseases have been identified for the sunflower plant in the world, there are only a few serious diseases that have been observed in the global production of sunflower.

In cool wet soils, the seeds or the seedlings may be attacked by fungi and these problems are typically treated with fungicide. Providentially, there are a huge number of different fungicides available that can be applied for different cultivars and different soil types (Myers, 2005:13; PANNAR, 2007:12). There are also various diseases (for example leaf and foliar) that will cause surface spots and/or yellow patches on the leaves and/or the petals of the sunflower. Fortunately, it does not impact the general yield and harvest of the crop (Putnam *et al.*, 1990:18; Schneiter, 1997:35).

2.5.4 Conclusion

Section 2.5 examined the weed control (that is mechanical and chemical), insects, and the diseases that influence the production (that is the yield) of sunflower seed. Previous sections discussed the growth, development, planting, and fertility needs of the sunflower plant. However, more clarity on the various yield limiting factors will be provided in the concluding section of this chapter. The next section (2.6) discusses the storage and the harvesting of sunflower seed.

2.6 Harvest and storage

It is essential to harvest the sunflower at the appropriate time. Sunflower seeds are generally physiologically mature when the back of the sunflower's head turns yellow (Myers, 2005:13; Wikipedia, 2006:14). When the head turns brown it indicates that the seeds are ready to harvest. However, in some cases it might be useful to harvest at a high moisture level to avoid extensive bird damage or to reduce the loss from lodging or seed shattering (Schneiter, 1997:35; Putnam *et al.*, 1990:18). In South Africa the platform (that is the wheat) row-crop, and maize heads on combine harvesters have all been used successfully with sunflower seed harvesting. However, row-crop heads are perhaps the best choice of combine harvesting equipment, because they can be used without a general modification. This often has a higher amount of seed and head loss than a row head (Putnam *et al.*, 1990:18; Myers, 2005:13; Sauer, 1993:18).

Tractors, trucks, and trailers are the primary transport equipment of the farmer on the farm. Due to the low test weight of sunflower seeds, the high sided semi-trailers are often utilised when sunflower seed is hauled over long distances in order to carry more grain, and to reduce the transportation cost (Myers, 2005:13; PANNAR, 2007:15). In South Africa, sunflower seed can be stored safely (that is during the colder periods) at a 10% or less moisture level. However, during the warmer months the storage moisture level should be at 8% or less. Where there is adequate ventilation, the moisture levels of the sunflower seed can be controlled. Should sufficient ventilation not be available, the sunflower seed should be rotated between the silos to avoid hot spots developing in the stored grain (Sauer, 1993:18; Putnam *et al.*, 1990:18; Myers, 2005:13).

When excessive trash is present in the harvested grain, the cleaning of it before storage can to a great extent reduce the incidence of storage problems (that is the formation of hot spots). Ambient air can be used to cool, dry, and clean the sunflower seed. However, if heated air is used caution should be taken because the sunflower dries more rapidly than maize or soybeans. Generally a few degrees Celsius increase in temperature over the ambient air is sufficient to increase the rate of drying. Sunflower seed should be monitored to avoid preventable over-drying (Myers, 2005:13; PANNAR, 2007:15).

Other key steps in the successful storage of sunflower include the cleaning of the silos (that is the monitoring of the silos on a regular basis for insects) and the grain handling equipment before storage (Wikipedia, 2006:14; Putnam *et al.*, 1990:18). Sunflower seeds that are grown for the snack food (that is the confectionery) market must be handled with extra care. As a result, the silos and the sunflower seed must be cleaned regularly, and should be free of any insect damage to meet food grade standards (Myers, 2005:13; PANNAR, 2007:15).

The sunflower plant and the products it produces have become a fundamental part of our modern society. Section 2.7 discusses the different uses of the sunflower plant and its products for the livestock, snack/fast food, and industrial sectors.

2.7 Utilisation of sunflower

2.7.1 Vegetable oil

The usage of sunflower oil for cooking first occurred in the Russian Empire in the 1800s and globally it was not seen as a vegetable oil source until the last fifty years. However, sunflower seed only began to be significantly grown for this purpose in South Africa approximately twenty-five years ago (Marvey, 2003:18; Putnam *et al.*, 1990:18; Wikipedia, 2006:14). Sunflower oil is considerably lower in saturated fat[9], compared to the majority of the vegetable oils available (see Table 2-10).

Table 2-10 Vegetable and animal oil comparison

Dietary Fat	Fatty Acid Content Normalised to 100%		
	Mono-Unsaturated	Polyunsaturated	Saturated
High Oleic Sunflower	82%	9%	9%
Olive Oil	72%	11%	17%
NuSun - Sunflower Oil	65%	26%	9%
Canola Oil	62%	32%	6%
Peanut Oil	49%	33%	18%
Lard	47%	12%	41%
Beef Fat	44%	4%	52%
Palm Oil	39%	10%	51%
Butter Fat	34%	2%	64%
Corn Oil	25%	62%	13%
Soybean Oil	24%	61%	15%
Linoleic Sunflower	20%	69%	11%
Cottonseed Oil	18%	55%	27%
Safflower Oil	13%	77%	10%

Source: NSA, 2006, 13; PANNAR, 2007 23

The development of the NuSun varieties that are mid-level in oleic acid has spurred further interest in the utilisation of sunflower oil in the preparation of food (NSA, 2006:13). NuSun oil has the primary benefit of being more stable than most vegetable oils and as a result there is no need for sunflower oil to be hydrogenated to improve its shelf life (Wikipedia, 2006:14). Considering the fact that sunflower oil is high in Vitamin E with a light clean taste, it is a healthy alternative for a person's cooking oil needs (NSA, 2006:13).

[9] *Saturated fat (for example butter, cream and lard) is associated with high serum cholesterol levels and heart disease in some people. Oils with linoleic acid levels above 2% (sunflower is 0%) tend to develop off flavours, because the linoleic acid oxidises quickly and must be hydrogenated to enhance the product's shelf life (O'Brien et al., 2001:3; Longman, 1993:928).*

Table 2-10 indicates the saturated, mono-unsaturated and the polyunsaturated fat content of the different sunflower oil types compared to other vegetable and animal oils. Globally there are three types of sunflower oil available which will be discussed shortly.

2.7.1.1 Linoleic sunflower oil

This oil is primarily found on the majority of grocery store shelves today and is high in polyunsaturated[10] or linoleic acid (see Table 2-10). Polyunsaturated fat is an essential fatty acid for fundamental human growth and development. It is an excellent home cooking oil and salad oil (that is a salad dressing) with a light clean taste, high smoke point, and a low level of saturated fat (see Table 2-10) (Marvey, 2003:18; NSA, 2006:13).

2.7.1.2 High oleic sunflower oil

It is classified as premium sunflower oil with high mono-unsaturated levels (see Table 2-10). This type of sunflower oil is used extensively in food and industrial applications where high mono-unsaturated levels are required (Marvey, 2003:18; NSA, 2006:13).

2.7.1.3 NuSun

It is mid-oleic sunflower oil that is basically new to the vegetable oil market. It was developed by standard hybrid procedures with a mono-unsaturated level (that is oleic) of 65% (Marvey, 2003:18). The saturated fat level of 9% of NuSun is 20% lower than linoleic sunflower oil and the balance of its composition is linoleic acid (see Table 2-10) (NSA, 2006:13).

2.7.2 Livestock

Sunflower oil constitutes approximately 42 - 45% of a sunflower seed by weight. Once the oil is extracted from the sunflower seed, the remaining seed material (that is the oilcake) is mainly fed to livestock (Marvey, 2003:18; PANNAR, 2007:15). The nutrient value of sunflower oilcake/meal depends primarily on the type of processing it has gone through. Firstly, it depends on whether the oil was mechanically pressed (that is expelled) from the seed or solvent extracted. Secondly, it depends on the degree to which the hulls were removed prior to the processing (Putnam *et al.*, 1990:18).

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[10] *It is when chemicals are combined in a certain order that is good for a person's health when eaten. The majority of vegetable oils are polyunsaturated (Longman, 1993:798).*

If part or all of the hulls remained on the seed prior to the oil extraction, the oilcake/meal will have a higher fibre content but lower protein and fat values (Myers, 2005:13). Solvent extracted sunflower oilcake/meal will have a protein percentage of approximately 41% if the seeds are de-hulled and around 28% if the hulls are left in tack (AFMA, 2007:25). However, the total fat content of solvent extracted oilcake/meal is roughly 1% and more or less 9% in mechanically pressed seed oilcake/meal. Regardless of the method of sunflower oilcake/meal manufacture, the product can serve as the sole source of supplemental protein in the diets of meat and dairy cattle, pigs and poultry (Myers, 2005:13; Marvey, 2003:18; AFMA, 2007:25).

2.7.3 Snack/fast food

Although whole seed (that is confectionery) utilisation of sunflower is only about 10 - 20% of the South African crop each year, it is a premium market in large parts of the world (Marvey, 2003:18; Putnam *et al.*, 1990:18). The prices for confectionery sunflower seed are significantly higher than sunflower seed that is destined for oil processing. The majority of the confectionery sunflower seed is sold for the snack food market (NSA, 2006:13). In the Russian Federation sunflower seeds are such a popular snack food that people carry packets of them around in their pockets. That makes sunflower seed even more popular in the Russian Federation than peanuts are in the USA.

Some confectionery sunflower finds its way into processed foods such as granola bars, multigrain breads or for other baking purposes (Myers, 2005:13). Confectionery sunflower varieties have seeds that are notably larger (approximately 1.5 centimetres long), easier to de-hull, lower in fat, and are typically striped or white. Oilseed types (as previously mentioned) are almost always black, but can be white or striped (Marvey, 2003:18).

Table 2-11 Nutrient comparison of sunflower kernels

Nutrient	Foliate (mcg)	Vitamin E (mg)	Selenium (mcg)	Iron (mg)	Zinc (mg)
Sunflower Kernels	64.46	11.34	16.87	1.92	1.43
Blueberries	1.81	0.28	0.17	0.05	0.03
Sesame Seed	27.41	0.64	1.62	4.12	2.20
Almonds	8.22	7.42	2.24	1.22	0.95
Walnuts	27.78	0.83	1.30	0.83	0.88
Pecans	6.24	1.04	1.70	0.72	1.28
Hazelnuts	32.04	4.31	1.13	1.33	0.70

Source: USDA, 2006:13.
Note: All values rounded to two decimal places.

Table 2-11 displays the nutrient comparison of sunflower kernels[11] to other seeds, nuts, and fruits per 28.35 grams serving (NSA, 2006:13). As evidenced by Table 2-11's contents, sunflower kernels are an excellent source of the essential vitamins, minerals, healthy fats, and antioxidants that are necessary to live a healthy and productive life. The heavy hull of the confectionary seed accounts for approximately half the weight of the seed and is generally loosely fixed to the kernel inside. The seed size is mostly affected by plant genetics, but planting density and weather do play an important role in the determination of the size of sunflower seeds (NSA, 2006:13). As previously mentioned, sunflower seeds are graded according to the size of the seed and are separated into different groups. The largest size will go into the in-shell[12] market, medium-sized seeds are usually hulled for the kernel market and the smallest size will go into the bird and pet feeding market (NSA, 2006:13; PANNAR, 2007:16).

2.7.4 Industrial

The average price of sunflower oil prohibits its widespread use in the industrial sector. However, there are several applications that have been explored, like the utilisation of sunflower oil in certain paints, varnishes, and plastics because of its good semi-drying properties. That is without the colour modification that is normally associated with oils that is high in linoleic acid (Putnam *et al.*, 1990:18). In Eastern Europe (that is the post-Soviet Union countries) and in the Russian Federation, where sunflower oil and other vegetable oils are abundant, sunflower oil is commonly used in the manufacture of soaps, pesticide carriers, agrichemicals, surfactants, adhesives, fabric softeners, and lubricants (Marvey, 2003:18; Myers, 2005:13).

Sunflower oil contains 93% of the energy of diesel fuel with an octane rating of 37. Considerable work has been done to explore the potential of sunflower oil as an alternative fuel source (for example bio-fuel) in diesel engines. The utility of these applications is usually contingent upon petrochemical feedstock prices. Therefore, particular blends of sunflower oil and diesel fuel are expected to have much more potential than the burning of pure vegetable oil (Putnam *et al.*, 1990:18; Wikipedia, 2006:14). Other grains and oilseeds identified as potential

[11] *Kernel means the hull was mechanically removed and exposed the "meat" of the seed (NSA, 2006:13).*

[12] *In-shell means that the seed is left intact with the "meat" of the seed still in the shell. It is normally roasted and seasoned. It is eaten as a snack by cracking the shell and eating the seed (that is the "meat") within (NSA, 2006:13).*

substitutes for sunflower seed to produce bio-diesel and bio-ethanol include soybeans, white and yellow maize (that is for ethanol production) (Marvey, 2003:18; Van Schalkwyk, 2003:6).

2.7.5 Conclusion

Section 2.7 examined the global utilisation of sunflower seed. This section identified the various domestic and industrial applications of the sunflower plant and its products in the vegetable oil, livestock, snack/fast food, and the manufacturing industries. Notable examples of these products include home cooking oil, high protein feed for livestock, confectionary processed foods, and even soap.

2.8 Conclusion

The significance of *Chapter 2* is that it is a comprehensive examination of the history, development, and the knowledge of the sunflower that is important to lay a clearly defined foundation. This foundation is essential to aid the identification process of the influential factors or variables which can be used to build an appropriate series of price models for the South African sunflower industry. This chapter will be utilised as a reference point and some of the potential influential factors identified in the subsequent chapters will refer to *Chapter 2* as a source of additional information.

In this chapter sunflower was identified as a crop that performs well under drought conditions. This is probably the main reason for the popularity of sunflower in the marginal areas of South Africa. Unfortunately, the crop is particularly sensitive to high soil temperatures during emergence. It is especially in the sandy soil of the Western Free State and the North-West Province where this problem often leads to poor or erratic plant density. In large parts of the sunflower seed producing areas in South Africa the soil has acidified considerably during the last decade. As a result large shortages in molybdenum frequently occur, and are possibly one of the greatest yield-limiting factors.

Additionally, the sunflower crop is exceptionally susceptible to bird damage and for this reason it cannot be cultivated at all in some areas in South Africa. However, some of the advantages of the sunflower plant are for example, its drought tolerance and the low average input cost of the crop in comparison to other crops. The short growth season of the crop (it can be planted over a period of at least three months) renders it immensely suitable for producers who make use of flexible crop rotation and/or crop-free systems. Consequently, sunflower production forms an essential component of the South African economy. It is, therefore, important to identify the influential chain in the production and the consumption of sunflower.

Specialisation in the production of sunflower occurs throughout the world. However, some countries do not have the climate and/or the physical capabilities (for example rich fertile soil) to produce agricultural commodities on a global scale. It is, therefore, vital to examine the global production and consumption of sunflower seed, oil, and oilcake/meal. *Chapter 3* uses annual data to indicate the key participants of the global sunflower market within a specific time frame.

3

International Sunflower Market

3.1 Introduction

Chapter 3 examines the sunflower (seed, oil, and oilcake/meal) market at a global industry level. The primary objective of this chapter is to identify and describe the global producers, consumers, importers and exporters of sunflower seed, oil, and oilcake/meal. A number of countries around the globe specialise in the production of sunflower products. When the domestic supply of sunflower products exceeds the domestic demand in such a country, a surplus is created which can be traded on the international sunflower market. It is, therefore, crucial to categorise the participating countries and to indicate their share in the global sunflower industry.

Chapter 3 is divided into four key parts. The first part (section 3.2) discusses the production and the consumption of sunflower seed, oil, and oilcake/meal at a global industry level. It provides the solid international foundation that is necessary for a regional analysis. The analysis of the production and consumption of sunflower products at a global level will reflect the total amount of sunflower seed, oil, and oilcake/meal that is produced and consumed annually. Consequently, it will provide a summary of the worldwide demand and supply of primary and secondary sunflower products.

The second part (sections 3.3 and 3.4) examines the production, consumption, and trade of sunflower products on a regional level and identifies the core production, consumption, and trade regions. These regions are mainly continental, but there are exceptions (for example individual countries) that make substantial contributions to the global production, consumption, and trade of sunflower seed, oil, and oilcake/meal. If exporters and importers agree on a specific price, they induce a market for a specific product. The consumption and trade of sunflower (section 3.4) identifies the main demand and trade factors that influence the global consumption and trade of sunflower products.

The commodity markets and the commodity market fundamentals that the exporters and the importers of sunflower products (with their supply and demand) incur, will be discussed in the third part of this chapter (section 3.5). This will provide the information needed to understand the price formation (that is price basis) on the spot and futures markets, and the factors responsible for these markets' price differences. These factors are, amongst others, the local supply and demand conditions of a country, the product characteristics of a specific agricultural crop, and the transfer costs associated with that identified crop. Section 3.5 places into perspective the buying and selling factors that influence the overall (that is the worldwide) price of sunflower seed, oil, and oilcake/meal. Subsequently, this section identifies the purpose of a spot and futures markets in the calculation of everyday commodity prices.

Through the comprehensive study of the global production, consumption, and trade of sunflower products, *Chapter 3* aims to identify the factors that potentially influence the price of sunflower in South Africa. These factors will be utilised to aid the discussion of the South African sunflower market in *Chapter 4* and the development of the South African sunflower price models in *Chapter 5*.

3.2 Global sunflower industry

3.2.1 Sunflower seed

Sunflower seed is consumed worldwide on a daily basis by either humans (that is for domestic and industrial purposes) or livestock (that is largely by the dairy, beef and poultry producing industries). It is for that specific reason that it is necessary to provide accurate worldwide production and consumption (that is total supply and demand) information on the sunflower industry (USDA 2006:13; SAGIS, 2006:22).

The total area of sunflower seed harvested in the 2004/05 production season was 20,774,000 hectares and that amount increased to approximately 23,473,000 hectares during the 2006/07 production season. Internationally the sunflower crop recovered from its 2004/05 decline with a 12% increase. This was due to definite improvements in the actual planting and cultivation methods (that is the enhanced yield capacity and advanced cultivars) of the sunflower plant, and due to the natural demand increase (that is the additional annual sunflower seed production due to the popularity of the crop) (FAPRI, 2005:251; FAPRI, 2007:258).

Table 3-1 Global sunflower industry

Sunflower Seed							
Production Season	**2000/01**	**2001/02**	**2002/03**	**2003/04**	**2004/05**	**2005/06**	**2006/07**
(Thousand Hectares)							
Area Harvested	19 973	18 805	20 160	22 748	20 774	22 655	23 473
(Thousand Metric Tons)							
Production	23 159	21 383	23 932	26 762	25 297	29 766	30 450
Beginning Stocks	1 818	883	792	1 313	1 896	1 456	1 606
Domestic Supply	24 977	22 266	24 724	28 075	27 193	31 222	32 056
Crush	20 844	18 482	20 079	22 706	22 336	25 603	26 668
Other Use	2 956	2 900	3 199	3 360	3 290	3 492	3 473
Residual	294	92	133	113	111	521	485
Ending Stocks	883	792	1 313	1 896	1 456	1 606	1 430
Domestic Use	24 977	22 266	24 724	28 075	27 193	31 222	32 056
Trade *	2 217	908	1 234	2 200	1 082	1 594	1 813
Sunflower Oilcake/Meal							
(Thousand Metric Tons)							
Production	9 583	8 413	9 052	10 259	9 931	11 276	11 759
Consumption	9 672	8 384	8 987	9 976	9 791	10 877	11 402
Ending Stocks	313	267	221	250	208	232	232
Trade *	2 146	1 850	2 152	2 671	2 555	3 130	3 228
Sunflower Oil							
(Thousand Metric Tons)							
Production	8 405	7 418	8 118	9 128	8 993	10 380	10 750
Consumption	8 328	7 530	7 844	8 358	8 488	9 782	10 182
Ending Stocks	688	462	485	506	571	553	522
Trade *	1 661	1 482	1 674	2 090	2 011	3 113	3 190
(Kilograms)							
Per Capita Consumption	1.35	1.21	1.25	1.31	1.32	1.50	1.54

Source: FAPRI, 2007:258; SAGIS, 2006:22; USDA, 2006:13; NSA, 2006:13.
Note: * Excludes intraregional trade

Table 3-1 signifies that the total area of sunflower seed harvested globally increased gradually from 19,973,000 hectares in 2000/01, to approximately 23,473,000 hectares during the 2006/07 production season. The total amount of sunflower seed produced during the 2004/05 production season was more or less 25,297,000 metric tons. However, because of the crop's yield improvements and the increase in the area harvested the production of sunflower seed grew with approximately 17% to a total of 30,450,000 metric tons in 2006/07. It was an increase of roughly 5,153,000 metric tons (see Table 3-1).

With the annual increase in sunflower seed production minus the annual consumption increase, it is only reasonable to assume that the amount available for trading will increase at the same time. Subsequently, the sunflower seed that was available for trading during the 2004/05 production season was roughly 1,082,000 metric tons. According to the Food and Agricultural Policy

Research Institute (FAPRI) the sunflower seed traded in 2006/07 was 1,813,000 metric tons (FAPRI, 2007:258).

3.2.2 Sunflower oilcake/meal

The worldwide production of sunflower oilcake/meal increased steadily from its 2000/01 production season level of around 9,583,000 metric tons to roughly 11,759,000 metric tons in 2006/07 (see Table 3-1). However, the global consumption of sunflower oilcake/meal developed slightly slower, but in relation to the total sunflower seed utilisation it remained at a reasonably low level (SAGIS, 2006:22). During the 2004/05 production season the consumption of sunflower oilcake/meal was approximately 9,791,000 metric tons, but the annual consumption increased to approximately 10,877,000 in 2005/06. This was due to the increase in the global population and the beef, poultry, and dairy industries' annual augmented feed requirements (refer paragraph 2.7.2, *Chapter 2*) (FAPRI, 2007:258).

According to FAPRI the annual worldwide consumption of sunflower oilcake/meal expanded to 11,402,000 metric tons during 2006/07 (FAPRI, 2007:258). Presumably, with the gradual increase in the production of sunflower oilcake/meal and the observed consumption patterns, the trading of sunflower oilcake/meal will fundamentally stay at a reasonably flat level over the next few years (see Table 3-1). However, FAPRI predicts that the trading of sunflower oilcake/meal will slowly but surely increase to new levels in the near future (FAPRI, 2005:251; FAPRI, 2007:258).

3.2.3 Sunflower oil

The international trade scenario of sunflower oil shows a strong relationship with the trade of sunflower seed and sunflower oilcake/meal. This trade relationship is increasing annually, and according to FAPRI the amount traded in the 2006/07 production season was approximately 3,190,000 metric tons (FAPRI, 2007:258). The annual demand for sunflower products are emphasised by Table 3-1's indication of the average per capita consumption of sunflower (seed, oil, and oilcake/meal). During 2004/05 the per capita consumption was more or less 1.32 kilograms, but the per capita consumption increased to roughly 1.54 kilograms in the 2006/07 production season (refer paragraph 2.7.1, *Chapter 2*).

Table 3-1 indicates that the global sunflower oil production for the 2004/05 production season was approximately 8,993,000 metric tons. However, due to the renewed interest of the international community into the production of bio-fuels and the almost global phenomenon of a healthier lifestyle, the production of sunflower oil increased to 10,750,000 metric tons during 2006/07 (NSA, 2006:13; SAGIS, 2006:22; FAPRI, 2007:258). FAPRI expects the production of sunflower oil to increase progressively as a result of the global energy crisis (FAPRI, 2007:258). The annual consumption (that is domestic and industrial) of sunflower oil increased from 8,328,000 metric tons in 2000/01 to approximately 10,182,000 metric tons during 2006/07. This increase in consumption is to a large extent the result of the production of bio-diesel (refer paragraph 2.7.4, *Chapter 2*).

3.2.3.1 Global bio-fuel industry

The production of bio-fuels (for example ethanol and bio-diesel) is on the increase due to the large number of countries that signed the Kyoto Protocol[13]. As a result, the various countries have committed themselves to make the processes that usually contribute to global warming more efficient and less pollutant (Wikipedia, 2007:20). Countries who are not signatories of the Kyoto Protocol, like the USA, are also experiencing expansive growth rates in their bio-fuels industry. However, these are mainly driven by alternative government policies such as the phasing out of the substance methyl tertiary-butyl ether (MTBE) from the USA's fuel supply (BFAP, 2007:7; Wikipedia, 2007:20). There are currently two different types of bio-fuels that constitute the bulk of renewable transport fuels around the world: these are ethanol and bio-diesel. Other fuels such as bio-gas and hydrogen (which can be produced from various organic sources) or synthetic petrol and diesel such as biomass-to-liquid (BTL), currently play only an insignificant role (FAPRI, 2007:318).

Both ethanol and bio-diesel can be produced from a wide range of feed stocks. However, the ethanol plants that are currently in production mostly utilise sugar cane or starchy crops (Von Lampe, 2005:10). Ethanol is produced by fermenting sugar to alcohol. The alcohol is then distilled to remove the residual water. However, starchy feed stocks first have to undergo an enzymatic process where the starch is broken down into sugars (FAPRI, 2007:318; Von Lampe, 2005:10). In all cases the feedstock value represents an important share in the total production

[13] *The Kyoto Protocol is a protocol to the International Framework Convention on Climate Change with the objective of reducing greenhouse gases that supposedly cause climate change (BFAP, 2007:7; Wikipedia, 2007:20).*

costs for ethanol. Subsequently, the ethanol produced in Brazil from low-cost sugar cane, represents a fuel that could compete on a production cost basis with oil-based fuel without any subsidies (FAPRI, 2007:318; Von Lampe, 2005:10).

Extensive research is underway to produce alcohol from cellulose. This is fundamentally where the cellulose[14] and the hemi-cellulose[15] are broken down into sugars. As the majority of the bio-mass (that is plant material) is cellulose, hemi-cellulose and lignin a much larger assortment of feed stocks could be used in this process (FAPRI, 2007:318; Von Lampe, 2005:10). These alternatives could potentially offer significant cost reductions in the longer run. Additionally, it would substantially reduce the land requirement for the production of any given ethanol quantity (Wikipedia, 2007:20). Bio-diesel is generally produced by the trans-esterification of vegetable oils, that is the so-called "fatty acid methyl esters" (FAME) (Von Lampe, 2005:10). The predominant oils used in bio-diesel production are rapeseed and sunflower oil in the European Union, and soybean oil in North America. Again the cost of the feed stock represents the major component of the total production costs of bio-diesel. Subsequently, cheaper oils such as palm oil or even used frying oil could have a noteworthy cost advantage (Coetzer, 2006:1; Wikipedia, 2007:20). Both ethanol and bio-diesel can be used either as pure fuels or blended with petrol and diesel[16].

Low-rate bio-fuel blends generally do not require any amendments to existing vehicle engines. However, higher shares of ethanol or bio-diesel require some modest modifications in tanks, fuel pipes, valves and various engine components. Flex-fuel engines[17] for motor vehicles that are compatible with any ethanol blend share between 0% and 100% are available on some national markets (Coetzer, 2006:1). It is also possible to blend ethanol with diesel, although the blending

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[14] *A complex carbohydrate* $(C_6H_{10}O_5)_n$ *that is composed of glucose units. It forms the main constituent of the cell wall in most plants (Wikipedia, 2007:20).*

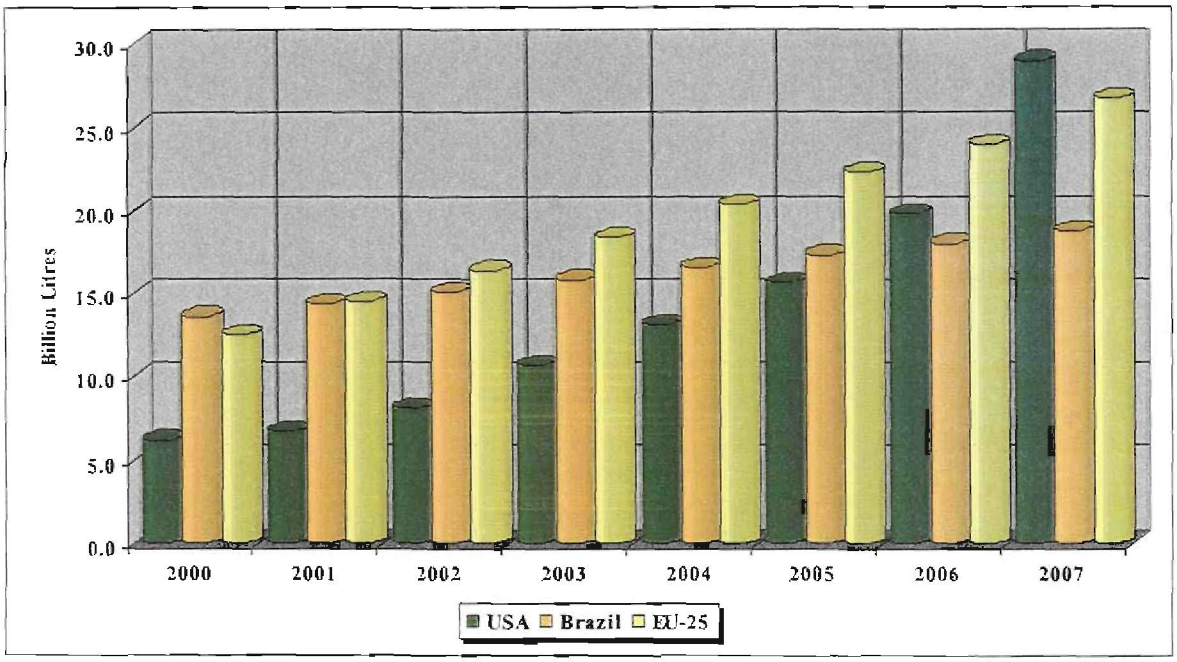
[15] *Any of several polysaccharides (that is molecules composed from more than one sugar molecule) that is more complex than a sugar and less complex than cellulose (Wikipedia, 2007:20).*

[16] *Note that ethanol can also be used together with isobutene (that is a petrol-based co-product of the oil and chemical industry) to produce ethyl tetra-butyl ether (ETBE). This can be used as an additive to petrol in higher blending rates than pure ethanol without modifications (Von Lampe, 2005:10).*

[17] *An important technological step in the spread of ethanol utilisation as a fuel was the introduction of "Flex Fuel Vehicles" (FFV) in recent years. These vehicles can run on various blends of ethanol with fuel ranging from pure petrol to pure ethanol (Wikipedia, 2007:20).*

shares are generally much lower than in petrol. The low cetan-number of ethanol makes it difficult to burn by compression ignition and therefore an emulsifier is needed to avoid the ethanol from separating from the diesel (Von Lampe, 2005:10; Wikipedia, 2007:20).

Figure 3-1 Major producers of bio-fuel (2000 - 2007)



Source: Von Lampe, 2005 10, FAPRI, 2007 320

The global production of ethanol and bio-diesel has been increasing in recent years at an impressive rate. Ethanol (that is excluding beverage alcohol), having been produced for decades for many uses including industrial and pharmaceutical applications, has seen a sudden rise in production due to the increased Brent crude oil prices. This happened before in the mid-1970s before slowing down in the mid-1980s when Brent crude oil prices tumbled again (FAPRI, 2007:318; Von Lampe, 2005:10).

Bio-fuel production was dominated by Brazil, but in recent years the USA and other regions/countries in the world started to produce enormous quantities of bio-fuel (see Figure 3-1). More recently new ethanol production plants are being constructed in a number of countries including several developing ones. Bio-diesel (that is solely used for fuel in the transport sector) started to be produced in the early 1990s. However, while the production quantities of bio-diesel are below those of ethanol, the supplies of bio-diesel increased significantly. The European Union is the largest producer of bio-diesel in the world (FAPRI, 2007:318; Von Lampe, 2005:10).

3.2.4 Conclusion

The production, consumption, and trade of sunflower products have been discussed on a global industry level. Certain key issues that influence the supply and demand of sunflower products have been identified. The main factors that influence the production and consumption of sunflower seed are the yield capacity of the sunflower plant, the area harvested, and the natural demand increase as a result of population growth. The increased per capita spending highlighted the initial discussion. The major factor that influences the production and consumption of sunflower oilcake/meal is the increase in the demand for high protein feed around the world as a result of the influence of an increasing global population. In addition to population growth, the increase in per capita income also increases demand pressures on the international sunflower sector. The chief factors that influence the production and consumption of sunflower oil are the amplified interest in bio-fuels due to the high international energy prices and the general global population's movement to a healthier lifestyle.

The regional analysis (sections 3.3 and 3.4) will split the global production, consumption, and trade of sunflower products into the following major sectors: Commonwealth of Independent States, Argentina, European Union-25, United States of America, China, Bulgaria and Romania (combined), and the Rest-of-the-World. The main objective of the regional analysis is to aid the identification process of the major contributors of sunflower seed, oil, and oilcake/meal to the international sunflower market. The following section separates the international sunflower industry into certain production regions/countries. Section 3.3 will indicate the area harvested in hectares, yield in metric tons per hectare, and the total production in metric tons for a specific region.

3.3 Regional production of sunflower

3.3.1 Commonwealth of Independent States

The Commonwealth of Independent States (CIS)[18] is the main sunflower seed production region in the world. This region holds a 41% share (see Figure 3-2 on page 40) in the total global production of sunflower seed (USDA, 2006:13; NSA, 2006:13; FAPRI, 2007:255).

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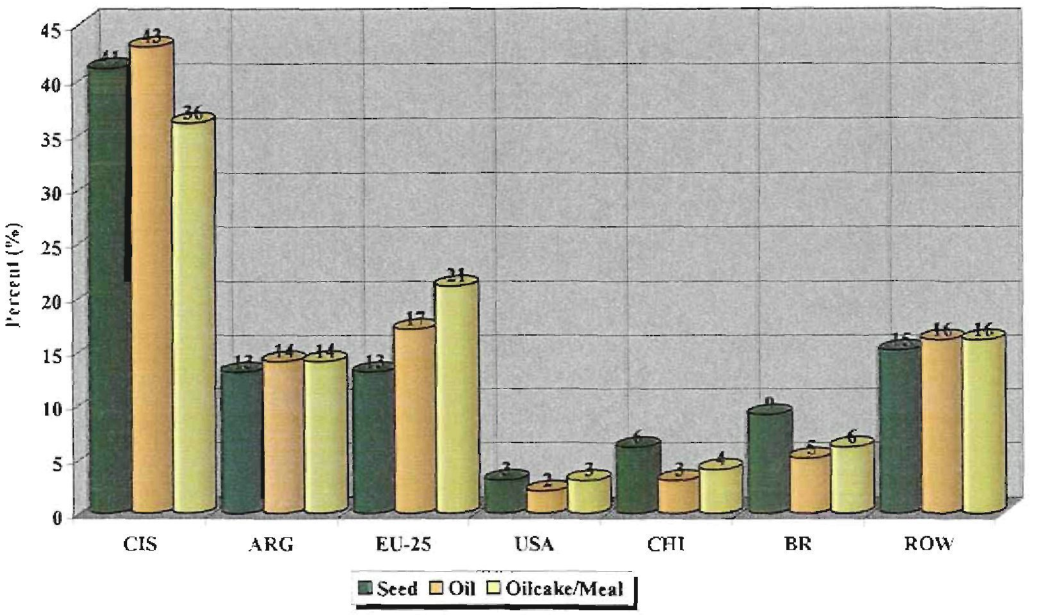
[18] *Commonwealth of Independent States: Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Russian Federation, Tajikistan, Ukraine and Uzbekistan (Wikipedia, 2007:12).*

Figure 3-2 Production of sunflower during 2006/07



Source: FAPRI, 2007:258; SAGIS, 2006:22; NSA, 2006:13.

During the 2000/01 production season the area of sunflower seed harvested was 7,682,000 hectares. The strong average global sunflower seed price encouraged a 25% harvested area expansion in the CIS during the 2006/07 production season to approximately 10,250,000 (see Table 3-2). According to FAPRI, the expected area of sunflower seed that will be harvested during the next few production seasons will increase extensively (FAPRI, 2007:255). The momentous growth (that is since 2000/01) in the production of sunflower seed was mainly due to significant yield improvements of the crop and the progressive increase in the area that was harvested. The average yield was 1.01 metric tons of sunflower seed per hectare in 2000/01 and the yield for 2006/07 was approximately 1.20 metric tons per hectare (see Table 3-2).

The CIS's contribution to domestically crushed sunflower seeds remains considerably high and growing. The full amount of crush for the 2000/01 production season was 5,556,000 metric tons. However, the sunflower seed crush increased to 11,002,000 metric tons during 2006/07. This sizeable growth (approximately 50%) was mainly due to the Russian Federation and the Ukrainian crushing industries that have been modernised in the last few years (FAPRI, 2005:248; NSA, 2006:13). Consequently, the Russian and the Ukrainian crushing industries can handle a much higher percentage of their domestic production of sunflower seed.

The CIS's total production of domestic sunflower crush is additionally supported by the high export taxes in Russia and the Ukraine (FAPRI, 2005:248; USDA, 2006:13; FAPRI, 2007:255).

Table 3-2 Commonwealth of Independent States' sunflower industry

Sunflower Seed							
Production Season	**2000/01**	**2001/02**	**2002/03**	**2003/04**	**2004/05**	**2005/06**	**2006/07**
(Thousand Hectares)							
Area Harvested	7 682	6 273	7 094	9 368	8 700	9 690	10 250
(Metric Tons per Hectare)							
Yield	1.01	0.85	1.06	1.05	0.97	1.21	1.20
(Thousand Metric Tons)							
Production	7 745	5 325	7 542	9 794	8 475	11 715	12 315
Beginning Stocks	139	55	15	55	407	337	259
Domestic Supply	7 884	5 380	7 557	9 849	8 882	12 052	12 574
Crush	5 556	4 865	6 676	7 607	7 902	10 658	11 002
Other Use	390	342	361	553	556	519	670
Ending Stocks	55	15	55	407	337	259	279
Domestic Use	6 001	5 222	7 092	8 567	8 795	11 436	11 951
Net Trade	1 883	158	465	1 282	87	616	623
Sunflower Oilcake/Meal							
(Thousand Metric Tons)							
Production	2 149	1 882	2 607	2 970	3 068	4 161	4 295
Beginning Stocks	2	2	2	24	25	25	30
Domestic Supply	2 151	1 884	2 609	2 994	3 093	4 186	4 325
Consumption	1 463	1 353	1 708	1 440	1 902	2 291	2 422
Ending Stocks	2	2	24	25	25	30	30
Domestic Use	1 465	1 355	1 732	1 465	1 927	2 321	2 452
Net Trade	686	529	877	1 529	1 166	1 865	1 873
Sunflower Oil							
(Thousand Metric Tons)							
Production	2 316	2 008	2 755	3 129	3 257	4 432	4 542
Beginning Stocks	99	95	85	54	83	195	131
Domestic Supply	2 415	2 103	2 840	3 183	3 340	4 627	4 673
Consumption	1 929	1 891	2 036	2 204	2 449	2 621	2 679
Ending Stocks	95	85	54	83	195	131	116
Domestic Use	2 024	1 976	2 090	2 287	2 644	2 752	2 795
Net Trade	391	127	750	896	696	1 875	1 878

Source: FAPRI, 2007:263; SAGIS, 2006:22; USDA, 2006:13; NSA, 2006:13.

In addition to being the world's largest production region of sunflower seed, the CIS is also the chief production region of sunflower oil and sunflower oilcake/meal. This region contributes approximately 36% to the global sunflower oilcake/meal production and 43% to the global sunflower oil production (see Figure 3-2 on page 40). The CIS produced 2,149,000 metric tons of sunflower oilcake/meal during the 2000/01 production season. However, due to the modernisation of the Russian and the Ukrainian processing sectors and the increase in the demand for feed by the beef, poultry and dairy industries, the production of sunflower oilcake/meal increased to 4,295,000 metric tons in 2006/07 (FAPRI, 2007:255).

3.3.2 Argentina

Argentina (ARG) is the second largest producer of sunflower seed in the world (13% of global production, see Figure 3-2 on page 40). Argentina produced 3,050,000 metric tons of sunflower seed during the 2000/01 production season. According to FAPRI, the production increased to approximately 4,000,000 metric tons in 2006/07 (see Table 3-3). Since the 2004/05 production season the Argentinean sunflower seed area harvested expanded by approximately 18%. This happened in response to the higher sunflower seed prices and the expectation of a severe drop in the international soybean prices (NSA, 2006:13; SAGIS, 2006:22; FAPRI, 2005:248).

Table 3-3 Argentina's sunflower industry

Sunflower Seed							
Production Season	**2000/01**	**2001/02**	**2002/03**	**2003/04**	**2004/05**	**2005/06**	**2006/07**
(Thousand Hectares)							
Area Harvested	1 886	2 015	2 350	1 830	1 890	2 200	2 300
(Metric Tons per Hectare)							
Yield	1.62	1.91	1.57	1.77	1.90	1.73	1.74
(Thousand Metric Tons)							
Production	3 050	3 844	3 700	3 240	3 600	3 800	4 000
Beginning Stocks	580	61	104	487	654	363	373
Domestic Supply	3 630	3 905	3 804	3 727	4 254	4 163	4 373
Crush	3 450	3 400	3 029	2 994	3 756	3 700	3 860
Other Use	42	47	80	53	47	57	65
Ending Stocks	61	104	487	654	363	373	378
Domestic Use	3 553	3 551	3 596	3 701	4 166	4 130	4 303
Net Trade	77	354	208	26	88	33	70
Sunflower Oilcake/Meal							
(Thousand Metric Tons)							
Production	1 435	1 427	1 258	1 252	1 568	1 545	1 600
Beginning Stocks	128	94	89	90	90	80	90
Domestic Supply	1 563	1 521	1 347	1 342	1 658	1 625	1 690
Consumption	189	272	127	307	472	479	475
Ending Stocks	94	89	90	90	80	90	90
Domestic Use	283	361	217	397	552	569	565
Net Trade	1 280	1 160	1 130	945	1 106	1 056	1 125
Sunflower Oil							
(Thousand Metric Tons)							
Production	1 440	1 415	1 294	1 209	1 510	1 490	1 555
Beginning Stocks	71	55	50	86	40	45	40
Domestic Supply	1 511	1 470	1 344	1 295	1 550	1 535	1 595
Consumption	452	263	360	248	329	370	385
Ending Stocks	55	50	86	40	45	40	35
Domestic Use	507	313	446	288	374	410	420
Net Trade	1 004	1 157	898	1 007	1 176	1 125	1 175

Source: FAPRI, 2007:260; SAGIS, 2006:22; USDA, 2006:13; NSA, 2006:13.

In 2000/01 the area of sunflower seed harvested was 1,886,000 hectares and the total area harvested expanded to approximately 2,300,000 hectares in 2006/07. The main reasons for this expansion were the higher prices during the 2004/05 and 2005/06 production seasons and the prediction of a convincingly flat price path over the next few years (FAPRI, 2005:248; FAPRI, 2007:10; USDA, 2006:13). With the average crop area expansions and the annual crop yield improvements (that is 1.62 metric tons per hectare in 2000/01 to 1.74 metric tons per hectare in 2006/07), FAPRI expects a substantial increase in the production of sunflower seed over the next few years (FAPRI, 2007:10).

Argentina is the third largest producer of both sunflower oilcake/meal (14% of global production, see Figure 3-2 on page 40) and sunflower oil (14% of global production, see Figure 3-2 on page 40) in the world. The constant per capita income growth in developing countries increases the actual demand for livestock products and vegetable oils. This subsequently, increases the demand for sunflower oil and sunflower oilcake/meal (SAGIS, 2006:22; FAPRI, 2007:10). During the 2000/01 production season Argentina produced 1,440,000 metric tons of sunflower oil. The production of sunflower oil increased to 1,555,000 metric tons in the 2006/07 production season because of the increase in domestic and industrial (that is bio-fuel) demand (see Table 3-3).

3.3.3 European Union-25

The third largest production region of sunflower seed (13% of global production, see Figure 3-2 on page 40) in the international sunflower industry is the European Union-25 (EU-25). The EU-25 is a combination of the European Union-15[19] and the New Member States[20]. During the 2000/01 production season the EU-25's area harvested was 2,285,000 hectares, but the total amount of area harvested during 2006/07 production season declined gradually to 2,224,000 hectares. The major reason for this annual decline in the area harvested was the result of crop substitution (that is the planting of other agricultural crops in the limited crop space available). According to FAPRI the total area of sunflower seed harvested for the EU-25 will decline (that is at the present rate) over the next few years (see Table 3-4) (FAPRI, 2005:11; NSA, 2006:13; USDA, 2006:13; FAPRI, 2007:10).

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[19] *European Union-15: Belgium, France, Germany, Italy, Luxemburg, Netherlands, Denmark, Ireland, United Kingdom, Greece, Portugal, Spain, Austria, Finland and Sweden (Europa, 2007:2; Wikipedia, 2007:12).*

[20] *New Member States: Cyprus, Czech Republic, Estonia, Latvia, Hungary, Lithuania, Malta, Poland, Slovakia and Slovenia (Europa, 2007:2; Wikipedia, 2007:12).*

Even though the annual yield of the European Union-25 increased from 1.74 metric tons per hectare in the 2000/01 production period to 1.82 metric tons per hectare during the 2006/07 production season, the decline in the area harvested was too great to influence the production of sunflower seed positively. The production of sunflower seed during the 2004/05 production season was 4,188,000 metric tons and in 2006/07 the EU-25 produced 4,055,000 metric tons. As a result, FAPRI expects the declining trend to continue over the next few years (see Table 3-4). This is mainly because of the planting of rapeseed for the production of bio-fuels in the EU-25 (FAPRI, 2007:10). The European Union-25 is the third largest producer of sunflower seed, but the second largest producer of sunflower oilcake/meal (21% of global production, see Figure 3-2 on page 40) and the second largest producer of sunflower oil (17% of global production, see Figure 3-2 on page 40) in the world.

Table 3-4 European Union-25's sunflower industry

Sunflower Seed							
Production Season	**2000/01**	**2001/02**	**2002/03**	**2003/04**	**2004/05**	**2005/06**	**2006/07**
(Thousand Hectares)							
Area Harvested	2 285	2 361	2 134	2 442	2 214	2 024	2 224
(Metric Tons per Hectare)							
Yield	1.74	1.62	1.74	1.65	1.89	1.84	1.82
(Thousand Metric Tons)							
Production	3 980	3 836	3 713	4 035	4 188	3 724	4 055
Beginning Stocks	622	457	431	437	447	450	387
Domestic Supply	4 602	4 293	4 144	4 472	4 635	4 174	4 442
Crush	5 207	4 103	4 078	4 815	4 163	4 030	4 400
Other Use	564	575	602	629	605	555	599
Ending Stocks	457	431	437	447	450	387	393
Domestic Use	6 228	5 109	5 117	5 891	5 218	4 972	5 392
Net Trade	-1 626	-816	-973	-1 419	-583	-798	-950
Sunflower Oilcake/Meal							
(Thousand Metric Tons)							
Production	2 920	2 300	2 285	2 700	2 332	2 260	2 465
Beginning Stocks	229	193	160	90	109	86	97
Domestic Supply	3 149	2 493	2 445	2 790	2 441	2 346	2 562
Consumption	4 778	3 935	4 100	4 570	4 124	4 206	4 433
Ending Stocks	193	160	90	109	86	97	97
Domestic Use	4 971	4 095	4 190	4 679	4 210	4 303	4 530
Net Trade	-1 822	-1 602	-1 745	-1 889	-1 769	-1 957	-1 968
Sunflower Oil							
(Thousand Metric Tons)							
Production	2 070	1 625	1 620	1 915	1 655	1 602	1 750
Beginning Stocks	285	312	266	270	269	234	228
Domestic Supply	2 355	1 937	1 886	2 185	1 924	1 836	1 978
Food Use	2 070	2 194	2 111	2 212	2 363	2 662	2 803
Industrial Use	96	80	83	82	94	94	95
Ending Stocks	312	266	270	269	234	228	230
Domestic Use	2 478	2 540	2 464	2 563	2 691	2 984	3 128
Net Trade	-123	-603	-578	-378	-767	-1 148	-1 150

Source: FAPRI, 2007:258; SAGIS, 2006:22; USDA, 2006:13; NSA, 2006:13.

In 2000/01 the European Union-25 produced 2,920,000 metric tons of sunflower oilcake/meal. This production decreased to 2,465,000 metric tons during the 2006/07 production period due to crop substitution (that is the planting of vast hectares of rapeseed for bio-fuel production in the EU-25). However, the annual production of sunflower oilcake/meal is expected to increase due to the expansion of the EU-25's livestock sector (that is the increased protein feed requirements for the beef, poultry, and dairy industries) (FAPRI, 2007:10).

3.3.4 Bulgaria and Romania

Bulgaria and Romania (BR) is the fourth largest sunflower seed producer in the world. They experienced a significant area of sunflower seed harvested expansion in the 2006/07 production season, because of the rising international price of sunflower seed (FAPRI, 2007:255).

Table 3-5 Bulgaria and Romania's sunflower industry

Sunflower Seed							
Production Season	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07
(Thousand Hectares)							
Area Harvested	1 272	1 188	1 310	1 710	1 440	1 542	1 760
(Metric Tons per Hectare)							
Yield	0.89	0.96	1.12	1.24	1.58	1.42	1.48
(Thousand Metric Tons)							
Production	1 137	1 136	1 470	2 120	2 275	2 185	2 600
Beginning Stocks	83	69	56	75	109	120	143
Domestic Supply	1 220	1 205	1 526	2 195	2 384	2 305	2 743
Crush	984	865	913	1 146	1 320	1 257	1 355
Other Use	57	59	69	162	215	165	263
Ending Stocks	69	56	75	109	120	143	160
Domestic Use	1 110	980	1 057	1 417	1 655	1 565	1 778
Net Trade	91	198	436	740	699	695	930
Sunflower Oilcake/Meal							
(Thousand Metric Tons)							
Production	491	433	459	576	666	632	682
Beginning Stocks	21	18	10	11	20	11	8
Domestic Supply	512	451	469	587	686	643	690
Consumption	338	280	313	370	395	427	456
Ending Stocks	18	10	11	20	11	8	9
Domestic Use	356	290	324	390	406	435	465
Net Trade	156	161	145	197	280	208	225
Sunflower Oil							
(Thousand Metric Tons)							
Production	372	342	365	459	526	519	541
Beginning Stocks	35	14	18	22	37	31	55
Domestic Supply	407	356	383	481	563	550	596
Consumption	371	329	359	353	416	451	459
Ending Stocks	14	18	22	37	31	55	55
Domestic Use	385	347	381	390	447	506	514
Net Trade	22	9	2	91	116	44	82

Source: FAPRI, 2007:261; SAGIS, 2006:22; USDA, 2006:13; NSA, 2006:13.

During the 2000/01 production season Bulgaria and Romania (combined) harvested 1,272,000 metric tons of sunflower seed. The average yield for the same production season was 0.89 metric tons per hectare. However, due to substantial enhancements in the production and cultivation methods, the area harvested for the 2006/07 production season was 1,760,000 metric tons. The yield of Bulgaria and Romania increased to 1.48 metric tons per hectare (FAPRI, 2007:10; FAPRI, 2007:255). Subsequently, Bulgaria and Romania produced 2,600,000 metric tons of sunflower seed during the 2006/07 production season. According to FAPRI this region's production is expected to increase significantly over the next few years (see Table 3-5).

Bulgaria and Romania produced 491,000 metric tons of sunflower oilcake/meal during the 2000/01 production season. However, due to an increase in the international sunflower oilcake/meal price and the global expansion in the livestock industry (that is the beef, poultry and dairy industries), Bulgaria and Romania produced 682,000 metric tons during the 2006/07 production season. That was an increase of approximately 28%. Subsequently, Bulgaria and Romania was the fourth largest producer of sunflower oilcake/meal in the world (6% of global production, see Figure 3-2 on page 40) (FAPRI, 2007:255; USDA, 2006:13; NSA, 2006:13).

During 2000/01 Bulgaria and Romania produced 372,000 metric tons of sunflower oil. However, because of the increasing demand for vegetable oil for food and industrial utilisation, substantial increases in the international sunflower seed prices and the high price of substitute vegetable oils, 541,000 metric tons of sunflower oil was produced in the 2006/07 production season (FAPRI, 2007:266; USDA, 2006:13; NSA, 2006:13). As a result, with an increase of approximately 31%, Bulgaria and Romania is the fourth largest producer of sunflower oil in the world (see Figure 3-2 on page 40).

3.3.5 China

With a total area of 1,100,000 hectares of sunflower seed harvested and an average yield of 1.73 metric tons per hectare during the 2006/07 production season, China (CHI) is the fifth largest producer of sunflower seed in the world (6% of global production, see Figure 3-2 on page 40). In the 2004/05 production season China produced 1,552,000 metric tons of sunflower seed (see Table 3-6). However, because of China's strong income growth, the production of sunflower seed increased to 1,900,000 metric tons during the 2006/07 production season (NSA, 2006:13; FAPRI, 2007:262). High income enlarges the demand for vegetable oil and livestock products and in turn increases the demand for sunflower oil and sunflower oilcake/meal. This was an increase of approximately 18% within a 2 year time frame, which was also the result of a continual annual gross domestic product growth rate of 9 - 10% throughout China (SAGIS, 2006:22; Wikipedia, 2008:18).

Table 3-6 China's sunflower industry

Sunflower Seed							
Production Season	**2000/01**	**2001/02**	**2002/03**	**2003/04**	**2004/05**	**2005/06**	**2006/07**
(Thousand Hectares)							
Area Harvested	1 229	1 016	1 131	1 173	935	1 020	1 100
(Metric Tons per Hectare)							
Yield	1.59	1.45	1.72	1.49	1.66	1.89	1.73
(Thousand Metric Tons)							
Production	1 954	1 478	1 946	1 743	1 552	1 927	1 900
Beginning Stocks	0	0	0	0	0	0	0
Domestic Supply	1 954	1 478	1 946	1 743	1 552	1 927	1 900
Crush	950	650	861	790	694	972	953
Food Use	860	717	910	787	647	749	739
Other Use	113	85	118	94	98	95	95
Ending Stocks	0	0	0	0	0	0	0
Domestic Use	1 923	1 452	1 889	1 671	1 439	1 816	1 787
Net Trade	31	26	57	72	113	111	113
Sunflower Oilcake/Meal							
(Thousand Metric Tons)							
Production	517	355	469	430	375	526	516
Beginning Stocks	0	0	0	0	0	0	0
Domestic Supply	517	355	469	430	375	526	516
Feed Use	437	280	402	364	305	455	446
Industrial Use	80	75	80	80	80	80	80
Ending Stocks	0	0	0	0	0	0	0
Domestic Use	517	355	482	444	385	535	526
Net Trade	0	0	-13	-14	-10	-9	-10
Sunflower Oil							
(Thousand Metric Tons)							
Production	335	230	305	280	247	346	339
Beginning Stocks	0	0	0	0	0	0	0
Domestic Supply	335	230	305	280	247	346	339
Consumption	335	230	313	329	248	351	344
Ending Stocks	0	0	0	0	0	0	0
Domestic Use	335	230	313	329	248	351	344
Net Trade	0	0	-8	-49	-1	-5	-5

Source: FAPRI, 2007:262; SAGIS, 2006:22; USDA, 2006:13; NSA, 2006:13.

Because of China's authoritarian grain policies and their increased demand for high protein feed for their livestock industries, this country is the fifth largest manufacturer of sunflower oilcake/meal (4% of global production, see Figure 3-2 on page 40) in the world (FAPRI, 2005:254; USDA, 2006:13; NSA, 2006:13; FAPRI, 2007:262). FAPRI expects the production of sunflower oilcake/meal in China to stay at its current level for the next few years, with a small probability of a slight decline in the production of sunflower oilcake/meal (FAPRI, 2007:262).

China's strong per capita vegetable oil demand is the main reason why this country is the fifth largest producer of sunflower oil (3% of global production, see Figure 3-2 on page 40) globally. During the 2005/06 production season China produced 346,000 metric tons of sunflower oil (see Table 3-6) (FAPRI, 2005:11; FAPRI, 2007:10).

3.3.6 *United States of America*

The United States of America (USA) is the sixth largest producer of sunflower seed (4% of global production, see Figure 3-2 on page 40) in the world. Since the beginning of the 1999/00 production season, the production of sunflower seed in the USA dropped substantially. The main causes for this significant decline in the production of sunflower seed were the unrelenting low prices in the late 1990s, continual drought conditions, and the periodic disease pressures experienced during the previous production seasons of the USA (NSA, 2006:13; SAGIS, 2006:22; FAPRI, 2005:91). During the 2004/05 production period the continued drought conditions in the Northern plains of the USA and the reduced sunflower area planted led to an overall decline in the production of sunflower seed (NSA, 2006:13; SAGIS, 2006:22; FAPRI, 2005:91). This consequently paved the way for an astounding sunflower seed price increase during the forthcoming production seasons.

With a return to relatively normal weather conditions and with the soaring sunflower prices offered, the area of sunflower seed harvested increased by 19% throughout the 2005/06 production period. Consequently, the production increased from 692,000 hectares of sunflower seed harvested in 2004/05 to a notable 1,056,000 hectares harvested in the 2005/06 production season (see Table 3-7). The increased sunflower seed production (that is 1,823,000 metric tons) for the duration of the 2005/06 production period and the lower international sunflower seed prices resulted in a reserved decline in the market returns for the remainder of the 2005/06 production season. As a result, the amount of sunflower seed harvested declined to 716,000 hectares during the 2006/07 production season (that is 972,000 metric tons) (FAPRI, 2005:91; USDA, 2006:13; FAPRI, 2007:10).

FAPRI predicts stable returns over the next few production seasons which will result in the decline of the area of sunflower seed harvested. This is because the majority of the proceeds from competing crops (that is soybeans) outpace the proceeds on sunflower seed (FAPRI, 2007:10).

Table 3-7 United States of America's sunflower industry

Sunflower Seed							
Production Season	**2000/01**	**2001/02**	**2002/03**	**2003/04**	**2004/05**	**2005/06**	**2006/07**
(Thousand Hectares)							
Area Harvested	1 071	1 034	877	889	692	1 056	716
(Metric Tons per Hectare)							
Yield	1.50	1.50	1.27	1.36	1.34	1.73	1.36
(Thousand Metric Tons)							
Production	1 608	1 551	1 112	1 209	930	1 823	972
Beginning Stocks	231	156	109	199	163	90	356
Domestic Supply	1 839	1 707	1 220	1 408	1 093	1 913	1 328
Crush	923	760	319	627	276	566	601
Food	624	680	634	538	631	852	519
Ending Stocks	156	109	199	163	90	356	131
Domestic Use	1 704	1 549	1 152	1 328	997	1 774	1 251
Net Trade	135	158	68	80	95	139	77
Sunflower Oilcake/Meal							
(Thousand Metric Tons)							
Production	458	358	172	308	136	279	299
Beginning Stocks	5	5	5	5	5	5	6
Domestic Supply	463	363	177	313	141	284	305
Consumption	450	358	232	316	133	277	295
Ending Stocks	5	5	5	5	5	6	5
Domestic Use	455	363	237	321	138	283	300
Net Trade	8	0	-60	-8	3	1	5
Sunflower Oil							
(Thousand Metric Tons)							
Production	396	305	156	270	120	247	261
Beginning Stocks	71	62	10	12	18	10	25
Domestic Supply	467	367	167	282	138	257	286
Consumption	162	168	131	168	106	163	204
Ending Stocks	62	10	12	18	10	25	27
Domestic Use	224	178	143	186	116	188	231
Net Trade	244	189	24	96	23	69	55

Source: FAPRI, 2007:259; SAGIS, 2006:22; USDA, 2006:13; NSA, 2006:13.

The USA is the sixth largest producer of both sunflower oilcake/meal (3% of global production, see Figure 3-2 on page 40) and sunflower oil (2% of global production, see Figure 3-2 on page 40). The consumption of sunflower oilcake/meal in this country increases by approximately 2% annually. The reasons for this annual increase are because of a constant growth in the USA's population and the higher per capita income (that is more people buy livestock products) (USDA, 2006:13; FAPRI, 2007:10).

FAPRI expects the production of sunflower oil and sunflower oilcake/meal in the USA to generally remain constant over the next few years (see Table 3-7). This is mainly because of the planting of soybeans and maize (that is the substitution practice) for the production of bio-fuels (FAPRI, 2007:10).

3.3.7 Rest-of-the-World

Table 3-8 signifies the total sunflower seed, oil, and oilcake/meal production for the Rest-of-the-World (ROW)[21]. This sector of the global sunflower industry produces approximately 15% of the sunflower seed utilised (see Figure 3-2 on page 40). The total area harvested in the 2000/01 production season was 4,548,000 hectares. As a result of crop substitution practices and the unpredictable weather conditions, the area harvested for the 2006/07 production season gradually increased to 5,123,000 hectares (FAPRI, 2007:265).

Table 3-8 Rest-of-the-World sunflower industry

Sunflower Seed							
Production Season	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07
(Thousand Hectares)							
Area Harvested	4 548	4 918	5 264	5 336	4 903	5 123	5 123
(Metric Tons per Hectare)							
Yield	0.81	0.86	0.85	0.87	0.87	0.90	0.90
(Thousand Metric Tons)							
Production	3 685	4 213	4 449	4 621	4 277	4 592	4 608
Beginning Stocks	163	85	77	60	116	96	88
Domestic Supply	3 848	4 298	4 527	4 681	4 393	4 688	4 696
Crush	3 774	3 839	4 203	4 727	4 225	4 420	4 497
Other Use	287	368	392	506	461	455	488
Ending Stocks	85	77	60	116	96	88	89
Domestic Use	4 145	4 284	4 655	5 349	4 782	4 963	5 074
Net Trade	-297	14	-128	-668	-388	-275	-378
Sunflower Oilcake/Meal							
(Thousand Metric Tons)							
Production	1 613	1 658	1 802	2 023	1 786	1 873	1 902
Beginning Stocks	1	1	1	1	1	1	1
Domestic Supply	1 614	1 659	1 803	2 024	1 787	1 874	1 903
Consumption	1 937	1 831	2 025	2 529	2 380	2 662	2 795
Ending Stocks	1	1	1	1	1	1	1
Domestic Use	1 938	1 832	2 026	2 530	2 381	2 663	2 796
Net Trade	-324	-173	-223	-506	-594	-789	-893
Sunflower Oil							
(Thousand Metric Tons)							
Production	1 476	1 493	1 623	1 866	1 678	1 744	1 762
Beginning Stocks	264	150	33	41	59	56	74
Domestic Supply	1 740	1 643	1 655	1 907	1 737	1 800	1 836
Consumption	2 913	2 375	2 451	2 762	2 483	3 070	3 213
Ending Stocks	150	33	41	59	56	74	59
Domestic Use	3 063	2 408	2 492	2 821	2 539	3 144	3 272
Net Trade	-1 324	-765	-837	-914	-803	-1 344	-1 436

Source: FAPRI, 2005:259; SAGIS, 2006:22; USDA, 2006:13; NSA, 2006:13.

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[21] *India, the Republic of South Africa, Turkey and the Republic of Serbia are the primary contributors to this region's sunflower industry data (see Figure 3-4 on page 57).*

Even though the area of sunflower seed harvested slowly increased by approximately 575,000 hectares, the total production of sunflower seed increased from 3,685,000 metric tons (in 2000/01) to 4,608,000 metric tons during the 2006/07 production season. That was due to the general increase in the global cultivation practices and the yield potential (that is 0.81 ton per hectare in 2000/01 to 0.90 tons per hectare in 2006/07) of the sunflower crop (see Table 3-8). FAPRI predicts that the production of sunflower seed for the ROW will gradually increase over the next few years. This is primarily because of the planting of oilseeds for the production of bio-fuels (FAPRI, 2007:10; FAPRI, 2007:265). The ROW sector of the global sunflower industry produces 16% of the sunflower oilcake/meal and 16% of the sunflower oil offered to the international sunflower oil and oilcake/meal market (see Figure 3-2 on page 40). During the 2006/07 production period the ROW sector produced 1,902,000 metric tons of sunflower oilcake/meal and 1,762,000 metric tons of sunflower oil (see Table 3-8).

3.3.8 Conclusion

Section 3.3 has examined and analysed the global production of sunflower products within seven main production regions. Definite production factors were identified within each of the regions/countries and will be incorporated into *Chapter 5* as potential influential factors to the South African sunflower price. The regions/countries consist of the CIS, Argentina, the EU-25, Bulgaria and Romania, China, USA, and the ROW.

Based on the analyses performed in this section, it was determined that the supply of sunflower products for all seven regions/countries is influenced by the total area of sunflower seed harvested. The yield of the sunflower plant is also a factor that influences the supply of sunflower products for the CIS, Bulgaria and Romania, China, and the ROW. Another common influential factor for the supply of sunflower products is the demand for protein feed by the human and livestock sector. This impacts the CIS, Argentina, EU-25, China, and the USA. In regions/countries where competing crops are produced such as soybeans, rapeseed and maize, the supply of sunflower products is also affected. This competition arises from the use of sunflower oil for the manufacture of bio-fuel and is prevalent in the EU-25 and the USA. The extent of the industrial utilisation of vegetable oil creates demand for sunflower oil which in turn influences the supply of sunflower oil. This factor is evident for the CIS, the EU-25, and China. The USA and the ROW are the only two regions/countries where weather conditions featured as a factor that influences the supply of sunflower products.

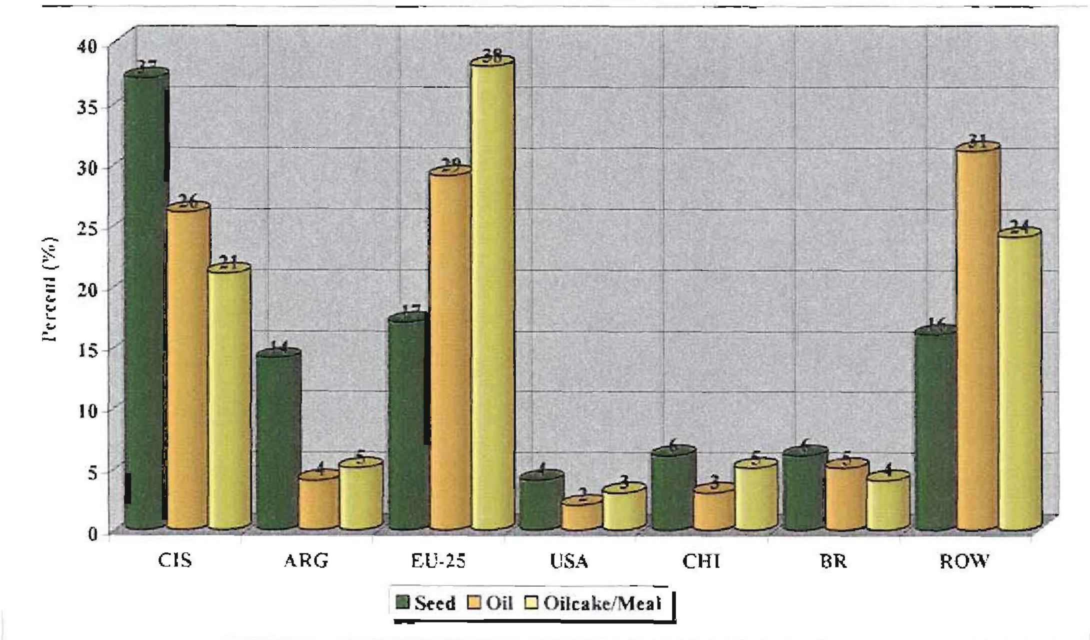
The next section (3.4) identifies the main participants in the consumption and trade segments of the global sunflower industry.

3.4 Regional consumption and trade of sunflower

3.4.1 Commonwealth of Independent States

The leading consumer-region of sunflower seed in the world is the CIS (37% of global consumption, see Figure 3-3). During the 2006/07 production season the CIS consumed 11,951,000 metric tons of sunflower seed (see Table 3-2). This was primarily supported by an increase in the domestic crush due to the improved crushing facilities of Russia and the Ukraine and due to continuous high export taxes (FAPRI, 2007:255). Even though the CIS is the major sunflower seed consumer region in the world, their annual rankings as sunflower oilcake/meal and sunflower oil consumers are lower.

Figure 3-3 Consumption of sunflower during 2006/07



Source: FAPRI, 2007:258; SAGIS, 2006:22; NSA, 2006 13.

The CIS is the third largest consumer region of sunflower oilcake/meal (21% of global consumption, see Figure 3-3) and the third largest consumer region of sunflower oil (26% of global consumption, see Figure 3-3) in the world. During the 2004/05 production season the global sunflower trade fell sharply compared with the previous production season (see Table 3-2). This was because of the decrease of shipments from the CIS. However, after a recovery in the 2005/06 production season the total international trade grew gradually back to its current levels (NSA, 2006:13; SAGIS, 2006:22; FAPRI, 2005:248; FAPRI, 2007:255).

3.4.1.1 CIS sunflower trading

At the CIS' current levels of production they still remain the principal exporter (see *Appendix A*) of sunflower oilcake/meal (1,873,000 metric tons, see Table 3-10) and sunflower oil (1,878,000 metric tons, see Table 3-11) in the world. As a result, it is important to consider the international sunflower oilcake/meal and sunflower oil prices as potentially influential to the South African sunflower price (FAPRI, 2007:255).

3.4.2 Argentina

Argentina is the fourth largest consumer (that is 4,303,000 metric tons of sunflower seed during the 2006/07 production season, see Table 3-3) of sunflower seed in the world (14% of global consumption, see Figure 3-3 on page 52). Argentina's real GDP grew by 8.4% in the 2006/07 production season and FAPRI expects it to grow at an annual rate of 5.5% for the next few years. As a result of the strong economic growth in Argentina, the consumption of sunflower crush will increase with the higher population growth, which will lead to higher demand (FAPRI, 2007:3).

However, because of the annual per capita income growth and a constant advancement of income into the sunflower industry, Argentina is the fourth largest consumer of both sunflower oilcake/meal (5% of global consumption, see Figure 3-3 on page 52) and sunflower oil (4% of global consumption, see Figure 3-3 on page 52) in the world (NSA, 2006:13; FAPRI, 2007:3). In the 2006/07 production season Argentina consumed 565,000 metric tons of sunflower oilcake/meal and 420,000 metric tons of sunflower oil (see Table 3-3).

3.4.2.1 Argentinean sunflower trading

Approximately 94% of Argentina's production of sunflower seed is used domestically by the export-orientated crushing industry. The differential export tax in Argentina encourages the producers to export more derived products than sunflower seed (FAPRI, 2007:255). This is primarily because of the production of protein feed and bio-fuels (FAPRI, 2007:10). Consequently, Argentina is the second largest exporter of sunflower oilcake/meal (see Table 3-10) and sunflower oil (see Table 3-11) in the world (see *Appendix A*).

Table 3-9 Trade of sunflower seed

Sunflower Seed							
Production Season	**2000/01**	**2001/02**	**2002/03**	**2003/04**	**2004/05**	**2005/06**	**2006/07**
(Thousand Metric Tons)							
Net Exporters							
Argentina	77	354	208	26	88	33	70
Bulgaria and Romania	91	198	436	740	699	695	930
China	31	26	57	72	113	111	113
CIS	1 883	158	465	1 282	87	616	623
USA	135	158	68	80	95	139	77
Total Net Exports *	2 217	908	1 234	2 200	1 082	1 594	1 813
Net Importers							
EU-25	1 626	816	973	1 419	583	798	950
Rest-of-the-World	297	-14	128	668	388	275	378
Residual	294	92	133	113	111	521	485
Total Net Imports	2 217	908	1 234	2 200	1 082	1 594	1 813

Source: FAPRI, 2007:256; SAGIS, 2006:22; USDA, 2006:13; NSA, 2006:13.
* Total net exports are the sum of all positive net exports and negative net imports.

3.4.3 European Union-25

The second largest consumer region of sunflower seed in the world is the EU-25 (17% of global consumption, see Figure 3-3 on page 52). The EU-25 consumed approximately 5,392,000 metric tons of sunflower seed during the 2006/07 production season (see Table 3-4). The European Union-25 is the second largest consumption region of sunflower oil (29% of global consumption, see Figure 3-3 on page 52) and the second largest importer of sunflower oil in the world (see Table 3-11). They consumed approximately 3,128,000 metric tons of sunflower oil in the 2006/07 production season (see Table 3-4). The EU-25's growing demand for sunflower products is expected to be supported by the internal trade agreements with Bulgaria and Romania as they become new members of the European Union (USDA, 2006:13; FAPRI, 2007:255).

3.4.3.1 EU-25 sunflower trading

The EU-25 is the only significant importer of sunflower seed due to growing domestic crush demand. The EU-25 imported 950,000 metric tons (see Table 3-9) of sunflower seed during the 2006/07 production season (FAPRI, 2007:255). The EU-25 remains the most significant buyer in the international sunflower market and is the main consumer region of sunflower oilcake/meal (38% of global consumption, see Figure 3-3 on page 52) in the world (see *Appendix A*). As a result of the cyclical increase in the livestock industry and the corresponding increase in the demand for protein feed (see Table 3-4), the EU-25 imported 1,968,000 metric tons of sunflower meal during the 2006/07 production season (see Table 3-10).

Table 3-10 Trade of sunflower oilcake/meal

Sunflower Oilcake/Meal							
Production Season	**2000/01**	**2001/02**	**2002/03**	**2003/04**	**2004/05**	**2005/06**	**2006/07**
(Thousand Metric Tons)							
Net Exporters							
Argentina	1 280	1 160	1 130	945	1 106	1 056	1 125
Bulgaria and Romania	156	161	145	197	280	208	225
CIS	686	529	877	1 529	1 166	1 865	1 873
USA	8	0	-60	-8	3	1	5
Total Net Exports *	2 146	1 850	2 152	2 671	2 555	3 130	3 228
Net Importers							
China	0	0	13	14	10	9	10
EU-25	1 822	1 602	1 745	1 889	1 769	1 957	1 968
Rest-of-the-World	324	173	223	506	594	789	893
Residual	-16	75	111	254	182	375	357
Total Net Imports	2 146	1 850	2 152	2 671	2 555	3 130	3 228

Source: FAPRI, 2007:256; SAGIS, 2006:22; USDA, 2006:13; NSA, 2006:13.
* Total net exports are the sum of all positive net exports and negative net imports.

The annual demand for sunflower oil in the EU-25 is rising as it becomes a feasible substitute for rapeseed and palm oil for food and industrial utilisation (FAPRI, 2007:255).

3.4.4 Bulgaria and Romania

Bulgaria and Romania is the fifth largest consumer of sunflower seed (6% of global consumption, see Figure 3-3 on page 52), the sixth largest consumer of sunflower oilcake/meal (4% of global consumption, see Figure 3-3 on page 52) and the fourth largest consumer of sunflower oil (5% of global consumption, see Figure 3-3 on page 52) in the world.

3.4.4.1 Bulgarian and Romanian sunflower trading

Net world sunflower trade jumped in the 2006/07 production season because of the increasing shipments from Bulgaria and Romania in response to strong demand from Turkey and Western Europe. The strong demand contributed to the rising international price which in turn resulted in significant area expansion for sunflower seed (USDA, 2006:13; NSA, 2006:13; FAPRI, 2007:255). Together, Bulgaria and Romania represent the chief exporter of sunflower seed in the world (see *Appendix A*) and exported approximately 930,000 metric tons of sunflower seed during the 2006/07 production season (see Table 3-9).

Table 3-11 Trade of sunflower oil

Sunflower Oil							
Production Season	**2000/01**	**2001/02**	**2002/03**	**2003/04**	**2004/05**	**2005/06**	**2006/07**
(Thousand Metric Tons)							
Net Exporters							
Argentina	1 004	1 157	898	1 007	1 176	1 125	1 175
Bulgaria and Romania	22	9	2	91	116	44	82
CIS	391	127	750	896	696	1 875	1 878
USA	244	189	24	96	23	69	55
Total Net Exports *	1 661	1 482	1 674	2 090	2 011	3 113	3 190
Net Importers							
China	0	0	8	49	1	5	5
EU-25	123	603	578	378	767	1 148	1 150
Rest-of-the-World	1 324	765	837	914	803	1 344	1 436
Residual	214	114	251	749	440	616	599
Total Net Imports	1 661	1 482	1 674	2 090	2 011	3 113	3 190

Source: FAPRI, 2007:257; SAGIS, 2006:22; USDA, 2006:13; NSA, 2006:13.
* Total net exports are the sum of all positive net exports and negative net imports.

3.4.5 China

China ranks sixth worldwide in the consumption of both sunflower seed (6% of global consumption) and sunflower oil (3% of global consumption) (see Figure 3-3 on page 52). Additionally China is the fifth largest consumer of sunflower oilcake/meal in the world, consuming approximately 526,000 metric tons of sunflower oilcake/meal during the 2006/07 production season (see Table 3-6). This was the result of the strong expansion in the Chinese livestock industry during the previous five production seasons (FAPRI, 2007:10).

3.4.5.1 Chinese sunflower trading

During the 2006/07 production season China exported 113,000 metric tons of sunflower seed (see Table 3-9) due to the production policies that favoured oilseed production and domestic crush (see *Appendix A*). This was combined with the growing global demand for protein feed and healthier fats (FAPRI, 2007:10). China is expected by FAPRI to increase its net vegetable oil imports significantly over the next few years because of the region's strong per capita consumption growth (FAPRI, 2007:10).

3.4.6 United States of America

The USA takes its place after China as the seventh largest consumer of sunflower seed in the world (4% of global consumption, see Figure 3-3 on page 52), consuming 1,251,000 metric tons of sunflower seed in the 2006/07 production season (see Table 3-7). The USA's production and consumption of sunflower seed are expected by FAPRI to remain constant over the next few years. Growth is not expected mainly because of the USA's strong hectare shift to maize as a result of the global ethanol boom for the production of bio-fuels (FAPRI, 2007:10; NSA, 2006:13; FAPRI, 2007:255; USDA, 2006:13). The USA is also the seventh largest consumer of both sunflower oilcake/meal (3% of global consumption) and sunflower oil (2% of the global consumption) in the world (see Figure 3-3 on page 52).

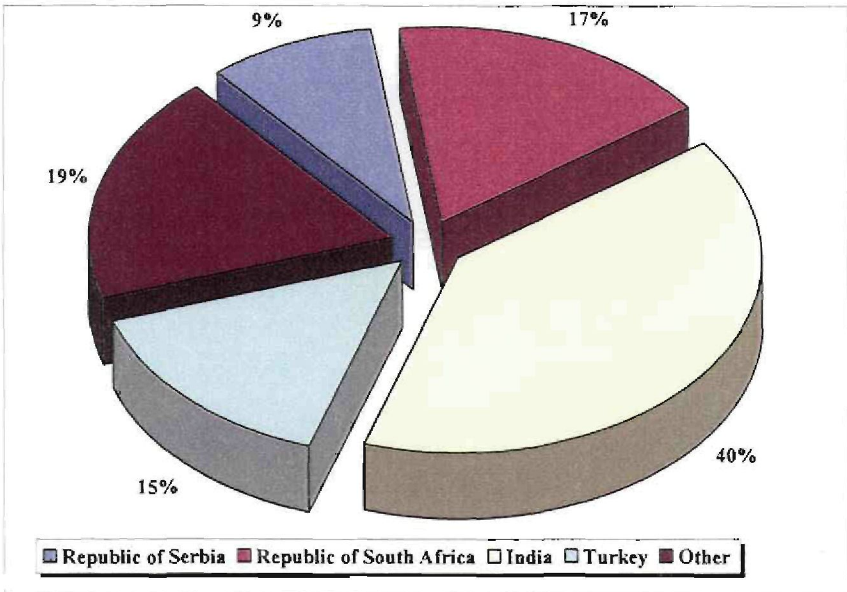
3.4.6.1 USA sunflower trading

FAPRI expects the consumption of sunflower oil and sunflower oilcake/meal for the USA to remain balanced because of the decrease in the area harvested (FAPRI, 2007:10). Similarly, the annual exportation of sunflower oilcake/meal (see Table 3-10) and sunflower oil (see Table 3-11) is expected to remain at a relatively stable level.

3.4.7 Rest-of-the-World

The ROW is the third largest consumer of sunflower seed (16% of global consumption, see Figure 3-3 on page 52) and consumed approximately 5,074,000 metric tons during the 2006/07 production season (see Table 3-8). The principal contributors of the ROW sector are India, the Republic of South Africa, Turkey and the Republic of Serbia (see Figure 3-4).

Figure 3-4 Contributors to the Rest-of-the-World during 2006/07



Source: FAPRI, 2007:258; SAGIS, 2006:22; NSA, 2006:13.

The consumption of sunflower seed recovered during the 2006/07 production season along with the annual soybean consumption and will maintain its relationship with other oilseeds for the next few years (AGRISA, 2006:12; SAGIS, 2006:3; FAPRI, 2007:255). With a consumption of approximately 3,272,000 metric tons in the 2006/07 production season (see Table 3-8) the ROW is the principal consumer region of sunflower oil (31% of global consumption, see Figure 3-3 on page 52). In addition, the ROW is the second largest consumer of sunflower oilcake/meal in the world (24% of global consumption, see Figure 3-3 on page 52).

On a per capita basis the global consumption of vegetable oil is increasing. This is mainly because of increasing personal incomes and annual growth in the population in developing countries. The average annual world soybean oil consumption grows by 1.8% and that is followed by palm and sunflower oil consumption with an annual growth of 1.3% and 0.3% respectively. The rapeseed oil consumption per capita declines by 0.7%, because this oil is mostly used for bio-diesel production. Accordingly palm oil has become the preferred substitute for other vegetable oils exhibiting soaring prices as opposed to the relatively economical price of palm oil (FAPRI, 2007:255; FAPRI, 2007:10). The ROW is the leading importer of sunflower oil followed by the EU-25 (see *Appendix A*) and the ROW imported 1,436,000 metric tons of sunflower oil during the 2006/07 production season (see Table 3-11).

3.4.8 Conclusion

Section 3.4 provided an overview of the global annual consumption and international trade of sunflower seed, oil, and oilcake/meal within the seven main production regions/countries that were identified in the previous section.

In the CIS the demand for sunflower products are influenced by the total crushing capacity of the CIS, export taxes, total number of shipments from the CIS, and the international sunflower oil and oilcake/meal prices. The major factors that influence the demand for sunflower in Argentina are the exportation of sunflower oil and sunflower oilcake/meal, the demand for protein feed by the human and livestock sectors, and the international sunflower oil and oilcake/meal prices.

The demand for sunflower products in the EU-25 region is affected by the demand for protein feed by the human and livestock sectors, and the substitution of different vegetable oils for food and industrial utilisation. The key factors that influence the demand for sunflower products in

Bulgaria and Romania are the total number of shipments from the region and the international sunflower oil and oilcake/meal prices.

The demand for sunflower products in China is influenced by the same factors as those of the EU-25, however in China's case the substitution of different vegetable oils for industrial utilisation does not play a significant role. In direct contrast to China, the demand for vegetable oils for industrial utilisation in the USA is the most significant factor that influences the demand for sunflower.

The chief factors that influence the demand for sunflower in the ROW are the planting of competing crops for the manufacture of bio-fuel and the demand for protein feed by the human and livestock sectors. Other influential factors include the demand for vegetable oil for food utilisation, the demand for vegetable oils for industrial utilisation, and international palm oil prices.

Specific consumption and trade factors were identified within each of the consumer regions. These factors will be incorporated into *Chapter 5* as potential influential factors to the South African sunflower price. More transparency on the potential factors identified will be presented in the concluding section of this chapter.

Sections 3.3 and 3.4 examined the production, consumption and trade of sunflower on a regional level and identified the contributing regions/countries. Considering the daily international trade of sunflower products, it is important to understand the worldwide price formation on the spot and futures market. Ultimately, the central factors that are responsible for spot and futures market price differences on an international and national level should be examined. These factors include the local supply and demand conditions of a country and the product characteristics of an agricultural crop. The transfer costs associated with a specific crop, government policies of a country, and the macroeconomic forces that influence the production and consumption of a specific agricultural crop, should also be taken into account.

The next section discusses the fundamentals of commodity markets and places the buying and selling factors that influence the worldwide price of sunflower seed, oil, and oilcake/meal into perspective. In addition, the primary functions of a spot and futures market within the calculation of everyday commodity prices are identified. The information discussed in the next section aims to motivate, facilitate, and sustain the identification of various international and national market factors. These factors are potentially influential to the price of sunflower in South Africa and will be considered accordingly.

3.5 Futures market fundamentals

3.5.1 Introduction

One of the most important features of the various international commodity markets is the significance of futures markets. Unlike cash markets that deal with the immediate transfer of goods, market players on futures markets buy and/or sell commodity contracts at a fixed price for the potential physical (but not necessarily) delivery at some future date (CFTC, 2007:7; Schnept, 2006:5; Kirsten and Vink, 2000:25). Agricultural commodity futures contracts are traded around the world on numerous commodity exchanges. Each exchange publishes its contract information. These include the months for which futures contracts are available, contract size, deliverable grades, and the trading hours. The contract period, minimum price fluctuations, daily price limits, and the margin information are also presented.

A futures contract specifies the grade, quality, amount, and the conditions for product delivery (including acceptable delivery locations) as well as the delivery month. In the majority of the global futures markets various product grades are deliverable instead of the futures contract's base grade or type. However, it is subject to general price premiums and/or discounts (CFTC, 2007:7; Schnept, 2006:5). The futures contract specifications are written to ensure that they closely mirror the cash market conditions. The months of futures contract trading are usually selected because of their significance in the crop marketing year (Murphy, 1984:11).

A futures market/exchange provides a convenient mechanism for buyers and sellers to trade commodity futures contracts openly. The futures exchange reports all market transactions to the public. The majority of futures exchanges around the world publish daily information on, for example, the opening, high, low, and closing prices of active futures contracts. Futures exchanges also publish additional information such as the volume traded and open interest. As a result of this activity, the futures markets function as a central exchange for domestic and international market information and as a primary mechanism for price discovery (CFTC, 2007:7). The steadfastness of a futures market's price discovery function is dependent on the volume of the daily transactions. Thinly traded markets are more vulnerable to price manipulation than heavily traded ones. Thinly traded markets are indicated by low trading volume. Consequently, the prices on the thinly traded futures markets may not accurately reflect either the price behaviour in the cash market or the expectations about the future (Gordon, 1984:36).

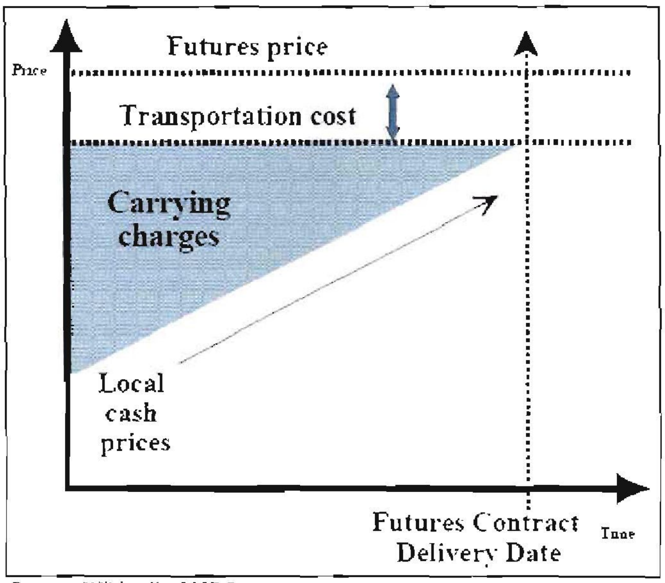
It is not abnormal for distant contracts to trade at very low volumes. A reason for this is that publicly announced futures prices play a critical role in the facilitation of the seasonal market operations. This is because they provide a forum for forward contracting and hedging (CFTC, 2007:7; Schnept, 2006:5; Kirsten and Vink, 2000:25). Speculators provide an important function in futures markets by expanding both the trading volume and the liquidity of the daily futures market transactions. Currently the speculators (including private investment funds) encompass the majority of futures market participants (CFTC, 2007:7).

The presence of many speculative traders tends to diminish the extreme price volatility, and that ultimately allows the hedgers to effortlessly buy and sell in large quantities. Regional and local grain silos rely on futures commodity exchanges for the hedging of grain purchases. The silos generally set their grain bid prices at a discount to a nearby futures contract in the areas that produce a surplus, or at a premium in areas that produce a deficit. As a result, the cash prices and the futures contract prices are sturdily linked. This is because both prices contain much of the same information about market conditions (CFTC, 2007:7; Schnept, 2006:8; Wikipedia, 2007:7).

The key price relationship between the cash price and the price for the nearby futures contract is *called the basis. The price basis is defined as the difference between the cash price of a* particular commodity at a precise location and the nearby futures contract (that is the closest contract month) for that specific commodity (CFTC, 2007:7). Under normal supply and demand conditions the price basis for a storable commodity is negative. This reflects the transportation cost that is associated with the moving of the commodity from a local market to the delivery point that is specified by the futures contract. In addition to the transportation costs, the carrying charges (for example the storage, interest, and insurance costs) form part of the price basis. These charges are associated with the holding of the commodity during the time period that separates the futures contract transaction date and the delivery (or contract expiry) date (see Figure 3-5).

As a futures contract expires and the delivery month approaches, the carrying charges approach zero and the cash and futures prices tend to converge. At the date of actual delivery the basis represents the pure transportation cost that separates the local market from the futures market's delivery point (Schnept, 2006:8; Wikipedia, 2007:7).

Figure 3-5 Price basis convergence of a futures contract



Source: Wikipedia, 2007:7

Where local demand surpasses local supply, due for instance to a crop shortfall or a nearby processing plant, the basis may be less than the transport margin or even surpass the futures market price. However, the full carrying charges are rarely ever achieved in the actual market behaviour, except in periods of substantial oversupply or excess stocks (Schnept, 2006:9). General repetitive patterns of the basis movements for storable agricultural commodities, make the basis more predictable from year to year than the movement of either cash or futures prices. As a result, the basis permits the producers and consumers to estimate an expected cash price from the currently reported value of a futures contract. This predictability significantly reduces the risk of using the futures market for hedging purposes (CFTC, 2007:7; Wikipedia, 2007:7).

The general factors that affect the local basis for oilseeds are similar to the factors that affect both cash and futures prices. The first factor is the overall production and consumption for each commodity by variety or type. The second factor is the supply and demand of other commodities that compete for either the same land in production or the same portion of consumer expenditure. The third factor is the geographical inconsistency in supply and demand. The fourth factor is the transportation price structure and the various transportation problems.

The fifth factor is the available storage space and crop quality factors. The sixth and final factor is the general market expectations (Schnept, 2006:10; Wikipedia, 2007:7).

Sub-section 3.5.2 examines the main factors that influence the cash and futures prices (that is the basis) of an agricultural commodity. This will be vital in the basic understanding of the identification process of potential factors that influence the price of sunflower in South Africa.

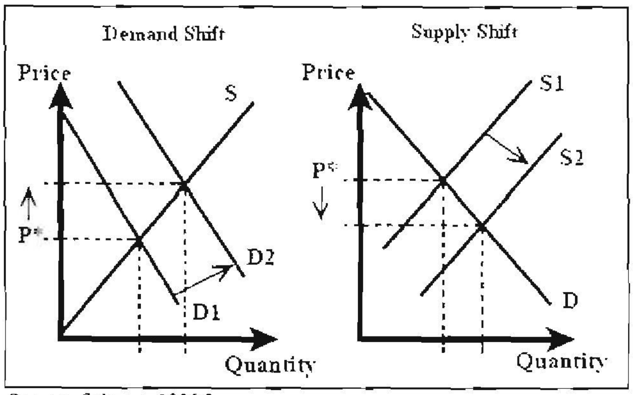
3.5.2 Market price differences

The general price levels of an agricultural commodity are influenced by a wide variety of market forces. These market forces can adjust the current or the expected balance between supply and demand. The majority of these market forces originate from the domestic food, livestock feed, and the industrial utilisation markets. They include the preferences of consumers and the changing needs of end consumers.

3.5.2.1 Local supply and demand conditions

The differences in the grain and the oilseed prices throughout the world reflect discrepancies in the local supply and demand conditions, as well as the differences in the local market structures. Generally the grain and the oilseed prices are lower in the inland producing regions (that is where they are in surplus) and higher in the grain and oilseed shortage regions (that is the densely populated and port regions) where the demand exceeds the local production (SAGIS, 2006:3; Schnept, 2006:2; Kirsten and Vink, 2000:25).

Figure 3-6 Price equilibrium of supply and demand



Source: Schnept, 2006:2.

The price (P^*) in Figure 3-6 represents the equilibrium point where the buyers (with their demand) and the sellers (with their supply) meet in the marketplace. New market information (for example crop failures in foreign markets, widespread animal disease outbreaks or major revisions of previous crop production estimates) can alter the expectations of the market participants. This may lead to a new equilibrium price as the sellers modify their offer prices, and the buyers adjust their purchase bids based on the new information. An outward shift in the demand from the market equilibrium would raise the price P^* as the demand shifts to the right (that is *D1* - *D2*) along the supply curve. For instance, this could be the result of news of a foreign crop failure raising expectations for increased exports. Similarly an outward shift in the supply from the market equilibrium would lead to a lower price P^* as the supply moves to the right (that is *S1* - *S2*) along the demand curve (see Figure 3-6). For example, this could be the result of an upward revision in the planted hectares that was estimated by the South African Grain Information Service (SAGIS), raising expectations for higher production.

Both of these theoretical price changes would only be short-term. In the long-run the producers would adjust their planting decisions in the light of the new price expectations and the speed and the effectiveness with which the various price adjustments occur. The latter mainly depend on the market structure within which a commodity is being traded (SAGIS, 2006:3; Schnept, 2006:2). In general the agricultural commodity prices respond swiftly to actual and anticipated changes in supply and demand conditions. However, certain characteristics of agricultural product markets set them apart from most non-agricultural products. They have a propensity to make agricultural product prices more volatile than the prices of most non-farm goods and services (Tomek and Robinson, 2003:2; CFTC, 2007:7).

Three such noteworthy characteristics of agricultural crops include the seasonality of production, the derived nature of their demand and the generally price-inelastic demand and supply functions.

3.5.2.1.1 Seasonality

Generally agricultural crops grown in temperate-zone countries, where freezing winters limit the crop production to a 6-9 month period have stronger seasonal production patterns. Consequently, the biological nature of the crop production plays an important role in the agricultural product price behaviour (Schnept, 2006:22; Kirsten and Vink, 2000:25). The production of spring-planted crops in particular has a lag in its response to market signals. The farmers must, therefore, make their planting decisions by early spring in order to purchase the seed and the other inputs needed for the production. However, farmers do not receive a price for their production until after the harvest when the ownership of the physical commodity is transferred. Therefore, the farmers' planting decisions are partially based on their expectations about the future crop yields. Farmers also base their decisions on the input and output prices needed to produce those products. Other decisions farmers have to consider are the government program support rates for alternative production activities, expectations concerning international market conditions, and the possibility for unexpected changes in the global trade of agricultural commodities (Schnept, 2006:22).

A region's agronomic conditions (for example its weather conditions and soil types) may influence the viability of producing a particular crop or the undertaking of a livestock activity. However, the expectations of market conditions such as the harvest-time output prices influence the final choice (CFTC, 2007:7; Schnept, 2006:22). Consequently, the expected changes in the supply and demand of crops (or other activities) that compete for land (or for other food sources) can ripple through the various agricultural markets, and as a result change the prices. However, since the end result of a planting-time production decision does not materialise until several months later at harvest time, it is possible that the market conditions will have changed considerably or that a producer's actual production may be very different from the planned production (CFTC, 2007:7). This can be due to unanticipated variations in weather, pests, diseases, and other significant conditions (Schnept, 2006:22).

3.5.2.1.2 Derived nature of agricultural product prices

The principal demand for agricultural products originates from consumers who use an assortment of food and industrial products. These products are produced from "raw" or unprocessed farm commodities such as grains, oilseeds and fibre. The term "derived demand" refers to the demand for inputs that are used to produce the final products. For example, sunflower and soybeans are important inputs in the livestock industry, wheat is used to make various baking ingredients, and cotton is used in the production of textiles. As a result, the demand for sunflower, soybeans, wheat, and cotton is derived from the demand for their various end products (Tomek and Robinson, 2003:25). Similarly, the demand for sunflower seed is derived from the demand for sunflower oil and sunflower oilcake/meal (that is the major products obtained from crushing sunflower seed).

It is possible for the overall supply of a non-specific commodity to be in abundant supply, while a specific variety of that commodity possessing the desired end-use traits may be in short supply (for example a livestock feeder trying to obtain the least-cost set of feed ingredients that yield a particular balance of protein, energy, fibre, and other nutrient components). Therefore, it is evident that generous price premiums and discounts may develop based on the commodities' end-use characteristics. This occurs repeatedly in the wheat market where the different wheat varieties have very unique baking and milling characteristics. However, it is also not unusual in other grain and oilseed markets. For example, the price of rice is based on the length of the grain and the price of maize is based on the colour, oil, or starch content. The price of sunflower seed and soybeans are based on their protein and/or oil content (Tomek and Robinson, 2003:26). The potential buyers of raw agricultural commodities are generally seeking an end-use characteristic and this will definitely influence the price of an agricultural commodity (Tomek and Robinson, 2003:26).

3.5.2.1.3 Price-inelastic demand and supply

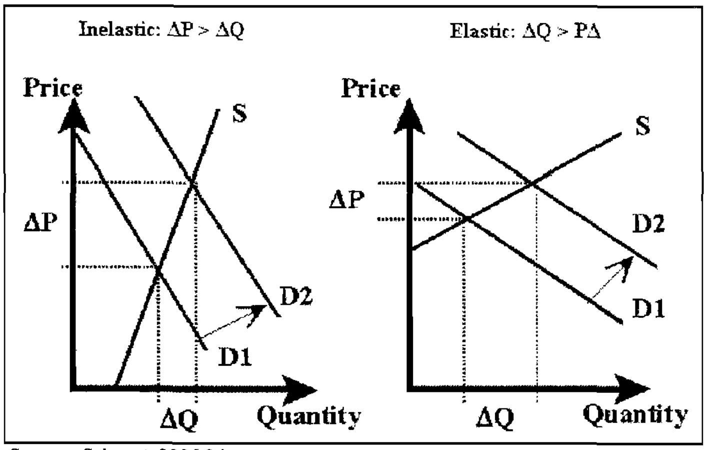
In general the demand and supply of farm products is relatively price-inelastic. The quantities demanded and supplied change proportionally less than prices and this implies that even minimal changes in the supply can result in large price movements. This specific price dynamic has long been a characteristic of the agricultural sector and a farm policy concern. Subsequent unexpected market news can produce potentially large swings in production prices and incomes (CFTC, 2007:7; Schnept, 2006:23; Kirsten and Vink, 2000:25).

The supply elasticity of an agricultural commodity reflects the swiftness with which the new supplies become available or whether the supplies available in the marketplace decline. This can be in response to a price rise (or fall) in a particular market, since the majority of the grains and oilseeds are limited to a single annual harvest. The new supply flows to the market (for example in response to a post-harvest price change) must come from either the domestic stocks or the international sources (SAGIS, 2006:3; Schnept, 2006:23). As a result, the short-term supply response to a price rise can be very restricted during periods of low stock holdings. However, in the longer run the expanded number of hectares and more intensive cultivation practices can increase the total production (SAGIS, 2006:3; Schnept, 2006:23).

On the other hand, when prices fall farmers might tend to withhold their commodity from the market. However, the cost of storage, the length of time before any expected price recovery, the anticipated strength of a price rebound, and a producer's current cash-flow situation needs to be considered to determine if the storage of the commodity is a practical alternative (SAGIS, 2006:3). If a return to higher prices is not expected in the near future, the storage of a commodity may not be a viable option. The continued marketing may add to the downward price pressures. Similarly the demand elasticity reflects a consumer's ability and/or willingness to alter the consumption when the prices for the desired commodity rises or falls (Schnept, 2006:23).

Consumers consider both own-price and cross-price movements of complementary and substitute products in their expenditure decisions. The consumers' eagerness to substitute another commodity when prices rise depends on several factors, including the number and availability of substitutes. The second factor that consumers consider is the importance of the commodity as measured by its share of consumers' budgetary expenditures. The third and final factor is the strength of consumers' tastes and preferences. Since the farm cost of basic grains and oilseeds generally amounts to a very large share of the retail cost of consumer food products, the changes in the grain prices commonly have a significant impact on the retail food prices. Consequently, there is a large impact on the behaviour of the consumer and the corresponding farm-level demand (CFTC, 2007:7; Schnept, 2006:23).

Figure 3-7 Price changes due to quantity changes



Source: Schnept, 2006:24.

Figure 3-7 displays examples of both inelastic and elastic supply and demand curves. The diagram on the left-hand side of Figure 3-7 shows fairly price-unresponsive (that is inelastic) demand and supply curves. This is typical of those associated with most seasonal agricultural markets. A sudden outward shift (that is an expansion) in the demand from *D1* - *D2* moves the market equilibrium outward along the supply curve *S*.

This change in the market equilibrium results in only a modest percentage change in the quantity supplied to the market (*ΔQ/Q*), compared with a much larger percentage increase in the prices (*ΔP/P*). A similar large price change is obtained from a sudden underperformance in the supplies represented by a leftward movement of the supply curve. However, in contrast to this, a greater than expected supply represented by a rightward shift of the supply curve *S* would lead to a large plunge in the market price, ignoring the long-term effects of government programs (CFTC, 2007:7).

The diagram on the right-hand side of Figure 3-7 displays the more responsive (that is more elastic) set of demand and supply curves. This is typical of those associated with many higher-valued, non-agricultural markets. For comparative purposes assume that the same sudden outward shift in the demand from *D1* - *D2* moves the market equilibrium outward along the supply curve *S*. The change in the market equilibrium results in a much larger percentage change in the quantity supplied to the market (*ΔQ/Q*), compared with a smaller percentage increase in the prices (*ΔP/P*). Subsequently, by increasing the demand for grains and oilseeds by the industrial processing sector or from the escalating industrial beef, poultry, or dairy feed operations, would further reinforce the general price elasticity of demand.

The industrial utilisation of sunflower seed is generally sensitive to price changes, since (as with retail prices of food) the price of this agricultural commodity usually symbolises a large share of the overall production costs of the finished product (Schnept, 2006:25). Furthermore, the industrial users have generally made significant investments in the plant equipment and must continue to operate at some minimal level of capacity all year-round in order to generate a return on that investment. However, inelastic demand and supply responsiveness characterises most of the agricultural products and there are distinct differences in the level and pattern of receptiveness across different commodities (Schnept, 2006:25; Kirsten and Vink, 2000:25).

3.5.2.2 Product characteristics

The current futures market participants tend to be very sophisticated buyers who carefully compare the prices of different agricultural commodities. As a result, the supply and demand circumstances in the agricultural markets may depend on a commodity's particular variety, quality, or its end-use characteristics. These characteristics also include whether the commodity is for exportation or not, for feed rations, fresh products, food processing, or textile manufacturing. This is more than the overall supply of the basic commodity (Schnept, 2006:2;

Wikipedia, 2007:7). For example, a flour processor may base his wheat purchasing decisions primarily on the specific variety of wheat and its particular milling and baking characteristics. A livestock or poultry operation strives for the least-cost, balanced ration (depending on the type of animal) that includes sufficient protein, carbohydrates, fats, vitamins, and roughage. An ethanol plant may select maize based on its starch content, while a food processor may prefer maize with above-average oil content.

3.5.2.3 Transfer costs

The key components of the global grain and oilseed handling network include on-farm storage, trucks, railroads, barges, and grain silos (including county, sub-terminal, and export silos). An intricate web of local supply and demand factors determines the movement of agricultural commodities through this network (CFTC, 2007:7; Schnept, 2006:4). Price changes at any point along the movement chain can result in shifts to alternate transport modes or routes as the grain marketers search for the cheapest method of moving grain between the buyer and the seller. The prices for grains and oilseeds at the local country silo are derived from a central market price less the transportation and handling costs (Wikipedia, 2007:7).

Country silo managers monitor the different prices in several markets very closely to determine where the demand is the greatest. Some of the prices that silo managers monitor are the prices quoted by the processing plants, feedlots, export terminals and the different futures exchanges. The silo managers deduct the transfer costs from the higher-priced market to determine the bids they can offer for the local producers. However, in cut-throat markets the transfer costs (that is the loading or handling and transportation charges) are usually the most important factors in determining the location-based price differentials (Schnept, 2006:4).

In the international marketplace the transfer costs include the obstructions to trade like the different tariffs and quotas. The more it costs to transport a commodity to a buyer the less the producer will receive. This is only applicable in countries where the prices of the different commodities are generally at the same level and *vice versa.* However, the price differentials between regions cannot exceed the transfer costs for very long. The marketers will rapidly move commodities from the low-priced markets (that is raising prices there) and ship them to the higher-priced markets (that is lowering prices there) (Amosson, Mintert, Tierney, and Waller, 2005:6; Schnept, 2006:4).

From the farm to the processing plant or export terminal, trucks, trains and barges compete and harmonise with one another in moving the grain and oilseeds successively to larger silos. The shipping distance often determines each mode's particular role (for example trucks traditionally have an advantage in the moving of grain over shorter distances and as a result function primarily as the short haul gatherers of grain and oilseed products). Railroads have a cost advantage in the moving of grain over longer distances, but barges have an even greater cost advantage where a waterway is available (Amosson *et al.*, 2005:6; Schnept, 2005:27).

Most economists and market analysts agree that reasonably priced barge transportation helps to keep the rates charged by the rail and truck transportation industries down. Any disruption to the agricultural transportation network generally results in higher transportation costs throughout the system. This happens as the demand for transportation services shifts to alternate modes and routes, in the continual search of the next best means of moving the crop production to the market (Schnept, 2005:27; Wikipedia, 2007:7).

3.5.2.4 Government policies

The intended functions of government programs vary from direct price support under commodity loan requirements to conservation management. This is because of a government's influence on per-hectare returns. The different government programs around the world play an important role in the selection of a crop and the marketing decisions of agricultural producers (CFTC, 2007:7; Schnept, 2006:5). The degree of influence of government programs can vary significantly from one commodity to another. Generally government programs increase the incentives to produce the crop that is receiving support.

Consequently, the annual supply of government-supported crops available to the market tends to be larger than the supply actually demanded by the market. This is under the normal supply and demand conditions that would prevail in the non-existence of government programs (Schnept, 2006:5; Kirsten and Vink, 2000:25). The consequence of over-supply is a lower price. The majority of the agricultural producing countries in the world provide some form of support. Although, in many cases it is in the form of border protection (that is tariffs, quotas, and other import restrictions), state-sanctioned monopolies, rural infrastructure development, and agricultural research, rather than direct payments (Schnept, 2006:5).

3.5.2.5 Macroeconomic forces

The long-run commodity demand of a country is driven to a large extent by the population of a country. A country's demographic composition by its age and ethnicity may play an important role in the preferences and food needs of a population. The per capita income growth of the population usually trends upward or downward progressively and predictably with the national economy. However, the demographic changes generally occur slowly and in harmony with general behavioural patterns (Schnept, 2006:21; Wikipedia, 2007:7). As a result, the short-term price movements are seldom driven by either of these phenomena (that is population and income dynamics). However, an important exception to this rule was the 1997 Asian financial crisis that dramatically and quite suddenly curtailed commodity import demand in several major agricultural importing countries of East and Southeast Asia. This contributed significantly to the price declines in the majority of the international commodity markets of the late 1990s (CFTC, 2007:7; Schnept, 2006:21).

Rapid changes in the currency exchange rates between trading nations can occur abruptly and have significant effects on the prices and international trade of commodities (Labonte, 2005:3; Wikipedia, 2007:7). For an exporting country a devaluation of its currency against other exporting countries has the same effect as a lowering of its export price against those competitor nations. This will make the products more competitive. In contrast for an importing country a devaluation of its currency against the currency of other exporting nations will make products from those exporters more expensive. This will lower a country's import demand (Labonte, 2005:3). Currency appreciation will have the opposite effect. It should be noted that exchange rate fluctuations and their economic implications are not exceptional to agricultural commodities, but instead influences all the goods and services traded between the identified nations (Labonte, 2005:3; Kirsten and Vink, 2000:25).

3.5.3 Conclusion

Section 3.5 examined the fundamentals of futures markets and discussed the key factors that influence the formation of futures prices in the world. The factors identified in this section, which are responsible for futures market price differences, are the local demand and supply conditions of a country. These include the yield, total area harvested, and input/output prices of an agricultural commodity. The availability of government support programs in a country for a specific agricultural commodity, weather conditions, and the soil types of a specific production region are additional factors that contribute to futures market price differences. Other factors identified in section 3.5 are the international agricultural market conditions, the global trade of an agricultural commodity, the end-use characteristic of an agricultural commodity, and the availability of substitute products. The characteristics of the specific agricultural product, the transfer costs associated with a specific agricultural crop, the different economic government policies, and the currency exchange rates between trading nations add to futures market price differences.

3.6 Conclusion

The fundamental objective of *Chapter 3* was to provide an advanced perspective on the international sunflower market. This chapter identified the different demand and supply factors that influenced the production, consumption, and trade of the different regions/countries in the world. The identified factors will then be considered as potential factors that influence the price of sunflower in South Africa.

Section 3.2 examined the total global production, consumption and trade of sunflower seed, oil, and oilcake/meal. Sections 3.3 and 3.4 studied the production, consumption, and trade of sunflower seed, oil, and oilcake/meal on a regional level and divided the globe into seven production regions/countries. These regions/countries were the Commonwealth of Independent States, Argentina, European Union-25, Bulgaria and Romania, China, United States of America, and the Rest-of-the-World.

Section 3.5's primary purpose was to discuss the significance and the efficiency of a commodity spot and futures market. It was found that in a perfect market the spot and futures prices will behave as a stochastic process. This process signifies where the conditional expectation of the next price (given the current and preceding prices) is the current price and where the futures prices will provide the best available estimates of the subsequent actual prices. The difference in the pricing performance between the futures markets indicates the significance of stock on the price spread and the influence of expectations on the price level.

The common attributes of spot and futures market structures include the number of buyers and sellers on the futures market, the commodity's homogeneity in terms of type, variety, quality and end-use characteristics, the number of close substitutes for the specific product, and the commodity's storability. The transparency of the formation of the different prices, the simplicity of commodity transfer between buyers and sellers (including between different spot and futures markets), and the artificial restrictions on the futures market processes are additional attributes that were identified in section 3.5. Some restrictions (for example import barriers) limit the supply and keep prices at a reasonable high level, while other types of restrictions (for example market collusion by a few large buyers), may control futures market prices.

Table 3-12 is a reassessment of all the influential factors that have been identified throughout *Chapter 3*. These factors were identified during the examination of the worldwide production, consumption, and trade of sunflower products. Within each section of *Chapter 3* clearly defined factors for those specific sections were identified and isolated. Table 3-12 is arranged into four key groups. This is done in order to alleviate the identification process of the potential factors that influence the price of sunflower in South Africa.

All the factors in Group A focus primarily on the production of sunflower seed, oil, and oilcake/meal in the international sunflower industry. The main international production factors identified throughout *Chapter 3* that influence the supply of sunflower products are the annual area where sunflower seed and soybeans are harvested, weather conditions within a country, and the yield of the sunflower and soybean plants (refer Table 3-12, Group A).

The major factors identified in Group B are the consumption factors that influence the demand for sunflower seed, oil, and oilcake/meal in the world. The principle consumption factors (identified in *Chapter 3*) that influence the demand for sunflower products are the increased consumption of protein feed (that is sunflower, palm, and soybean oilcake/meal), increased demand for vegetable oil (that is sunflower, palm and soybean oil) for human and industrial utilisation, and the international trade of sunflower products (refer Table 3-12, Group B).

Group C in Table 3-12 indicates the factors that mainly focus on the trade of oilseeds and its products on a global scale. The chief factors that influence the trade of sunflower products are the international vegetable oil prices (that is sunflower, palm, and soybean oil prices) and the international oilcake/meal prices (that is sunflower, palm, and soybean oilcake/meal prices) (refer Table 3-12, Group C).

Table 3-12 Factor comparison of *Chapter 3*

Identified Influential Factors	Section 3.2	Section 3.3 and Section 3.4							Section 3.5	Group
Region (Subdivision)	**Global**	**CIS**	**ARG**	**EU-25**	**BR**	**CHI**	**USA**	**ROW**	**Global**	
Area Harvested	☑	☑	☑	☑	☑	☑	☑	☑	☑	A
Competing Crop (Rapeseed)				☑						A
Competing Crop (Soybeans)				☑			☑	☑		A
Crushing Capacity of Oilseeds		☑								A
Export Taxes		☑								A
Government Policies and Support Programs						☑			☑	A
Input Prices (Production)									☑	A
Storage Costs									☑	A
Transportation Costs									☑	A
Weather Conditions							☑	☑	☑	A
Yield of the Sunflower Plant	☑	☑			☑	☑		☑	☑	A
Per Capita Spending (Income)	☑									B
Protein Feed (Beef, Poultry and Dairy Industries)	☑	☑	☑	☑		☑	☑	☑		B
Protein Feed (Human Consumption)	☑	☑	☑	☑		☑	☑	☑		B
Soybeans Demand (Substitute Oilseed)									☑	B
Sunflower Seed Demand (Domestic Price)	☑								☑	B
Vegetable Oil (Bio-Etanol and Bio-Diesel)	☑	☑		☑		☑	☑	☑		B
Vegetable Oil (Healthier Lifestyle)	☑			☑		☑		☑		B
Trade of Sunflower Oilcake/Meal		☑	☑	☑	☑	☑		☑	☑	B
Trade of Sunflower Oil		☑	☑	☑	☑	☑		☑	☑	B
International Palm Oil Prices				☑				☑	☑	C
International Soybean Oilcake/Meal Prices		☑	☑	☑		☑	☑	☑	☑	C
International Soybean Oil Prices				☑		☑	☑	☑	☑	C
International Sunflower Oilcake/Meal Prices		☑	☑	☑	☑	☑		☑	☑	C
International Sunflower Oil Prices		☑	☑	☑	☑	☑		☑	☑	C
Macro-Economic Forces									☑	D
Rand/US-Dollar Exchange Rate									☑	D

Source: Table 3-12 was derived from the information in *Chapter 3*

The final group in Table 3-12 is Group D. This group centres on the factors that influence the production, consumption, and trade of agricultural crops as an integrated industry around the world. The Rand/US-Dollar exchange rate is identified as the only key influential macroeconomic factor to the global oilseed industry (refer Table 3-12, Group D).

The Republic of South Africa was identified in sections 3.3 and 3.4 as being part of the Rest-of-the-world production and consumption region. South Africa holds a 17% share in the Rest-of-the-world sector (see Figure 3-4). The general objective of this dissertation is to identify the factors that influence the price of sunflower in South Africa. Therefore, by applying the international factors that were examined in Table 3-12, *Chapter 4* will identify the factors that influence the production, consumption, and trade of sunflower products in South Africa.

4

South African Sunflower Market

4.1 Introduction

The majority of the agricultural commodities produced in South Africa are characterised by many producers that compete to produce a uniform product at a low cost. These producers are not only competing with the rest of the South African Development Community's (SADC) producers, but also with other producers throughout the world. The risks inherent in the production of agricultural products are certainly enormous. The biological nature of production with its exposure to weather variability causes the supply available to the marketplace to be volatile. Accordingly, the prices generated by a commodity market with these characteristics are also subject to high levels of variability. *Chapter 4* is an extensive examination of the South African sunflower market.

Chapter 4 is divided into five sections. Section 4.2 is an overview of the sunflower industry in South Africa and serves as an introduction to the subsequent sections in *Chapter 4*. Section 4.3 inspects the production and consumption of sunflower seed in South Africa. Amongst other topics, this section includes detail of the closing stock, the total number of processed sunflower seed, and the production of bio-fuel in South Africa. Section 4.4 focuses on the production and consumption of sunflower oil and oilcake/meal in South Africa (that is the oil processing industry in South Africa).

Section 4.5 examines the South African Futures Exchange's (SAFEX) development and the South African sunflower's price development. This is necessary in order to aid the identification process of the potential influential factors to the price of sunflower in South Africa. Section 4.6 is a conclusion of all the factors identified in this chapter. The factors that are relevant to the formation and configuration of the sunflower price in South Africa will be incorporated into the development of the SASPM in *Chapter 5*.

4.2 Overview of the sunflower industry

4.2.1 Introduction

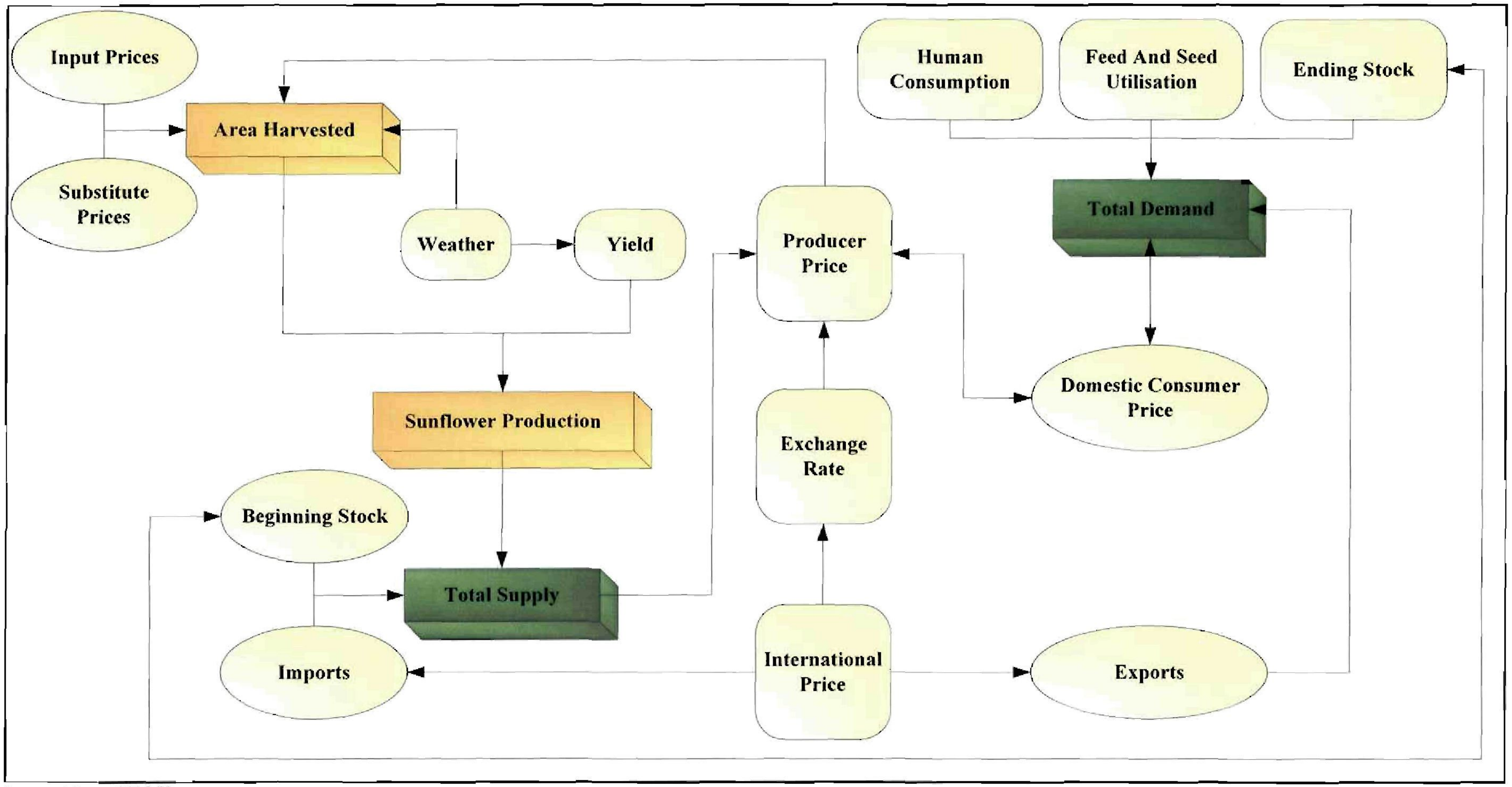
Figure 4-1 illustrates the development of sunflower through the market channel from the sunflower producer to the final consumer of the sunflower product. While the flow representation cannot emulate all the decisions occurring within the sunflower industry, the most important behavioural relationships are nevertheless captured within this discussion. The South African sunflower industry is fundamentally an interdependent system of three sectors, namely the supply, demand, and price linkage (that is the market) sectors. There is a unique relationship between the demand and supply sectors. A general interaction exists that influences the production and consumption within the demand and supply sectors (Meyer, 2005:69; SAGIS, 2006:3). The diagram (Figure 4-1) is utilised to facilitate the general economic understanding of the relationship as well as the interaction among the different sectors.

4.2.2 Supply sector

In the supply sector the farmer has to make the initial decision on the size of the area to be planted. However, the area harvested can be implemented as a good proxy for the area planted in South Africa. It is also a reliable indicator of the planned production for a specific season (Meyer, 2005:69). Using the area harvested in the estimation of the potential supply of sunflower seed does, on the other hand have some problems. For example, the total area planted may not always be harvested. This could be due to the changing weather patterns in a country, yet in South Africa there has traditionally been a small difference between the area planted and the area harvested (Liebenberg and Groenewald, 1997:4; Berglund, 1994:25).

The input prices of sunflower seed and the input prices of substitutes and complements will influence the sunflower producer's decision to plant this crop during a certain production season. Additional factors a sunflower producer has to consider are the weather conditions and the previous year's area planted (NDA, 2006:7; Martin, Oudwater, and Meadows, 2000:5). The previous year's planted area is included in this flow diagram to capture the dynamics of the South African sunflower industry. It is specified by the line between the "Beginning Stock" and the "Ending Stock" sectors of Figure 4-1. The remainder of the lines indicate the relationships between the area harvested, and the production price of sunflower.

Figure 4-1 South African sunflower industry



Source. Meyer, 2005:70.
Note: Adjusted for sunflower seed production in South Africa.

After the sunflower producer has decided to plant, the yield (which is influenced by the weather and soil conditions) will determine the total production of the crop. The total supply of sunflower seed in South Africa is calculated by adding (see Figure 4-1) the beginning stock of the crop and the total imports to the total annual production (Schmitt, 2005:37; Martin *et al.*, 2000:5). The total imports are determined by both the world price of sunflower and the local production figures (NDA, 2006:7; Berglund, 1994:25; AGRISA, 2006:12).

4.2.3 Demand sector

The human consumption, feed and seed consumption, exports (that is if there is a surplus), and the ending stocks of sunflower determine the total demand for sunflower in South Africa (see Figure 4-1). Human consumption is influenced by the current consumer price. A two-directional arrow illustrates the relationship between direct human consumption and the consumer price (AGRISA, 2006:12; Meyer, 2005:69). The consumption of high protein feed (that is by the livestock industry in South Africa) makes up a relatively large portion of South Africa's sunflower market. As a result, the human consumption and the feed consumption are included in the calculation of total demand (AFMA, 2007:25).

4.2.4 Market sector

The final sector in the development of the South African sunflower industry is the price linkage sector (that is the South African Futures Exchange). This sector formalises the interaction between the supply and demand sectors in South Africa and links international prices to the local production and consumption prices (NDA, 2006:7; Berglund, 1994:25; GRAINSA, 2007:4). During the time the Oilseed Board (that is the Marketing Board for sunflower seed, soybeans and groundnut) existed, sunflower farmers knew what the selling price would be for the upcoming production season and made their planting decisions based on the information provided by the Oilseed Board. This was because the Oilseed Board used a fixed formula to calculate the producer prices of sunflower seed (NDA, 2006:7; Berglund, 1994:25).

However, the Oilseed Board closed its doors on 30 September 1997. Since then, the production prices in South Africa are determined by international market forces (that is world prices and the exchange rates). As a result farmers now base their planting decisions on the production prices of the previous year's season, which influences their expectations regarding future prices.

Alternatively, they make use of the futures market to minimise their price risks (ACO, 2006:26; Berglund, 1994:25). The ending stock in period *t* depends on the local production of sunflower, the consumer price of sunflower, and the beginning stock in period *t*. For that reason, the ending stock in period *t* is equal to the beginning stock for period *t+1* (see Figure 4-1).

4.2.5 Conclusion

Section 4.2 examined the basic functioning of the sunflower industry in South Africa. This section provided the essential foundation that is necessary to examine the South African sunflower industry (seed, oil, and oilcake/meal) from a production and consumption perspective. Some of the potential influential factors to the price of sunflower in South Africa have been introduced in this section. These factors will be analysed in more detail in the following two sections (4.3 and 4.4) of *Chapter 4*. A summary of the potential factors that influence the price of sunflower in South Africa will be compiled in the concluding section of this chapter.

4.3 Demand and supply of sunflower seed

4.3.1 National level

The total production of sunflower seed during the 2006/07 production season was 619,000 metric tons with a domestic consumption of approximately 460,000 metric tons (Table 4-1).

Table 4-1 South African sunflower seed industry

Sunflower Seed							
Production Season	**2000/01**	**2001/02**	**2002/03**	**2003/04**	**2004/05**	**2005/06**	**2006/07**
(Thousand Metric Tons)							
Beginning Stocks	451	153	147	283	125	120	100
Production	545	664	914	656	651	614	516
Net Imports	1	8	2	2	18	6	3
Total Production	997	825	1063	941	794	740	619
Crush	816	648	700	801	661	632	454
Withdrawn	15	19	16	8	3	2	2
Released	2	2	3	2	2	3	3
Planting Seed	2	2	3	2	1	3	1
Exports	0	1	46	0	0	0	0
Total Consumption	835	672	768	813	667	640	460
Surplus/Deficit	162	153	295	128	127	100	159
Net Trade	9	6	12	3	7	0	-2
Ending Stocks	153	147	283	125	120	100	161

Source: BFAP, 2006:24; SAGIS, 2007:19; SAGIS, 2006:3; GRAINSA, 2007:3; NDA, 2006:7.

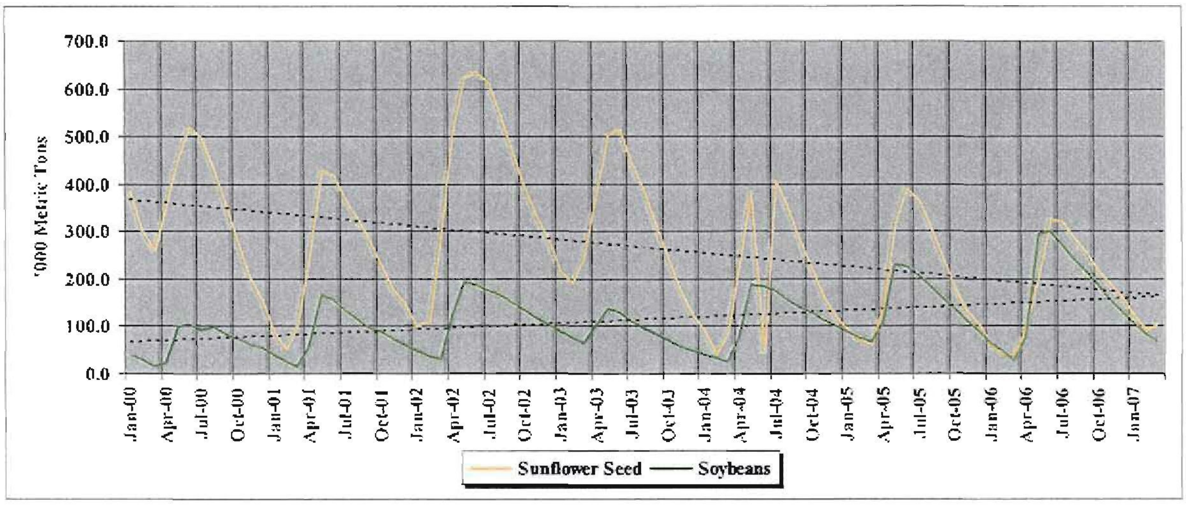
The main factors that influenced the 2006/07 production season's demand and supply were the weather conditions (that is the rainfall) and the decrease in the domestic price of sunflower seed in South Africa (BFAP, 2007:23; GRAINSA, 2007:3). However, the Bureau for Food and Agricultural Policy (BFAP) expects the production of sunflower seed in South Africa to exceed the utilisation of seed by the local crushers over the next few years. This will be the result when the production of bio-diesel from sunflower seed is expected to gain momentum. Even though the utilisation is anticipated to increase over the projected production seasons, it does not grow fast enough to accommodate the increase in production (BFAP, 2007:23).

In the 2000/01 production season the total consumption of sunflower seed in South Africa was 835,000 metric tons. However, due to low-cost imports of supplementary commodities (that is soybeans and palm oil) and a general decline in the production of sunflower seed, the total consumption decreased to approximately 460,000 metric tons during the 2006/07 production season. That was a decrease of roughly 45% over a period of seven years, due to cheaper alternatives (SAGIS, 2006:3; GRAINSA, 2007:3; NSA, 2006:13). The production and consumption of sunflower seed in South Africa can be determined by the closing stock of sunflower seed and the total amount of processed sunflower seed.

4.3.1.1 Closing stock of oilseeds

The calculation of the closing stock of sunflower seed in South Africa takes the following factors into account: the area harvested of sunflower seed (that is the opening stock of sunflower seed), the yield of sunflower seed per hectare (that is the deliveries of sunflower seed), and the importation of sunflower seed. The amount of processed sunflower seed in South Africa (excluding the sunflower seed crushed for oil and oilcake/meal), the amount of sunflower seed withdrawn by the South African grain industries, and the amount of sunflower seed released to the end consumers are, furthermore, included in the closing stock calculation. The amount of sunflower seed held for replanting purposes and the exporting of whole grain sunflower seed to neighbouring countries (that is if enough sunflower seed is produced to meet the local demand) comprise the final variables in the closing stock calculation. In summary, the closing stock will indicate the production and a number of the consumption factors of sunflower seed in South Africa (GRAINSA, 2007:3; SAGIS, 2006:3; SAGIS, 2007:19).

Figure 4-2 Closing stock of sunflower seed and soybeans in South Africa



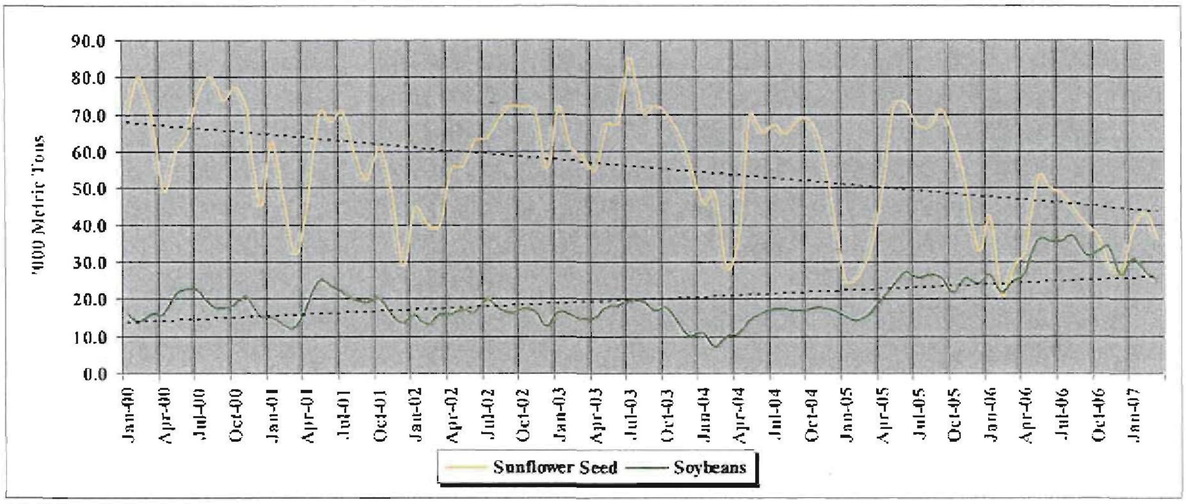
Source. SAGIS, 2006:26; SAGIS, 2007:19

Figure 4-2 reflects the closing stock of sunflower seed and soybeans in South Africa with definite trend lines. Since January 2006 the closing stock of sunflower seed (exhibiting a decreasing trend line) and the closing stock of soybeans (exhibiting an increasing trend line) moved (to a fair extend) as one. If the trends of the closing stock of both sunflower seed and soybeans continue, soybeans will in the near future become the principal oilseed crop in South Africa (SAGIS, 2006:3; SAGIS, 2007:19). This is mainly due to the oil content of soybeans (that is for the production of industrial vegetable oil) and the higher protein feed value of soybean oilcake/meal. See Table 4-11 for a protein feed nutrient comparison.

4.3.1.2 Processed oilseeds

The consumption of sunflower seed in South Africa is indicated by the total amount of sunflower seed utilised for the processing of sunflower oil and sunflower oilcake/meal. The amount of sunflower seed processed for consumption is determined by the demand (that is driven by the South African population and the average income per capita) for sunflower oil and sunflower oilcake/meal (GRAINSA, 2007:3; SAGIS, 2006:3). The income dynamics of the population of South Africa will directly determine the demand for beef, poultry, and dairy products. As a result, the protein feed requirements by the beef, poultry and dairy industries determine, to a large extent, the consumption of sunflower oilcake/meal in South Africa (GRAINSA, 2007:3; SAGIS, 2006:3; SAGIS, 2007:19).

Figure 4-3 Processed sunflower seed and soybeans in South Africa



Source: SAGIS, 2006:26; SAGIS, 2007:19.

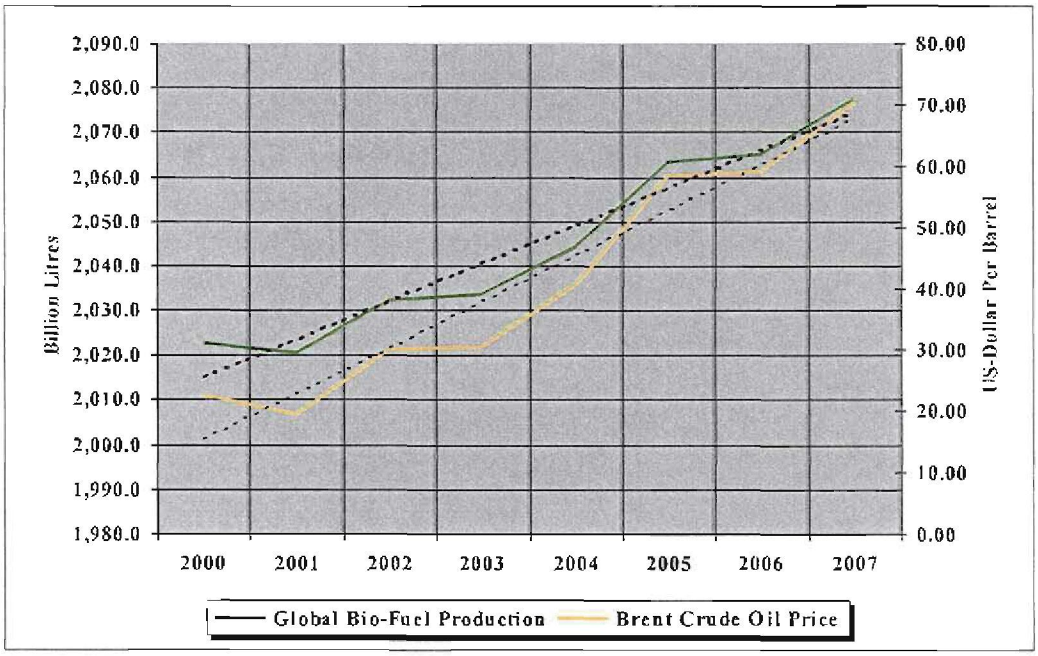
Figure 4-3 reflects the total amount of sunflower seed and soybeans processed in South Africa for use as sunflower oil and oilcake/meal or soybean oil and oilcake/meal respectively. As with the closing stock of sunflower seed and soybeans in South Africa (see Figure 4-2 above), the amount of metric tons of processed sunflower seed (with a decreasing trend line) and soybeans (with an increasing trend line) were comparatively level since January 2006. As previously noted, the continuation of the trends of both the amount of processed sunflower seed and processed soybeans will result in soybeans becoming the dominant oilseed crop in South Africa. This is due to rotational and crop substitution practices within the various oilseed crops for the production of bio-fuel (SAGIS, 2006:3; SAGIS, 2007:19).

4.3.1.3 Production of bio-fuel

In the face of higher Brent crude oil prices in South Africa, many farmers will seek to pass onto their consumers much of the additional costs associated with higher fuel bills (SAGIS, 2006:3; SAGIS, 2007:19). In a period of rapidly escalating fuel prices (that is where the prices of agricultural products are habitually marked upward to recover the additional costs of fuel and petroleum-related products) the inflationary pressures quickly rise further. This erodes the real purchasing power of fixed incomes and dividends (GRAINSA, 2007:3; Kingwell, 2003:4). When Brent crude oil prices ultimately escalate in the face of diminishing world reserves and the prospects for a recession emerge, then firstly (apart from energy resources) the commodity prices tend to fall (that is at least in real terms) (GRAINSA, 2007:3).

The depreciating Rand assists the agricultural industries that are export-orientated by lessening the demand reductions associated with a global recession. However, the price of imported inputs like machinery, fertilisers, chemicals, and fuel are made more expensive by the depreciation of the Rand, ultimately leading to higher domestic inflation (SAGIS, 2006:3; SAGIS, 2007:19). As a consequence of higher inflation, the South African Reserve Bank (SARB) will increase the repurchase rate to encourage economic growth by controlling inflation. Since a depreciation of the Rand causes inflation, SARB increases the nominal interest rate and thus increasing the interest payments on farming loans. Therefore, it is evident that in times of recession, political pressures frequently arise which generate more protectionist agricultural policies, which often harm agricultural commodity exporters. These policies reduce a country's access to overseas markets or lessen the competitiveness of a country's agricultural commodities in these markets (GRAINSA, 2007:3; Kingwell, 2003:4; SAGIS, 2006:3).

Figure 4-4 Brent crude oil price and global bio-fuel production



Source: EconStats, 2007:18, FAPRI, 2007:318.

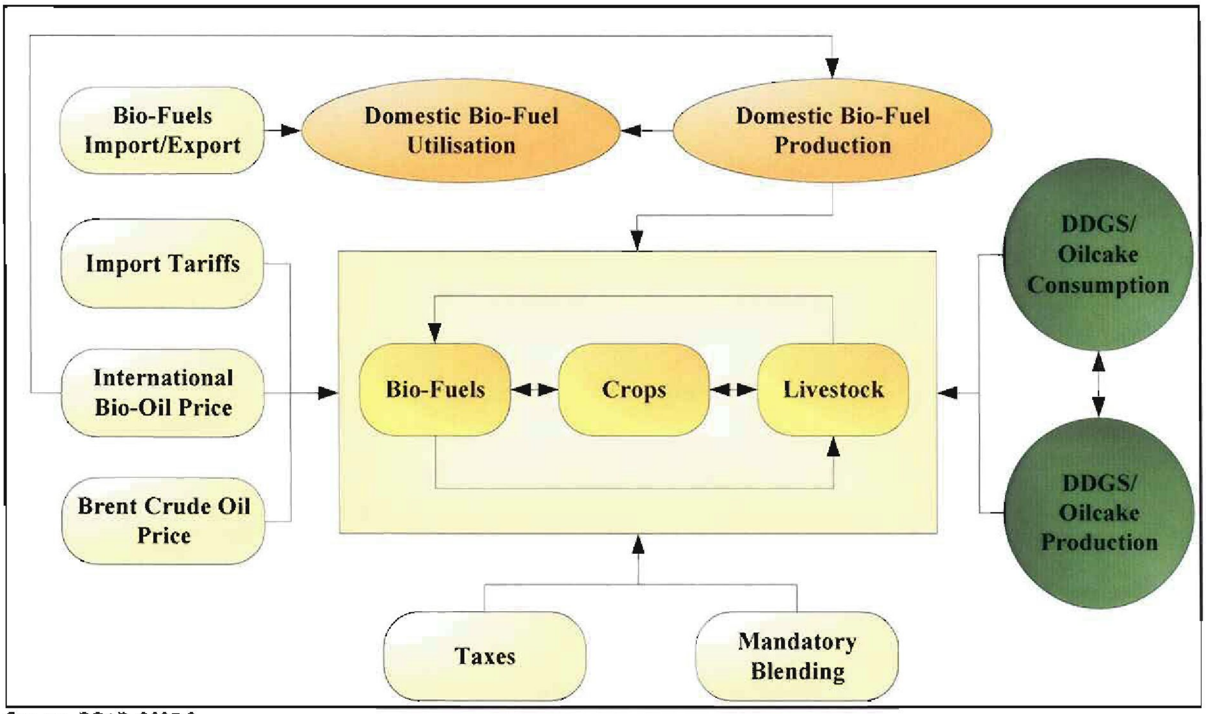
If cost-effective energy sources and technologies are not hastily developed as the Brent crude oil stocks deplete, the rising fuel prices will encourage both inflation and a global recession (GRAINSA, 2007:3; Kingwell, 2003:4). The economic penalty for the South African agricultural industry will be mixed, depending on the export orientation of the industry and their dependence on imported goods and loans (SAGIS, 2007:19). As Brent crude oil prices increase, substitute and complementary energy sources will become increasingly utilised such as blended fuels, synthetic oil and natural gas (see Figure 4-4). Subsequently, the technologies that deliver further fuel economy (that is bio-fuels) will also become more competitive (Kingwell, 2003:7). Farmers may find various market opportunities in the growing of high-yielding industrial vegetable oil crops that are suitable for blended fuels. Animal fat and other oils may also become attractive alternatives to process into fuel components. Eventually bio-fuels will become more and more competitive with the rising prices of energy which will trigger the development and the utilisation of other technologies from which all sectors will benefit. The speed and success with which these new technologies can be developed will determine how prolonged the adverse consequences are of the decline in the Brent crude oil reserves and the associated shortages (GRAINSA, 2007:3; Kingwell, 2003:5; SAGIS, 2006:3).

The BFAP (2007) released a report that discusses the different means of producing bio-fuels in South Africa. The report evaluated the impact that critical elements may have on the ethanol and bio-diesel production plants in South Africa. The report made use of a scenario planning exercise to point out the critical factors that determine the economical feasibility of ethanol and bio-diesel production (BFAP, 2007:7; GRAINSA, 2007:3). BFAP has developed the capacity to model the bio-fuels industry on a system of equations that interact directly with the crop and livestock industries. The new BFAP sector model now has the ability to simulate the impact of various policy scenarios and macroeconomic factors on the potential bio-fuels industry in South Africa. In summary, it takes the dynamic interaction between the different field crops, livestock industries, and government policies into account to simulate the possible impact a bio-fuels industry could have on South Africa (SAGIS, 2007:19).

The field crops in South Africa such as sunflower seed, soybeans, and maize comprise the source of supply for the bio-fuels industry and their prices will influence the competitiveness and feasibility of the bio-fuels industry (BFAP, 2007:8; SAGIS, 2007:19). The livestock sector acts as the uptake market for the by-product, which implies that the price at which the by-product sells, is determined in the livestock market. Depending on how the government structures the policy and incentive program, the price of ethanol and bio-diesel is mainly a function of the retail price of fuel (see Figure 4-4). Figure 4-5 displays graphically how the model reaches equilibrium and how the interactions between the different industries take place (BFAP, 2007:8; GRAINSA, 2007:3). The bio-fuels section within the model is influenced by fuel taxes, import tariffs and a number of macroeconomic factors such as the international Brent crude oil price, international vegetable oil prices, and the Rand/US-Dollar exchange rate.

The demand and supply dynamics within each of the industries are solved until the model reaches equilibrium. The by-products of ethanol production from maize (that is dried distillers feed with soluble -- DDGS) and bio-diesel production from soybeans and sunflower seed (that is the oilcake/meal) will compete in the feed market as alternative sources of protein (see Figure 4-5). Only commercial crops (that is maize, sugar, soybeans and sunflower seed) are currently taken into consideration in the BFAP sector model for the potential production of bio-fuels in South Africa.

Figure 4-5 South African grain, livestock and bio-fuels sector model



Source: BFAP, 2007:8.

The 2004/05 production season serves as a typical example of where the maize prices decreased to export parity levels due to a large surplus (refer paragraph 4.5.3.1). In this specific season the strong Rand/US-Dollar exchange rate[22] together with the average international prices, led to very low export parity prices (BFAP, 2007:7; GRAINSA, 2007:3). In fact the price of yellow and white maize decreased to levels where the majority of the South African maize farmers could not produce economically. As a result, the large carry over stocks fuelled the debate to find alternative uses for the surplus production of maize. Other drivers such as the South African government's commitment to produce renewable energy of 10,000 GW by 2013, of which a

[22] *The Rand/US-Dollar exchange rate remains one of the strongest driving factors of agricultural price levels and trade volumes of food products in the South African agricultural sector (Killian, 2006:1; Berg, 2006:1).*

certain percentage needs to come from the production of bio-fuels, has automatically involved the government in the debate on bio-fuels. In the years to come the production of oilseeds must increase to meet the growing demand arising from the production of bio-fuels in South Africa (BFAP, 2007:7; GRAINSA, 2007:3; SAGIS, 2007:19).

4.3.2 Provincial level

South Africa is divided into nine provinces (that is the Western Cape, Northern Cape, Eastern Cape, Free State, KwaZulu-Natal, Mpumalanga, Limpopo, Gauteng, and the North-West Province). The production and consumption of sunflower seed will be analysed on a provincial and regional level. This is because some of the production regions include two or more provinces. One of the most important factors on the supply side of an agricultural crop is to identify the total number of sunflower seed harvested during a specific production season. Hence, to calculate the total production of sunflower seed in South Africa, it is necessary to analyse the total area harvested.

4.3.2.1 Area harvested

Table 4-2 indicates the area of sunflower seed grown for each of the nine provinces of South Africa. The provincial areas that are utilised to plant sunflower seed are indicated for each production season. Although the highest area harvested for the period ending 2002/03 was 667,510 hectares, this still did not surpass the 1998/99 historic high of 828,000 hectares. This historic high was the result of the increase in the international sunflower price and the higher global demand (SAGIS, 2006:3; GRAINSA, 2007:3).

Table 4-2 Area of sunflower seed grown in South Africa

Province	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	Average
(Thousand Hectares)								
Western Cape	0.00	0.00	0.00	0.35	0.38	0.30	0.08	0.16
Northern Cape	0.25	0.25	0.25	0.30	0.56	0.50	1.20	0.47
Eastern Cape	0.10	0.20	0.20	0.20	0.26	0.20	0.20	0.19
Free State	180.00	195.00	305.00	290.00	212.50	185.00	170.00	219.64
Kwazulu-Natal	0.00	0.05	0.06	0.10	0.00	0.00	0.00	0.03
Mpumalanga	22.00	20.00	30.00	40.00	34.00	29.00	45.00	31.43
Limpopo	28.00	29.00	40.00	37.00	25.00	40.00	45.00	34.86
Gauteng	6.00	7.20	12.00	13.50	17.30	10.00	11.00	11.00
North-West	160.00	270.00	280.00	225.00	240.00	195.00	200.00	224.29
Total	396.35	521.70	667.51	606.45	530.00	460.00	472.48	522.07

Source: SAGIS, 2006:3; GRAINSA, 2007:3, NDA, 2006:7.
Note: Years are production seasons.

The provinces with the largest area devoted to the planting of sunflower seed are the North-West Province and the Free State with an average area of approximately 224,290 and 219,640 hectares respectively (see Table 4-2). This is mainly due to the favourable soil and weather conditions of those provinces for the planting and harvesting of sunflower (BFAP, 2007:23).

As previously mentioned, during the 2002/03 production season the total area harvested increased to 667,510 hectares. In addition, this was also due to the relative high returns of sunflower seed when it was compared to maize (BFAP, 2005:21). After the production success of sunflower seed in the 2002/03 production season, the annual area of sunflower seed planted decreased steadily to approximately 472,480 hectares during the 2006/07 production season. The key reasons responsible for this decrease were the persistent drought conditions in South Africa and the low domestic sunflower seed price offered to farmers for their product (SAGIS, 2006:3; GRAINSA, 2007:3).

4.3.2.2 Yield of the sunflower plant

Another important crop production factor for sunflower seed is the yield of the crop. Table 4-3 is a summary of all the provinces in South Africa with their yearly and provincial yield averages. The best average yields per province were achieved by the Northern Cape (an average yield of 2.26 tons per hectare) and Gauteng Province (an average yield of 1.40 tons per hectare). However, even though these provinces had the largest yield potential, they are not considered the major producer regions of sunflower seed in South Africa. This is due to limiting factors specific to each province for instance, in Gauteng there is a shortage of adequate agricultural land and in the Northern Cape there are changing weather conditions (SAGIS, 2006:3; NSA, 2006:13; SAGIS, 2007:19).

Table 4-3 Yield per hectare of sunflower seed in South Africa

Province	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	Average
(Metric Tons per Hectares)								
Western Cape	-	-	-	1.00	1.00	1.50	1.00	1.13
Northern Cape	3.70	2.70	2.00	2.40	1.52	2.00	1.50	2.26
Eastern Cape	1.00	0.75	1.00	1.20	1.04	1.20	1.20	1.06
Free State	1.46	1.30	1.45	1.14	1.30	1.41	1.21	1.32
Kwazulu-Natal	2.11	2.11	1.50	1.00	0.00	0.00	0.00	0.96
Mpumalanga	1.10	1.15	1.75	1.12	1.35	1.57	1.25	1.33
Limpopo	1.20	0.90	1.25	0.60	1.48	0.90	0.91	1.03
Gauteng	1.50	1.50	1.50	1.20	1.30	1.40	1.40	1.40
North-West	1.25	1.20	1.30	1.01	1.10	1.35	1.00	1.17
Average	1.67	1.45	1.47	1.19	1.12	1.26	1.05	-

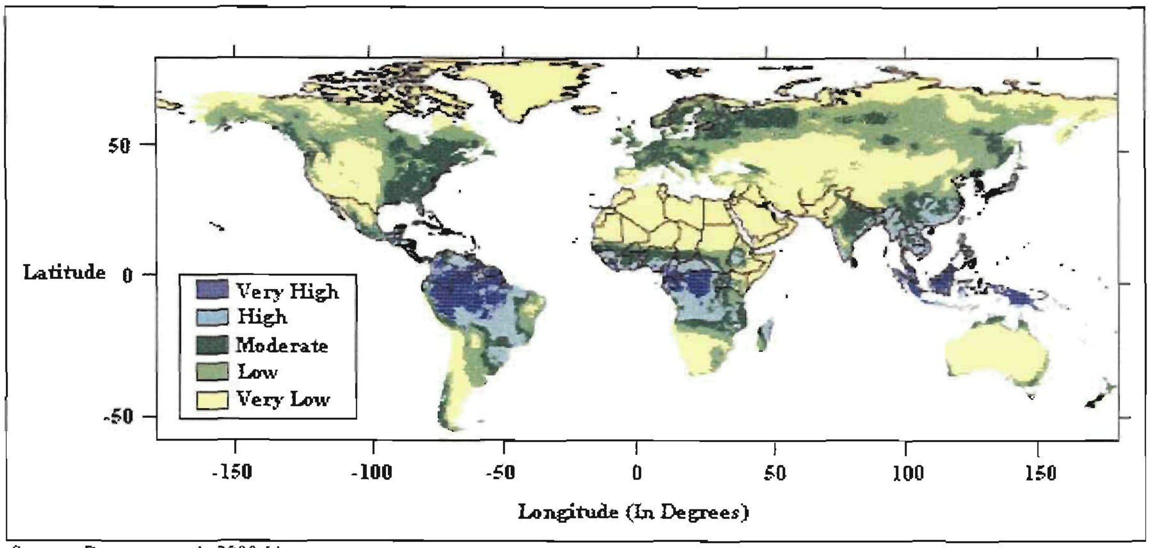
Source: SAGIS, 2006:3; GRAINSA, 2007:3; NDA, 2006:7.
Note: Years are production seasons.

The principal production regions (provinces) of sunflower seed in South Africa are the North-West and Free State Provinces. They have average yields of 1.17 and 1.32 tons per hectare respectively (see Table 4-3). The cultivation methods of the soil utilised for the production of sunflower seed and the average annual rainfall are the main influences to the annual yield of sunflower seed (GRAINSA, 2007:3; BFAP, 2007:23). The next segment discusses the general South African soil and weather patterns.

4.3.2.3 Soil and rainfall conditions

Figure 4-6 depicts the potential for rain-fed agriculture as expected by using the International Water Management Institute's (IWMI) climate atlas, the global soil-water-holding capacity map, and the soil-water and crop model. The four basic groups identified in the IWMI's rain-fed agricultural map are defined (randomly to some extent) at the estimated production levels of 0 – 3,500 kg/ha, 3,501 – 7,500 kg/ha, 7,501 – 12,500 kg/ha and higher than 12,501 kg/ha. These are for very low, low, moderate, high, and very high suitability respectively (Droogers, Seckler, and Makin, 2001:10). The extensive areas where the potential yields of purely rain-fed agriculture are zero are striking. The distribution in the area of these groups indicates that approximately 46% of the earth's surface is unsuitable for rain-fed agriculture (see Figure 4-6).

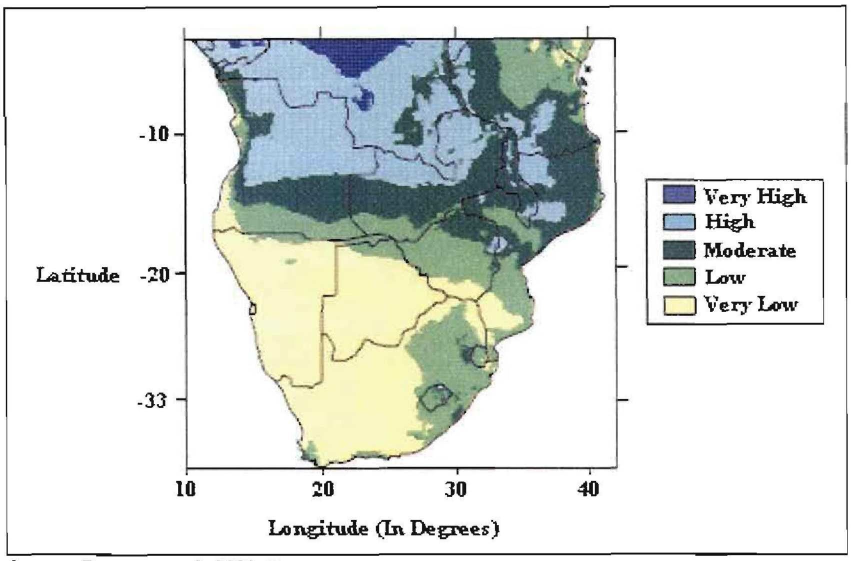
Figure 4-6 Global rain-fed agriculture



Source: Droogers *et al.*, 2000:11

This is due to the limitations in the climatic conditions of the world (GRAINSA, 2007:3; SAGIS, 2006:3; SAWS, 2007:26). This leaves roughly 7 billion hectares with a potential for rain-fed crop production, from which an area of 4.7 billion hectares is classified as moderately, highly or very highly suitable. According to values from the World Resources Institute (WRI), 1.5 billion hectares are currently cropped (that is utilised for agriculture). The remaining hectares most probably comprise the forests, grasslands and wetlands of the world (Droogers *et al.*, 2001:10).

Figure 4-7 Rain-fed agriculture in sub-Saharan Africa



Source: Droogers *et al.*, 2000:11

Figure 4-7 shows a detailed map of the potential for rain-fed agriculture in sub-Saharan Africa. It is evident that the potential for rain-fed crop production are almost zero in Namibia and Botswana. In addition, the WRI signified that substantial parts of South Africa and Mozambique have low rain-fed production potential. As a result only rainwater harvesting techniques, irrigated agriculture, or extensive livestock activities can sustain food supply in these countries (Droogers *et al.*, 2001:10).

Table 4-4 Rain-fed potential for some selected countries

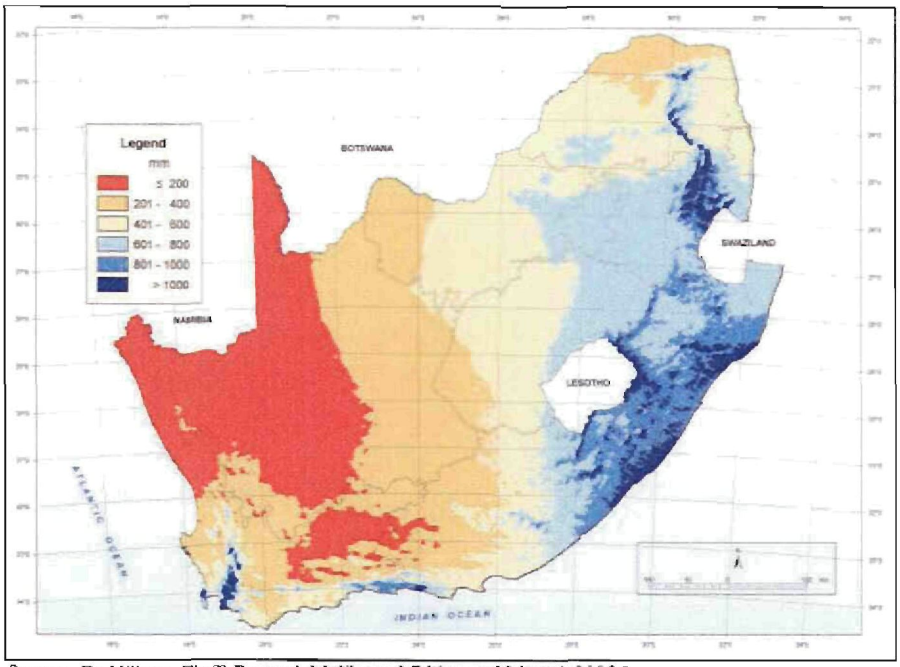
Region	Land Area	Rain-Fed Potential		Actual Cropped WRI	Irrigation WRI
		All	Suitable		
	(Thousand Hectares)				%
World	13 614 741	7 343 920	4 740 047	1 459 338	17
USA	794 270	392 021	272 374	189 799	11
Spain	48 240	12 362	2 615	20 512	18
Pakistan	87 310	4 951	2 009	20 330	80
India	317 649	252 456	195 107	169 078	29
Morocco	41 199	337	0	8 352	13
South Africa	122 125	39 940	2 841	13 169	8

Source: Droogers *et al.*, 2001:12.
Note: The rain-fed potential areas (all and suitable) are classified as ranging from low to very high. The actual cropped area and percentage of cropland irrigated are presented by the World Resources Institute (2000).

Based on the analysis presented in Table 4-4 above, it is clear that countries such as the USA and India do not fully develop their potential area (see Table 4-4). This is in contrast to Spain, Pakistan, Morocco and South Africa which have larger actual cropped areas than potential areas. This can be due to such factors as runoff, fallowing and other kinds of irrigation factors (Droogers *et al.*, 2001:11). It should be stressed that the values for potential areas are only defined by using the climate and soil water as restrictive factors and by ignoring the fact that other commitments are made to land. Countries where the actual cropped area is larger than the potential cropped area might have a fair amount of crops irrigated (for example Pakistan) or are using large areas with only limited suitability for rain-fed agriculture (for example South Africa). The values for Spain are somewhat peculiar as the actual cropped area is much larger than the potential cropped area, while the percentage irrigated is quite low (Droogers *et al.*, 2001:11; SAGIS, 2006:3; SAWS, 2007:26).

The rainfall pattern of South Africa is generally divided into the drier Western and the wetter Eastern regions (see Figure 4-8). It can be said that an imaginary 500 millimetres annual rainfall line exists that runs from North to South and divides South Africa into more or less equal parts. The drier Western part is considered to be unsuitable for regular crop production and consists of the Northern Cape, the majority of the Western and Eastern Cape and the arable areas in the higher rainfall Eastern parts. Crop production in the higher rainfall Eastern region is limited by the large areas of steeply undulating hills or mountainous terrain such as can be found in Mpumalanga, Limpopo and KwaZulu-Natal.

Figure 4-8 Annual rainfall map of South Africa



Source: De Villiers, Eloff, Barnard, Mulibana, Mkhize, and Msomi, 2005:2.

In addition, most of the soils in the higher rainfall area which are derived from parent material producing unstable highly erode-able soils are non-arable. Over 60% of South Africa receives less than 500 millimetres rain per year, which is theoretically the minimum rainfall necessary for a successful dry land cropping system, while 21% of South Africa receives less than 200 millimetres annually (De Villiers *et al.*, 2005:2). The annual rainfall in South Africa is seasonal and extremely variable with extensive deviations from the mean annual rainfall. This is especially eminent in the low rainfall areas. However, high energy rainstorms that contribute to soil runoff, soil crusting, and compaction (these are all yield limiting factors) are the rule rather than the exception in South Africa (De Villiers *et al.*, 2005:1; GRAINSA, 2007:3).

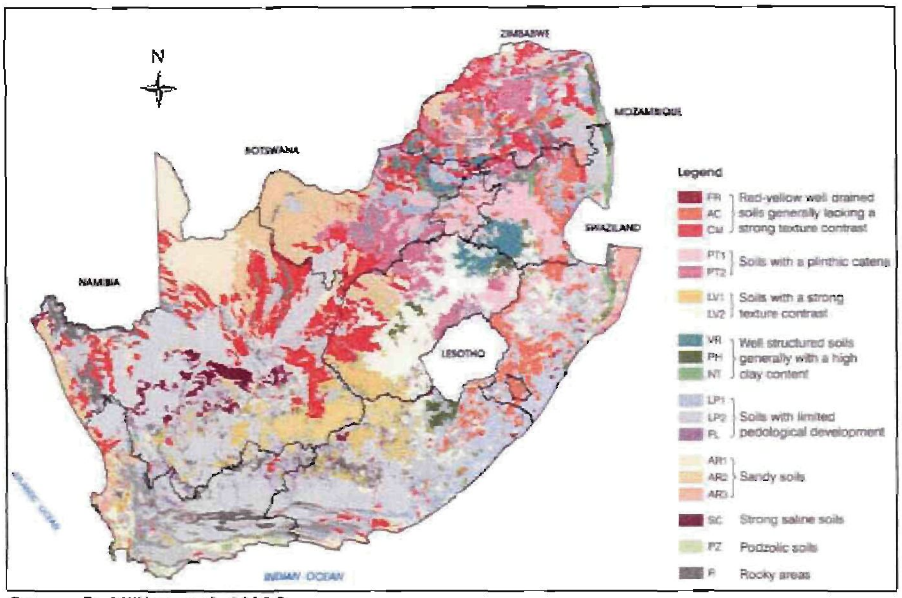
Neither drought nor floods are uncommon in South Africa and the high summer temperatures and cloudless days are the foundation of a high evaporation rate. Approximately 91% of South Africa consists of arid, semi-arid, or dry sub-humid areas (see Figure 4-8) and the evaporation-transpiration (varying from 1,100 - 3,000 millimetres per year) far exceeds the annual rainfall (De Villiers *et al.*, 2005:3). The quantity and quality of water in South Africa may be key constraints for the country's vision of sustainable agricultural and rural development, with the probability of South Africa becoming a water scarce country by 2025 (De Villiers *et al.*, 2005:3; GRAINSA, 2007:3).

Sunflower seed plants are dependent on the first rain of the season to aid their germination process. However, with the probability of water becoming a scare commodity, the amount of rainfall may have an adverse influence on the production of sunflower seed in South Africa. The soil properties of South Africa are of particular concern for the production of sunflower seed and other crops. Soil quality is directly associated with the natural limitations of sunflower seed production as well as its vulnerability to chemical, physical, and biological degradation. The major forms of land deprivation are soil acidity and alkalinity, nutrient, and biological depletion, erosion, compaction, crusting and pollution, and the degeneration of the fragile dry land ecosystems. In the years to come this land degradation could progressively cause desertification if it is not stopped and reversed (De Villiers *et al.*, 2005:1; GRAINSA, 2007:3).

The diversity in South African soil is attributed to certain soil formation factors such as the climate and parent material. This, in conjunction with various weathering processes, resulted in the country's complex soil mantle with its large variation in soil properties (De Villiers *et al.*, 2005:1). The surface of South Africa (that is the soil mantle) is composed of approximately 81%

Calcareous[23] and Eutrophic[24] soils, 12% Mesotrophic[25], and 7% Dystrophic[26] soil. Over 30% of the South African surface area (see Figure 4-9) contains sandy soils with a clay content of less than 10%. As a result, approximately 60% of the soils have a low soil organic matter (SOM) content. This contributes to the low soil productivity and soil degradation in South Africa (De Villiers *et al.*, 2005:1).

Figure 4-9 Soil pattern map of South Africa



Source: De Villiers *et al.*, 2005:2

Table 4-5 indicates the total production of South African sunflower seed on a provincial level, total production for the different production seasons and the average production for each province. The North-West Province and the Free State (that is the provinces with the largest area devoted to the planting of sunflower seed) are the largest producers of sunflower seed. Their

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[23] *Refers to a sediment, sedimentary rock or soil type that is formed from or contains a high proportion of calcium carbonate in the form of calcite or aragonite. It is also used to refer to relatively alkaline soil. This is frequently due to a high calcareous content, but there are other causes for a high soil pH (Wikipedia, 2007:20).*

[24] *The increased content of nitrates in the soil frequently leads to undesirable changes in the vegetation composition. Many plant species are endangered as a result of eutrophication in terrestrial ecosystems. These ecosystems are overgrown by faster growing and more competitive species-poor vegetation (like tall grasses), that can take advantage of the unnaturally elevated nitrogen levels. Consequently, the area may be changed beyond recognition and vulnerable species may be lost (Wikipedia, 2007:20).*

[25] *Mesotrophic soils are soils that have moderate nutrient levels (Wikipedia, 2007:20).*

[26] *It is a low natural productive soil with a strong weathered profile. This soil is frequently of shallow depth (Wikipedia, 2007:20).*

average production amounts to 252,170 and 289,170 metric tons respectively (see Table 4-5) (SAGIS, 2006:3; GRAINSA, 2007:3; NSA, 2006:13).

Table 4-5 Production of sunflower seed in South Africa

Province	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	Average
(Thousand Metric Tons)								
Western Cape	0.00	0.00	0.00	0.10	0.00	0.40	0.00	0.07
Northern Cape	0.90	0.10	0.60	1.30	1.20	0.70	0.80	0.80
Eastern Cape	0.00	0.00	0.10	0.10	0.00	0.00	0.00	0.03
Free State	256.00	254.50	444.40	314.20	276.00	275.40	203.70	289.17
Kwazulu-Natal	0.00	0.30	0.10	0.10	0.00	0.00	0.30	0.11
Mpumalanga	54.50	59.30	63.90	39.80	43.4	41.10	43.20	50.30
Limpopo	21.30	19.80	44.00	48.50	44.40	43.10	61.10	40.31
Gauteng	17.10	18.80	28.10	23.00	23.20	12.90	14.20	19.61
North-West	195.00	311.60	333.00	228.90	263.20	240.70	192.80	252.17
Total	544.80	664.40	914.20	656.00	608.00	614.30	516.10	652.59

Source: SAGIS, 2006:3; GRAINSA, 2007:3; NDA, 2006:7; SAGIS, 2007:19.
Note: Years are production seasons.

During the 1998/99 production season South Africa produced 1,109,000 metric tons of sunflower seed. However, without the protection of the Oilseed Board and the availability of economical imports from the major sunflower production countries, South Africa gradually decreased its production of sunflower seed to approximately 516,100 metric tons in the 2006/07 production season (SAGIS, 2006:3; GRAINSA, 2007:3). Another reason for this major decline in the production of sunflower seed in South Africa is the general weather pattern, mainly the El Niño/Southern Oscillation[27] (that is ENSO in short) effect (SAGIS, 2007:19).

4.3.2.4 Average production cost and profitability per hectare

The examination of the consumption and production of sunflower seed in South Africa will not be complete without an assessment of the average production cost (that is the input prices) per hectare. The average production cost per hectare's information was gathered by the South African Grain Information Service (SAGIS) and by Grain South Africa (GRAINSA). The sample utilised for the assembling of the information consisted of the largest farmers of sunflower seed for each production-region in South Africa. A mathematical average of the main influences on the production price per hectare was identified. Certain weights in the form of an average price per hectare were assigned to the particular factors that influence the production of

[27] *It is an abnormal warming of the surface ocean waters in the Eastern tropical Pacific (one part of what is called the Southern Oscillation). The Southern Oscillation is the see-saw pattern of reversing surface air pressure between the Eastern and Western tropical Pacific. When the surface pressure is high in the Eastern tropical Pacific it is low in the Western tropical Pacific and vice versa (NASA, 2007:23).*

sunflower seed for a specific production region. As previously mentioned (see Table 4-2), the major planter provinces of sunflower seed in South Africa is the North-West Province and the Free State. These two provinces are also the largest producers of sunflower seed in South Africa (see Table 4-5). Therefore, it is crucial to discuss these two provinces' average production in detail and attempt to identify crucial production factors that influence the price of sunflower in South Africa.

The North-West Province and the Free State are divided into three summer production regions, which are the North-West (NW) region, North-West – Free State (NW-FS) region, and the Eastern Free State (EFS) region (SAGIS, 2006:3; GRAINSA, 2007:3). Each of these regions will be discussed and analysed in detail in anticipation of identifying potential factors. These factors could ultimately lead to the construction of a series of price models for sunflower in South Africa. Table 4-6, Table 4-7, and Table 4-8 show the average production cost and profitability per hectare of sunflower seed for the NW, NW-FS, and the EFS regions respectively. Furthermore, these tables detail the variable cost, capital cost, income, and profit/loss attributable to these regions from the production of sunflower seed.

4.3.2.4.1 North-West region

According to Table 4-6 the key variable costs for the NW region are the cost of sunflower seed for planting, the cost of fertiliser and lime for soil cultivation, and the price of fuel (that is diesel for the tractors, planters and harvesters). Additional production factors that were identified are the repairs and parts for the tractors, planters and harvesters, the permanent labour cost, and the interest on production credit (that is the interest on a loan). These variable costs are factors which influence the production price of sunflower in South Africa. As a result, they must be kept in mind when constructing a series of models for the South African sunflower price.

The total cost per hectare of the NW region (see Table 4-6) provides a summarised overview of the production costs for the seven production seasons under inspection. The substantial increase in the total cost per hectare (that is on a periodic basis) influenced the total production of the NW region negatively. During the 2002/03, 2003/04, 2005/06, and 2006/07 production seasons the NW region produced sunflower seed at an average loss per hectare and per ton (SAGIS, 2006:3; GRAINSA, 2007:3; SAGIS, 2007:19).

Table 4-6 North-West region's sunflower seed industry

Production Season	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	Average
Variable Cost								
Seed	83.88	91.11	113.16	102.86	104.69	117.50	125.40	105.51
Fertiliser & Lime	133.09	277.23	305.30	248.23	285.75	334.34	371.68	279.37
Weed Control	41.18	34.18	73.55	68.88	78.46	85.07	97.31	68.38
Pest Control	5.67	11.39	8.23	9.54	10.45	11.37	12.14	9.83
Fuel	257.01	275.58	239.20	309.66	330.95	300.76	350.91	294.87
Repairs & Parts	178.42	279.20	359.99	308.39	315.91	399.18	446.25	326.76
Crop Insurance	13.94	41.55	91.07	54.98	22.51	93.55	110.81	61.20
Casual Labour	60.24	37.59	37.15	32.55	35.10	37.15	37.59	39.62
Marketing Cost	23.20	44.64	62.74	63.67	63.42	83.44	97.39	62.64
Drying & Cleaning	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Permanent Labour	163.54	146.92	160.01	186.11	195.51	184.35	192.43	175.55
Interest on Production Credit	83.72	84.57	114.72	114.72	93.24	130.22	142.54	109.10
Contract Work	34.46	80.18	48.77	44.78	53.34	51.94	51.89	52.19
Other Cost	57.53	60.79	147.94	184.48	174.19	229.69	276.49	161.59
Total Variable Cost	1 135.88	1 464.93	1 761.83	1 728.85	1 763.52	2 058.52	2 312.82	1 746.62
Capital Cost								
Machinery & Equipment:								
Depreciation	158.80	169.91	147.90	147.90	147.90	150.43	150.33	153.31
Interest	238.20	254.85	221.85	221.85	221.85	234.43	235.65	232.67
Fixed Improvements:								
Interest	49.52	49.52	49.52	51.20	52.38	52.38	52.38	50.99
Depreciation	13.20	13.20	13.20	14.30	15.40	16.50	17.60	14.77
Repairs & Maintenance	15.80	15.80	15.80	15.80	15.80	15.80	15.80	15.80
Total Capital Cost	475.52	503.28	448.27	451.05	453.33	469.54	471.76	467.54
Total Cost per Hectare	**1 611.40**	**1 968.21**	**2 210.10**	**2 179.90**	**2 216.85**	**2 528.06**	**2 784.58**	**2 214.16**
Yield (tons/ha)	1.40	1.70	1.10	1.12	1.40	0.97	1.05	1.25
Cost (R/ton)	1 151.00	1 157.77	2 009.18	1 946.34	1 578.80	2 606.25	2 651.98	1 871.62
Income								
Producer Price (R/ton)	1 313.99	2 233.03	1 809.13	1 874.26	1 663.91	2 121.83	2 247.52	1 894.81
Per Hectare	1 839.59	3 796.15	1 990.04	2 099.17	2 336.37	2 058.18	2 359.90	2 354.20
Profit/Loss								
Per Hectare	228.19	1 827.94	-220.06	-80.73	119.52	-469.88	-424.68	140.04
Per Ton	162.99	1 075.26	-200.05	-72.08	85.12	-484.42	-404.46	23.19

Source: SAGIS, 2006:3, GRAINSA, 2007:3; NDA, 2006:7.
Note: The costs are in South African Rand (ZAR).

4.3.2.4.2 North-West – Free State region

The second summer production region in South Africa is the NW-FS region (see Table 4-7). According to the SAGIS and GRAINSA, the main factors that influence the production of sunflower seed in the NW-FS region are the cost of sunflower seed for the planting of sunflower seed, the cost of fertiliser and lime for the cultivation of the highly acidic soil, the price of fuel, and crop insurance (that is to indemnify the crop against fire and unfavourable weather conditions). Additional factors identified are repairs and parts for the tractors, planters and harvesters, the cost of permanent labour, and the interest on production credit. The production factors of the NW-FS region were generally the same as the factors of the NW region, with the exception of an additional factor for the NW-FS region, namely crop insurance (see Table 4-7). This is due to the higher risk associated with the cultivation of the land and the inconsistent weather conditions for this region (GRAINSA, 2007:3).

Table 4-7 North-West - Free State region's sunflower seed industry

Production Season	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	Average
Variable Cost								
Seed	76.72	86.32	93.06	150.71	161.79	158.88	181.75	129.89
Fertiliser & Lime	191.56	410.43	473.30	555.12	629.09	695.99	811.35	538.12
Weed Control	14.05	38.70	52.30	62.28	21.51	81.41	97.23	52.50
Pest Control	5.08	12.90	5.81	12.87	12.95	14.64	16.21	11.49
Fuel	235.12	348.16	337.91	280.99	293.26	332.39	345.12	310.42
Repairs & Parts	182.46	247.87	246.25	268.25	228.36	300.15	325.72	257.01
Crop Insurance	45.77	99.86	129.97	122.82	75.38	164.92	191.05	118.54
Casual Labour	5.26	20.49	19.98	12.84	36.77	20.20	22.42	19.71
Marketing Cost	9.59	30.33	35.23	36.86	3.60	49.68	58.35	31.95
Drying & Cleaning	0.00	0.00	0.00	3.21	0.00	1.61	1.93	0.96
Permanent Labour	102.84	167.11	143.19	161.48	190.50	181.66	196.86	163.38
Interest on Production Credit	78.01	140.12	123.03	117.18	106.37	139.69	149.73	122.02
Contract Work	33.40	58.62	57.67	115.73	94.91	127.87	152.47	91.52
Other Cost	73.29	127.74	162.84	182.78	158.42	227.56	263.91	170.93
Total Variable Cost	1 053.15	1 788.65	1 880.54	2 083.12	2 012.91	2 496.61	2 814.09	2 018.44
Capital Cost								
Machinery & Equipment:								
Depreciation	176.20	176.20	176.20	176.20	176.20	176.20	176.20	176.20
Interest	264.30	264.30	264.30	264.30	264.30	264.30	264.30	264.30
Fixed Improvements:								
Interest	52.35	52.35	52.35	53.45	54.55	54.66	55.21	53.56
Depreciation	13.96	13.96	13.96	14.67	15.78	13.98	16.78	14.73
Repairs & Maintenance	32.22	73.89	75.20	35.16	74.68	56.65	57.66	57.92
Total Capital Cost	539.03	580.70	582.01	543.78	585.51	565.79	570.15	566.71
Total Cost per Hectare	**1 592.18**	**2 369.35**	**2 462.55**	**2 626.90**	**2 598.42**	**3 062.40**	**3 384.24**	**2 585.15**
Yield (ton/ha)	1.51	1.86	1.57	1.48	1.63	1.51	1.47	1.58
Cost (R/ton)	1 054.42	1 273.84	1 568.50	1 774.93	1 595.69	2 028.08	2 299.08	1 656.36
Income								
Producer Price (R/ton)	1 112.00	2 238.79	1 721.98	2 044.45	1 546.51	2 349.44	2 577.49	1 941.52
Per Hectare	1 679.12	4 164.15	2 703.51	3 025.79	2 518.34	3 547.65	3 794.07	3 061.80
Profit/Loss								
Per Hectare	86.94	1 794.80	240.96	398.89	-80.09	485.25	409.83	476.65
Per Ton	57.58	964.95	153.48	269.52	-49.18	321.36	278.42	285.16

Source: SAGIS, 2006:3; GRAINSA, 2007:3; NDA, 2006:7.
Note: The costs are in South African Rand (ZAR)

The production factors identified for the NW-FS region are factors that influence the production price of sunflower in South Africa and also need to be considered when constructing a series of South African sunflower price models. The NW-FS region is on average the most profitable summer production region of sunflower seed in South Africa. The only average loss (per hectare and per ton) recorded for this region was during the 2004/05 production season (see Table 4-7).

This was due to the low price offered for sunflower seed in South Africa and the high total costs during the 2004/05 production season (GRAINSA, 2007:3; SAGIS, 2007:19).

4.3.2.4.3 Eastern Free State region

The EFS is the final influential summer production region of sunflower seed in South Africa (see Table 4-8). The cost of sunflower seed for planting, the cost of fertiliser and lime for the cultivation of the soil, and the cost of fuel were identified as influential factors for this production region. Additional factors are costs in respect of tractor repairs and parts for the planters and harvesters, crop insurance, and permanent labour. The final factor that influences the production price of sunflower in the EFS region is the interest on production credit.

Table 4-8 Eastern Free State region's sunflower seed industry

Production Season	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	Average
Variable Cost								
Seed	108.73	177.00	104.00	92.00	132.00	111 21	107.36	118.90
Fertiliser & Lime	239.78	216.00	322.00	292.00	336.00	361.69	388.53	308.00
Weed Control	58.88	111.00	50.00	38.00	9.00	1.55	-15.73	36.10
Pest Control	40 08	50.00	35.00	70.00	7.00	26 57	21.95	35.80
Fuel	250.56	270.00	344.00	261.00	392.00	385.68	413.06	330.90
Repairs & Parts	250.56	352.00	402.00	301.00	403.00	376.72	396.85	354.59
Crop Insurance	41.30	256.00	194.00	108.00	154.00	173.88	181 62	158.40
Casual Labour	1.00	1.00	9.00	12.00	5.00	11.30	13.20	7.50
Marketing Cost	25 97	10.00	52.00	27.00	41.00	45.31	50.02	35.90
Drying & Cleaning	10.70	7.00	21.00	26.00	17.00	25.82	28.98	19.50
Permanent Labour	118.77	165.00	177.00	151.00	233.00	233.29	254.74	190.40
Interest on Production Credit	100.95	150.79	129.99	93 18	104.82	107.70	103.29	112.96
Contract Work	61.82	61.00	32.00	69.00	27.00	54.09	53.34	51.18
Other Cost	65.43	98.00	115.00	106.00	110.00	130.79	144.66	109.98
Total Variable Cost	1 374.53	1 924.79	1 986.99	1 646.18	1 970.82	2 045.59	2 141.88	1 870.11
Capital Cost								
Machinery & Equipment:								
Depreciation	164.44	172.60	172.60	172.60	172.60	175.86	177.50	172.60
Interest	246.66	258.90	258 90	258.90	258.90	263.80	266.24	258.90
Fixed Improvements:								
Interest	128.55	121.35	52.50	88.70	78.43	87.23	82.34	91.30
Depreciation	34.28	32.36	14.00	23.56	21.56	32.36	23.83	25.99
Repairs & Maintenance	13.27	28.00	104.00	34.00	34.00	56.89	61.64	47.40
Total Capital Cost	587.20	613.21	602.00	577.76	565.49	616.14	611.55	596.19
Total Cost per Hectare	**1 961.73**	**2 538.00**	**2 588.99**	**2 223.94**	**2 536.31**	**2 661.73**	**2 753.43**	**2 466.30**
Yield (ton/ha)	1.29	1.30	1.30	1.20	1.40	1.33	1.35	1.31
Cost (R/ton)	1 520.72	1 952.31	1 991.53	1 853.28	1 811.65	1 995.30	2 045.64	1 881.49
Income								
Producer Price (R/ton)	1 326.41	2 158.00	2 031.00	1 682.00	1 401.00	1 621.64	1 588.95	1 687.00
Per Hectare	1 711.07	2 805.40	2 640.30	2 018.40	1 961.40	2 163.26	2 138.73	2 205.51
Profit/Loss								
Per Hectare	-250.66	267.40	51.31	-205.54	-574.91	-498.47	-614.69	-260.80
Per Ton	-194.31	205.69	39.47	-171.28	-410.65	-373.66	-456.68	-194.49

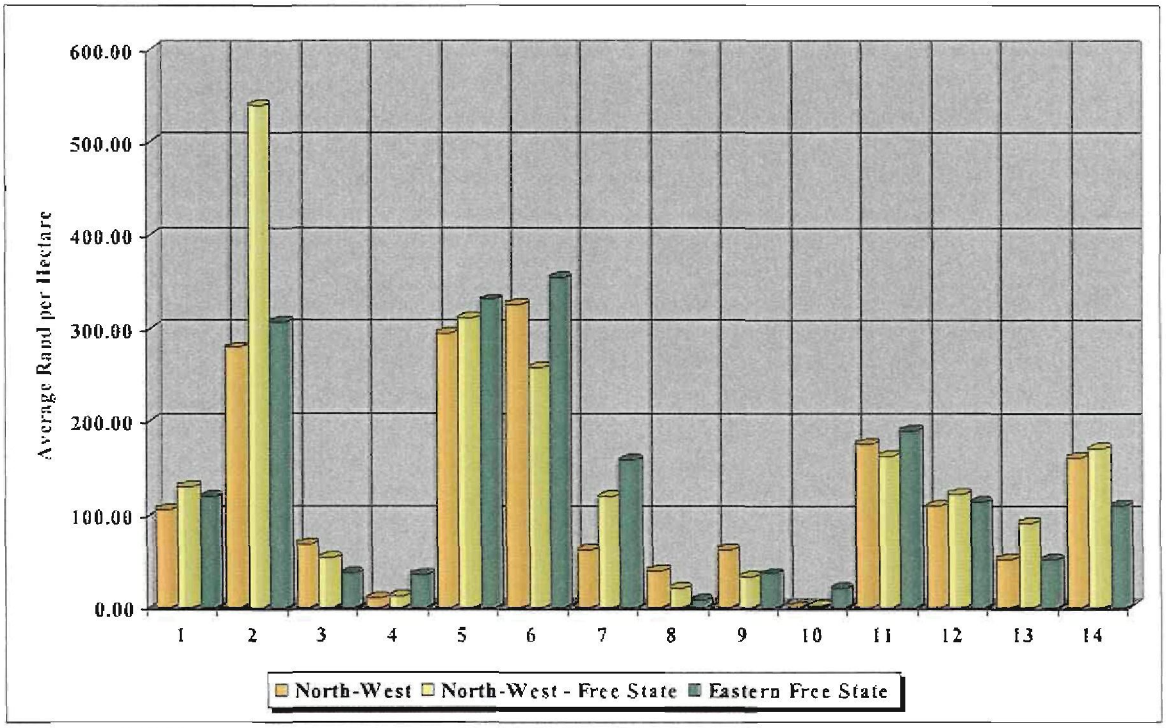
Source: SAGIS, 2006:3; GRAINSA, 2007:3; NDA, 2006:7.
Note: The costs are in South African Rand (ZAR).

The average production of sunflower seed in the EFS region is at a loss of R260.80 per hectare and R194.49 per ton (see Table 4-8). This is because of the low prices offered for the production of sunflower seed in this region (SAGIS, 2006:3; GRAINSA, 2007:3). Since the production of sunflower seed in this region is not profitable on average, the focus is more on the production of competing crops like soybeans. Therefore, it is evident that this will lead to a substantial decline in the total production of sunflower seed in South Africa (SAGIS, 2006:3; SAGIS, 2007:19).

4.3.2.4.4 Conclusion

The key factors that influence the production of sunflower seed in South Africa were identified for the three major summer production regions of South Africa, as discussed above. It is vital to compare the three major production regions and to classify the production factors into potential influential factors to the South African sunflower price. Figure 4-10 summarises the average costs associated with the production of sunflower seed in the three major production regions of South Africa by utilising the data of Table 4-6, Table 4-7, and Table 4-8.

Figure 4-10 Regional production comparison in South Africa



Source: SAGIS, 2006:3; GRAINSA, 2007:3; NDA, 2006:7.
Note: The costs are in South African Rand (ZAR).

1	Seed	5	Fuel	9	Marketing Cost	13	Contract Work
2	Fertiliser & Lime	6	Repairs & Parts	10	Drying & Cleaning	14	Other Cost
3	Weed Control	7	Crop Insurance	11	Permanent Labour		
4	Pest Control	8	Casual Labour	12	Interest on Production Credit		

The three most influential production factors identified for the principle production regions of South Africa are the utilisation of fertiliser and lime for soil cultivation, the price of fuel, and the reparations of the machinery needed to plant, cultivate, and harvest the sunflower seed. Secondary influential factors to the production of sunflower seed in South Africa identified are the cost of sunflower seed for planting, crop insurance, permanent labour, and the interest on production credit.

4.3.3 Conclusion

Section 4.3 examined the production and consumption of sunflower seed in South Africa and identified various potential factors that influence the price of sunflower in South Africa. The factors that influence the supply of sunflower seed in South Africa are weather conditions, the domestic price of sunflower seed, and the demand for sunflower seed for the production of bio-fuel. The importation of economical substitutes (for example soybeans and palm oil) and the closing stock of sunflower seed and soybeans in South Africa are additional supply factors. The input cost of sunflower seed and the Brent crude oil price are the final supply factors identified.

The factors that influence the demand for sunflower seed in South Africa are the total amount of sunflower seed processed for the sunflower oil and oilcake/meal industries, and the total amount of soybeans (substitute or complementary commodity) processed for the soybean oil and oilcake/meal industries. The demand for supplementary protein feed is also an important demand factor that is a function of the income dynamics of South Africa. In addition, the import parity prices of sunflower products (that is the international sunflower prices) and the Rand/US-Dollar exchange rate are to a greater extend factors that influence the demand for sunflower seed in South Africa.

The identified supply and demand factors will be summarised in the concluding section of this chapter. These factors will subsequently be incorporated into *Chapter 5* for the construction of the different SASPM. The next section (4.4) discusses the production and consumption of sunflower oil and oilcake/meal in South Africa.

4.4 Demand and supply of sunflower oil and oilcake/meal

4.4.1 Introduction

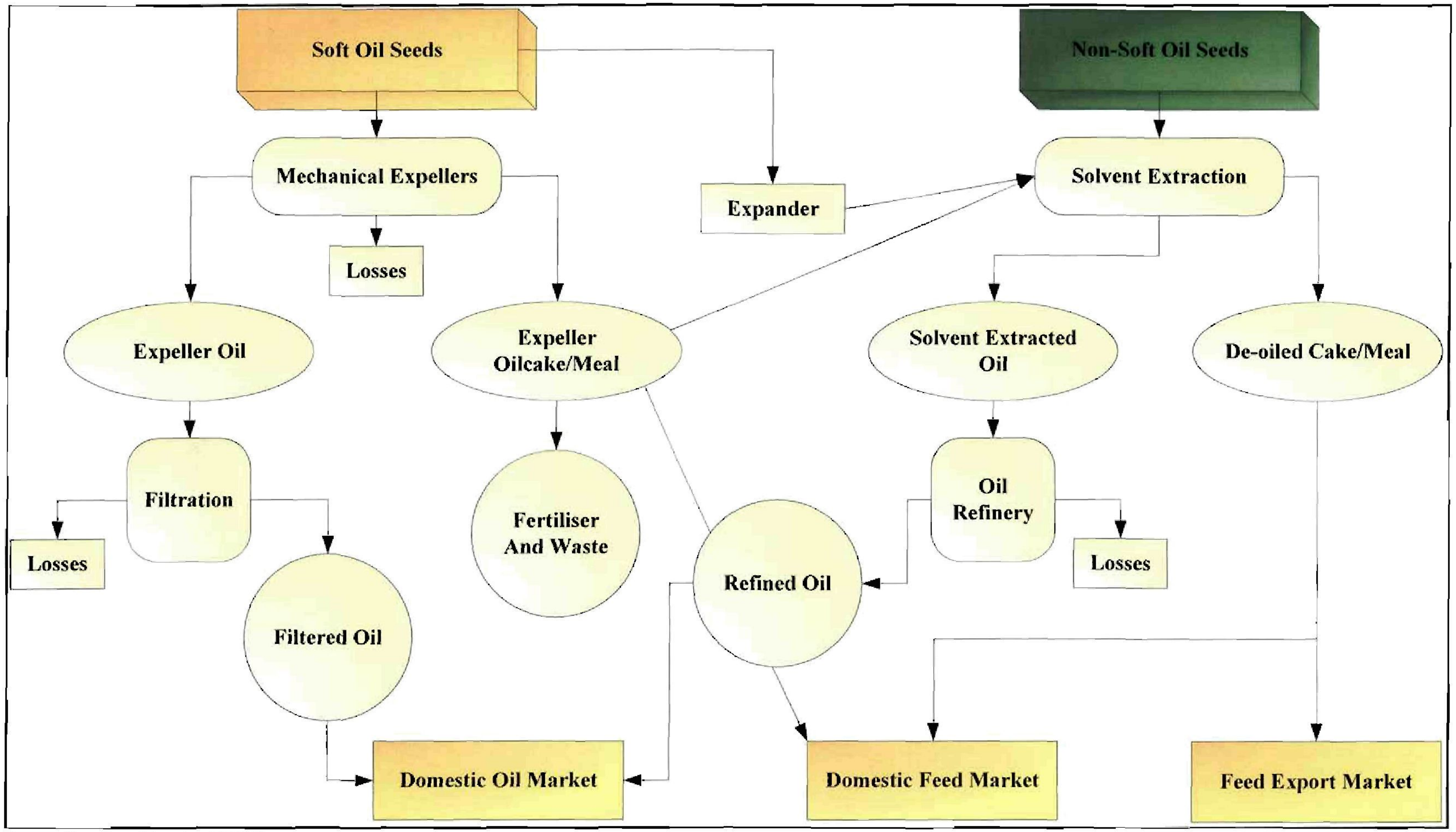
The South African oilseed processing industry is a combination of three very important processing divisions as reflected in Figure 4-11 below. The first major processing method is the traditional mechanical crushing or expelling method used for oilseeds with relatively high oil content. Soft oil seeds like sunflower seeds are processed by the utilisation of the mechanical crushing or expelling method. This extraction method produces expeller oil and oilcake/meal, and includes physical losses (for example wastage). The expeller oil obtained from this method is filtered and the subsequent products of this filtering process are the filtered oil and any oil processing losses incurred.

The expeller oilcake/meal is graded according to certain standards and is either sent to the fertiliser and waste sector, domestic feed market, or the solvent extraction division for further extraction (that is second and third processing methods). The final step in the traditional mechanical crushing or expelling method is to provide the filtered oil to the consumers through the domestic oil market (AFMA, 2007:25; Suresh and Landes, 2003:12).

The second major processing method in Figure 4-11 is the solvent extraction method for the processing of oilseeds and expeller oilcake/meal with less than 20% oil content. Non-soft oil seeds like soybeans are processed by the utilisation of this method in order to produce the solvent extracted oil and de-oiled cake/meal. The solvent extracted oil acquired from this method is sent to an oil refinery. After certain processing losses are incurred, the refined oil is ready to be sold on the domestic oil market for consumption. If there is a surplus in the production of de-oiled cake/meal, it will either go to the feed export market for exportation, or be sold in the domestic feed market at a discount (AFMA, 2007:25; Suresh and Landes, 2003:12).

The third major processing method in Figure 4-11 is the expander-solvent extraction method, which is a hybrid process used for raw materials with higher oil content (AFMA, 2007:25; Suresh and Landes, 2003:12). Before the soft oil seeds go through the solvent extraction method, it will first be subjected to an expander process that prepares the specific soft oil seed for maximum oil extraction. After the expander process the normal solvent extraction method follows (that is the second major processing method).

Figure 4-11 South Africa's oilseed processing industry



Source: Suresh and Landes, 2003:12.
Note: Adjusted for sunflower and soybean production in South Africa.

The South African oilseed processing industry also includes an oil refining sector and a hydrogenated oil sector. These sectors primarily refine and hydrogenate the domestic solvent-extracted oils, imported crude oil, and the imported solvent-extracted oils (AFMA, 2007:25).

Approximately 95% of the entire amount of sunflower seed produced in South Africa is destined for the oilseed processing industry for the production of sunflower oil and oilcake/meal (NAMC, 2007:230; AFMA, 2007:25). Sunflower oilcake/meal is generally regarded as a low-value product that does not compare well to soybean oilcake/meal in terms of nutritional value. Therefore, the predicament of the South African sunflower market is that not enough sunflower seed is produced locally for the oil processing industry and once the seed has been crushed the by-product is regarded as a low-valued product (AFMA, 2007:25).

4.4.2 Oilseed crushing industry

During the Oilseed Board era, numerous crushing plants were erected randomly. This happened because the government provided huge incentives to certain areas to stimulate economic growth (NDA, 2006:7; NAMC, 2007:234; Coetzer, 2006:1; SAGIS, 2006:12). From a market perspective it is evident that in the case of sunflower oil and sunflower oilcake/meal the most suitable position for crushing is in Gauteng. Theoretically, the demand will motivate (for example by means of a better price for sunflower seed) the farmers to plant sunflower seed closer to the market. However, the competition between the different grains (for example maize, sunflower, soybeans, and sorghum) also influences this decision (AGRISA, 2006:6; SAGIS, 2006:12; NDA, 2006:7).

If it is assumed that South Africa remains a predominantly maize producing country with relatively small sunflower seed crops, it can be expected that the coastal regions will tend to import both sunflower oil and oilcake/meal. This is while the inland crushers will provide incentives for inland farmers to expand their production of sunflower seed (GRAINSA, 2007:12; NDA, 2006:7; AGRISA, 2006:6). Table 4-9 signifies that the top eight seed-crushing plants in South Africa produce an average of 250,000 metric tons of sunflower meal per annum. However, with a total crushing capacity of approximately 950,000 metric tons of sunflower seed (given the total production of sunflower seed of 516,100 metric tons for the 2006/07 production season) only 55% of the total local crushing capacity is utilised.

Table 4-9 Seed-crushing plants in South Africa

Oilseed - Crushers		
Processor	**Location**	**Capacity (Metric Tons)**
*Nola**	Boksburg	180 000
*Nola**	Randfontein	144 000
*Continental**	Viljoenskroon	132 000
*EPKO 1**	Lichtenburg	96 000
*EPKO 2***	Lichtenburg	72 000
*Elangeni****	Isithebe	36 000
*Willowton Oil Mills**	Pietermaritzburg	132 000
*Willowton Oil Mills****	Isando	120 000
*Nedan****	Rivonia	24 000
Total		**936 000**

Source: Killian, 2006:1.
Note: * Currently utilised for sunflower seed crushing.
** Currently utilised for maize crushing.
*** Currently utilised for soybean crushing.

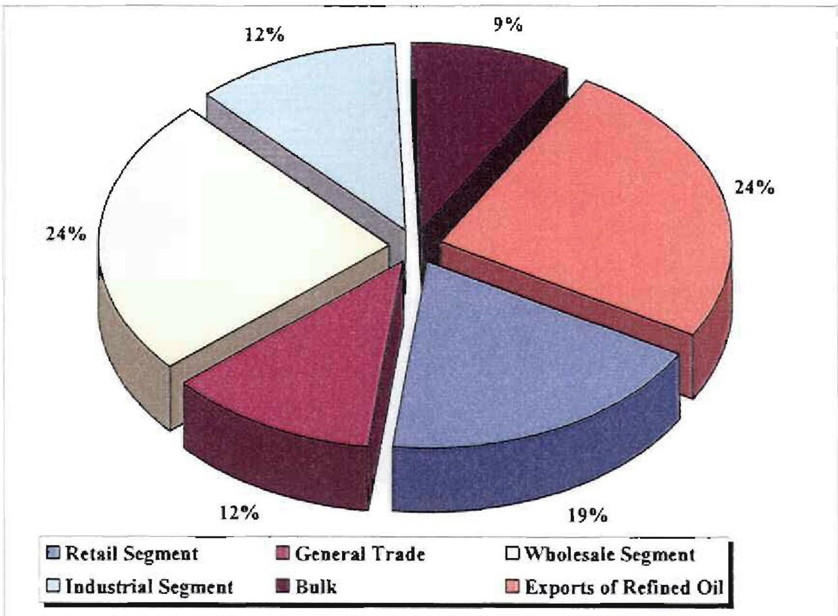
This situation of surplus crushing capacity opens a window for what is in the industry referred to as "toll crushing". Consequently there is an opportunity for any role player in the South African industry to crush seed, sell the crude vegetable oil at a lower price than the import parity price, and still manage to realise some form of profit (NAMC, 2007:234; AFMA, 2007:25). This scenario makes the seed-crushing industry highly competitive, since the utilisation of the crushing capacity is readily available to anyone in the business. The fact that surplus capacity exists in South Africa is wielding added pressure on the capability of large and small processors to reach and maintain an optimal level of economies of scale (NAMC, 2007:234; AFMA, 2007:25; NDA, 2006:7).

Not all the crushers in South Africa have a refining capacity, and not all the refiners have a crushing capacity. Some of the largest refineries are relatively close to the Durban harbour from where sunflower crude oil is imported (NAMC, 2007:234; NDA, 2006:7). The fact that large quantities of crude oil are entering the South African harbours for refining makes it very difficult for large and small processors to survive. Oil mills (that is the crushers) near the respective harbours have a big advantage in this regard, as their transport costs are very low (for example from Durban harbour to Pietermaritzburg). As a result, the location of processing facilities and the transport costs involved can be regarded as very important factors that influence the price of sunflower oil in South Africa (NAMC, 2007:234; NDA, 2006:7).

Another very important issue that needs to be considered is that the oilseed processing industry is highly capital-intensive. Therefore, it requires expert knowledge and state-of-the-art technology in to order to function at optimal levels (NAMC, 2007:235). The majority of the seed-crushing plants in South Africa were established in the mid-eighties and have not been revamped since. The larger of the seed-processors have to keep themselves up-to-date with new technological innovations in the oilseed processing industry in order to compete with the large overseas processors. As a result of these entry barriers, the ability of the oilseed processing industry to maintain or reach economies of scale is impeded (NAMC, 2007:235).

During the past fifteen years the total demand for sunflower seed has increased to over 1,000,000 metric tons. That makes South Africa, as previously noted, a net importer of sunflower products. However, it is imperative to note that it is not sunflower seed that is imported, but crude sunflower oil and sunflower oilcake/meal (NAMC, 2007:231; Coetzer, 2006:1).

Figure 4-12 Consumption of sunflower oil per segment

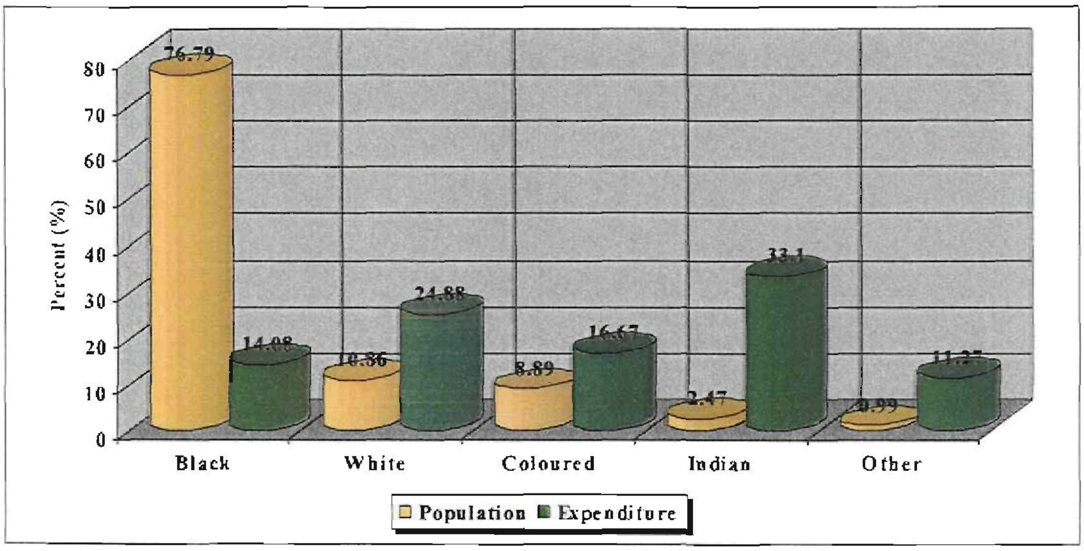


Source: NAMC, 2007:231; SAGIS, 2006:12.

Figure 4-12 shows the total consumption of sunflower oil in South Africa per economic segment. The consumption of the wholesale segment (24% of the South African production), and the exports of refined oil (24% of the South African production) are the biggest consumers of South African sunflower oil. The total consumption of sunflower oil is estimated to decrease over the next few years because of substantial decreases in the import of sunflower crude oil. This includes the export of sunflower oil to the neighbouring countries in the SADC. This is due to the strong increase in the crude sunflower oil prices and the depreciation of the Rand/US-Dollar exchange rate (NAMC, 2007:230; AFMA, 2007:25; GRAINSA, 2007:12).

The retail segment of the sunflower oil industry in South Africa consumes approximately 19% (see Figure 4-12) of the total South African production of sunflower oil (including the imports of sunflower products). As a result, it would be important to categorise the main consumers of sunflower oil in the retail segment. Figure 4-13 is a comparison between the total percentage expenditure and the total percentage utilisation of sunflower oil of the South African population.

Figure 4-13 Sunflower oil utilisation spread



Source: NAMC, 2007:231; SAGIS, 2006:12

Despite the fact that the Indian population makes up approximately 2.5% of the total South African population, their expenditure on sunflower oil is estimated at an average of 33.1% of the total South African expenditure. The white population is responsible for more or less 24.9% of all the expenditure on sunflower oil and they represent approximately 10.9% of South Africa's population. In spite of being the largest race group in South Africa, the black population's expenditure on sunflower oil is approximately 14.1%. This is due to various demographic and income distribution factors (NAMC, 2007:231; SAGIS, 2006:12).

South Africa is not only a net importer of sunflower products, but of other oilseed products too. Table 4-10 signifies the availability of oilcake/meal in South Africa. The importation of sunflower oilcake/meal shows a decreasing trend compared to the total available oilcakes/meals, while the usage of soybean oilcake/meal increased substantially over the same period (AFMA, 2007:25; SAGIS, 2006:12).

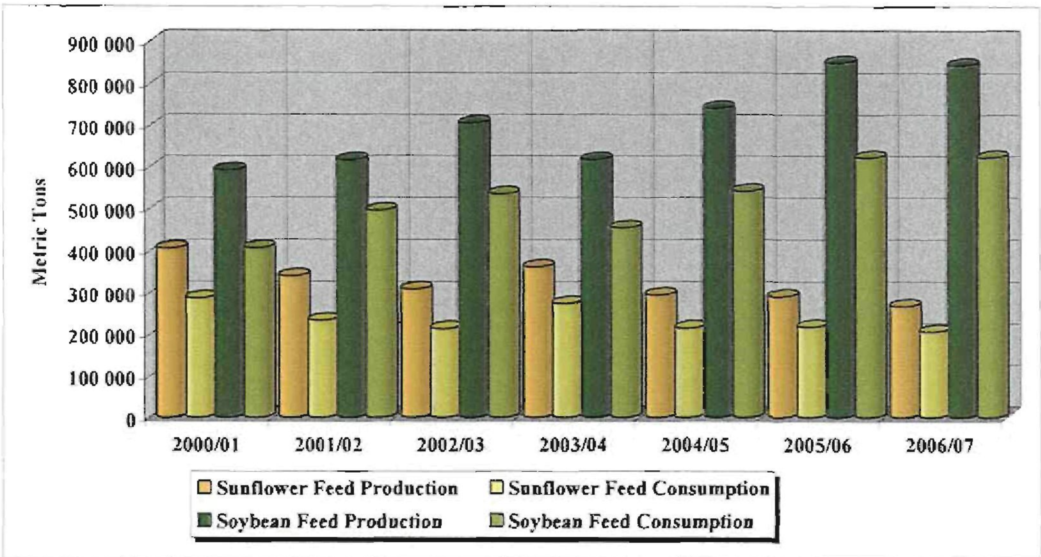
Table 4-10 Oilcake/meal utilisation by AFMA members

	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	Average
	(Metric Tons)							
*Soybean**	406 677	495 546	534 869	453 832	541 616	621 587	622 193	525 189
Sunflower	286 078	232 460	212 359	273 019	213 837	216 605	204 802	234 166
*Cottonseed***	43 758	53 741	51 707	42 736	50 736	57 319	54 981	50 711
*Canola****	8 683	8 347	7 514	7 843	7 678	6 562	6 543	7 596
Copra & Palm Kernel	-	1 719	2 808	5 769	4 009	2 873	4 488	3 611
Groundnuts	3 845	5 164	7 386	1 762	891	2 636	1 165	3 264
Total	749 041	796 977	816 643	784 961	818 767	907 582	894 968	824 134

Source: AFMA, 2007:25.
Note: * Including soy oilcake/meal and full fat soy.
** Including oilcake/meal and full fat cotton.
*** Including full fat canola.

Figure 4-14 illustrates that over the past seven production seasons the total production of sunflower oilcake/meal has exceeded the total consumption. As a result of these circumstances, an increased downward pressure on the price of sunflower oilcake/meal has been created, with the production of sunflower oilcake/meal in South Africa decreasing with approximately 34% since 2000/01 (NAMC, 2007:232). However, the production of soybean oilcake increased with 252,181 metric tons over the past seven production seasons (see Figure 4-14). This is primarily due to the increased demand for high protein feed and the production of bio-fuel (BFAP, 2006:23).

Figure 4-14 Sunflower and soybean oilcake/meal industries



Source: AFMA, 2007:25.

The price of sunflower oilcake/meal is derived from its relative nutritional value compared to other oilcakes/meals. Table 4-11 signifies that sunflower oilcake/meal has always been a viable alternative to soybean oilcake/meal in South Africa, providing that it conforms to certain standards (AFMA, 2007:25). According to the members of the Animal Feed Manufacturers Association of South Africa (AFMA) the South African feed industry is capable of utilising more than 300,000 metric tons of sunflower oilcake/meal per annum.

Table 4-11 Nutrient composition of different oilcakes/meals

	Sunflower (With Hulls)	Sunflower (Without Hulls)	Soybean (With Hulls)	Soybean (Without Hulls)	Peanut
Nutrient					
Crude Protein (%)	28.34	43.00	44.00	49.00	42.00
Crude Fibre (%)	23.00	13.00	6.00	3.00	12.00
Energy (ME/Kcal/kg)	1760	2320	2320	2530	2200
Amino Acids					
Lysine	1.18	1.70 (84)	2.70 (90)	3.07 (92)	1.70 (83)
Methionine	0.72	1.65 (93)	0.63 (91)	0.68 (94)	0.50 (93)
Cystine	0.55	0.40 (78)	0.70 (82)	0.69 (92)	0.62 (78)
Threonine	1.21	1.70 (85)	1.70 (87)	1.94 (92)	1.28 (85)

Source: NAMC, 2007:233; FASS, 2007:28.
Note: The figures in brackets indicate percentage digestion coefficients of respective amino acids

However, the utilisation of sunflower oilcake/meal in South Africa is restricted by the ratio of soybean to sunflower oilcake/meal prices and the high transport costs to the coastal regions. The inconsistent quality of the sunflower oilcake/meal from the crushers (that is the high fibre and the low protein content), and the low availability of sunflower oilcake/meal as a result of low sunflower oil prices (that is reduced crushing) are additional restrictions (BFAP, 2006:23; NAMC, 2007:232; AFMA, 2007:25).

Table 4-11 presents the nutrient composition of a range of oilseed oilcakes/meals. Sunflower, soybean, and peanut oilcake/meal compete in the protein feed market. Although sunflower oilcake/meal can be utilised in feed rations as a less expensive source of protein, the high fibre content limits the amount that is utilised in the major feed rations to less than 7% (AGRISA, 2006:6; AFMA, 2007:25). However, the Bureau for Food and Agricultural Policy expects the local oilcake prices to increase over the next few years. This is due to the constant increase in the consumption of oilcake/meal in the protein feed market and the projected increase in the soybean meal price (BFAP, 2006:23; GRAINSA, 2007:12).

4.4.3 Conclusion

Section 4.4 examined the production and consumption of sunflower oil and oilcake/meal in South Africa. The factors that influence the supply of sunflower oil and oilcake/meal in South Africa are the production of sunflower and soybean oilcake/meal for the protein feed market, the importation of sunflower oil for the domestic oil market, and the importation of soybean oil for the domestic oil market. Additional supply factors are the importation of sunflower oilcake/meal for the domestic market and the importation of soybean oilcake/meal for the domestic market. The location and transport costs associated with the production of sunflower oil and oilcake/meal and the general utilisation of the South African crushing capacity (that is toll crushing) are the final supply factors identified in this section.

The factors that influence the demand for sunflower oil and oilcake/meal in South Africa are the wholesale and retail consumption of sunflower oil and oilcake/meal, substitute vegetable oils (that is soybean and palm oil), and protein feed (for example soybean meal). Additional demand factors include the exports of sunflower oil and oilcake/meal, soybean oil and oilcake/meal, and the transport cost associated with the movement of vegetable oils and protein feed to the different oil and oilcake/meal markets. The final demand factor is the low quality of sunflower oilcake/meal as a result of low sunflower oil prices internationally.

The primary (seed) and the secondary (oil and oilcake/meal) industries of sunflower in South Africa yielded a large number of potential influential factors to the price of sunflower. The next section (4.5) will examine the South African Futures Exchange (SAFEX) and the different factors that influence the formation of sunflower futures prices on SAFEX.

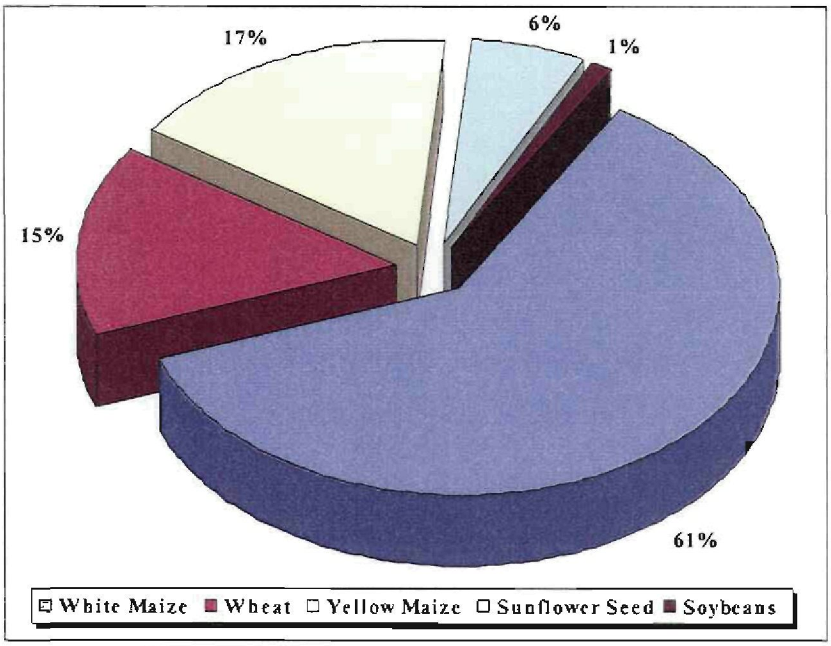
4.5 South African futures exchange (SAFEX)

4.5.1 Introduction

The passing of the Marketing of Agricultural Products Act of 1996 paved the way for a new marketing order in the South African grain and oilseed industry. As a result, the producers, traders, and the processors of grains and oilseeds were able to trade in a "free" market and respond to the forces of supply and demand in the development of commodity prices (ECONLIB, 2006:17; Kirsten and Vink, 2000:25). In practice the producers, traders, and the processors look to the prices that are generated through the formal commodities market in South Africa. This serves as a point of reference for the prices they will ask or offer in the market of daily trading in grains and oilseeds (Kirsten and Vink, 2000:25; SAFEX, 2006:17).

The Agricultural Markets Division (AMD) of South Africa was established in January 1995 as a division of SAFEX. The AMD introduced the trading of derivatives (for example futures) for a wide variety of agricultural commodities (that is maize, sunflower seed, and wheat) in South Africa (SAFEX, 2006:17). In so doing the AMD quickly established itself as the agricultural market leader with respect to price transparency (that is especially in the maize market) in Southern Africa. Since the deregulation of SAFEX and the AMD, the agricultural commodity market of South Africa has been exposed to numerous market conditions which affected the demand and supply of agricultural commodities (CFTC, 2006:17; Schmitt, 2005:37). During the first half of 2001 the members of SAFEX accepted an offer by the Johannesburg Securities Exchange to become part of the Johannesburg Stock Exchange (JSE). Subsequently, the AMD of SAFEX became the Agricultural Products Division (APD) of the JSE Securities Exchange of South Africa (SAFEX, 2006:17; ECONLIB, 2006:17).

Figure 4-15 Agricultural commodities traded on SAFEX during 2005/06



Source: SHIM, 2006:28

The white maize futures contract is the most liquid contract on SAFEX, followed by the yellow maize, wheat, sunflower seed, and soybean futures contracts. The general expansion in the liquidity and growth in the agricultural market is the result of a number of factors: the increased number of participants in the APD, a greater understanding of the futures, and the development of numerous South African marketing strategies that are based on various derivative products (SAFEX, 2006:17; ECONLIB, 2006:17).

Figure 4-15 depicts the commodities traded on SAFEX and their percentage of the total value traded for the 2005/06 production period. The white maize, yellow maize, and wheat futures contracts are the primary negotiated futures contracts in South Africa and accounted for more than 90% of the total value traded during the 2005/06 production period. Sunflower seed futures contracts and soybean futures contracts are also offered, but trade at a much smaller volume than maize and wheat (see Figure 4-15).

The next segment discusses the basic trading characteristics of sunflower futures contracts on the South African Futures Exchange.

4.5.2 Sunflower seed futures contracts on SAFEX

Countries that are considering the development of a futures market must be aware of the general requirements for the success of a futures market. In the overall development of more improved futures contracts, commodity exchanges need to know why the futures markets succeed or fail. The most important requirement for the success of a futures market is an active cash market, which is central to the existence of futures contracts (Brorsen and Fofana, 2001:141; Sharekhan, 2006:17). The implication for countries that are considering the development of their own futures markets is that, unless an active cash market exists, the resources invested in the development of futures markets will be wasted.

Those countries should first direct their immediate efforts toward the development of an active cash market and an effective grading system. Subsequently, they can consider the possibility of developing a futures market (Sharekhan, 2006:17; SAFEX, 2007:8). For those commodities with a cash market active enough to support a futures market, other factors (for example cash market size, liquidity cost, market structure, and grading system effectiveness) help to determine the volume and the open interest. However, the changing structure (for example buyer concentration and vertical integration) of the market for some commodities will create a decline in futures contract volume and open interest. This may ultimately cause these contracts to fail (Brorsen and Fofana, 2001:141; Sharekhan, 2006:17; SAFEX, 2006:17).

The universal definition of a futures position is an agreement between two parties (that is a buyer and a seller) to exchange a standardised good (that is the commodity) for an agreed upon price at a specific date in the future (that is the delivery date). As soon as the farmer sells at that predetermined price, he will get no more or no less for his commodity. Subsequently, a decline in the price will result in a profit for the holder of the short position on SAFEX. An increase in the price will mean losses on SAFEX that is ultimately compensated for by the higher amount received when selling the physical stocks (FLETCHER, 2003:17; SAFEX, 2007:8). To avoid potential losses on SAFEX the transfer of price risk can be obtained by a certain method called hedging[28]. This dissertation will not discuss the methodologies of hedging. It is, however, important to mention that hedging occurs within SAFEX.

The buyer concentration and vertical integration of SAFEX for several commodities are within a reasonable range. At any given point in time there will be more than one agricultural futures contract listed on SAFEX for the same commodity (SAFEX, 2006:17). The only dissimilarity between the various contracts is the expiry (that is delivery) date. Table 4-12 is an overview of all the important components of a sunflower seed futures contract on SAFEX. These components are dependent on sunflower production conditions and are not cast in stone. One sunflower seed futures contract is worth 50 metric tons of sunflower seed and these futures are generally traded throughout the year. However, the main futures contract months are March, May, July, September, and December (FLETCHER, 2003:17).

If the sunflower seed harvest is early, SAFEX will introduce a June sunflower seed futures contract. However, this is not common practice and only happens under exceptional circumstances (SAFEX, 2006:17). All the commodity contracts on SAFEX also have a constant "spot" month contract (see Table 4-12). Thus, if a farmer's delivery of his commodity is not

[28] *If the farmer sells his sunflower seed now for delivery in 6 months, he is the holder of a short futures contract. When the price drops, he will lose money in the physical market (sell his physical stock for less), but gain the same amount in the futures market. Because he loses the same amount that he gains, he effectively sold his product at the level of the futures contract, thus fixing his price of his produce.*

within one of the determined delivery dates, he can simply sell his merchandise on the SAFEX spot market (FLETCHER, 2003:17).

Table 4-12 is an explanation of a SAFEX sunflower seed futures contract as it was determined during the 2006/07 production season. Sunflower futures contracts differ due to numerous factors like volatility in the commodities markets. It is, therefore, important to discuss the general characteristics of a futures contract and to bear in mind that the development of these futures contracts is dependent on a wide range of factors. To ensure the performance of futures contracts on SAFEX a system of margining occurs. This happens on the basis of the closing price at the end of each day's trading. If the futures' prices decline below the price a person sold at, his/her account is credited and if the futures' prices rise above a person's selling price, then his/her account is debited (FLETCHER, 2003:17; SAFEX, 2006:17).

Table 4-12 Explanation of a SAFEX sunflower seed futures contract

Sunflower Seed	
ATS Code	SUNS
Trading Hours	09:00 to 12:00
Underlying Commodity	FH South African Origin. High oil content sunflower seeds meeting specified criteria.
Contract Size	50 metric tons.
Expiry Dates & Times	12:00 on the eighth last business days of March, May, July, September and December. Physical deliveries from first business day to last business day of the expiry month
Constant Month Contract	All other calendar months are introduced 20 business days proceeding the new month Once the month is introduced it is traded in the same fashion as the 5 hedging months.
Settlement Method	Physical delivery of SAFEX silo receipts at approved silos at an agreed storage rate
Quotations	Rand per ton.
Minimum Price Movement	R 1.00 per ton.
Daily Limits	R 90.00 per ton (extended limits R 135.00 per ton).
Initial Margin	R 9,500.00 per contract up to first notice day. R 12,500.00 per contract up to expiry day. R 25,000.00 per contract up to last delivery day. R 2,850.00 per contract for calendar spreads.
Maximum Position Limits	1000 contracts within 10 days of the expiry month.
Expiry Valuation Method	Closing futures price as determined by the Clearing House
JSE Booking Fees	R 6.00 per contract.
JSE Delivery Fees	R 100.00 per contract

Source: SAFEX, 2006:17; SAFEX, 2007:8.

Table 4-12 indicates the amounts that have to be paid in as the initial margin. For instance, R9,500.00 per contract up to the first notice day is paid. If two adjacent futures contracts trade at limits for two consecutive days, then extended limits apply which have no maximum limiting price movement. If sunflower seed futures contracts trade at certain limits, then the initial margin is also increased by R3,000.00. As a result, R9,500.00 + R3,000.00 = R12,500.00 is paid for futures contracts up to the expiry date. When the sunflower seed futures contracts revert to normal limits, these initial margins are credited back to a person's variation margin account. The initial margin can also be increased from the first notice day, to the last business day of the expiry month. The last day to trade a future is eight business days before the end of the expiry month (FLETCHER, 2003:17; SAFEX, 2007:8).

The maximum daily price movement up or down of the sunflower seed futures contract is limited to R90.00, but these limits can be extended to R135.00 under unusual circumstances (SAFEX, 2006:17). Most members require that clients deposit an additional amount so that there is a balance available to meet the daily margin requirements. If there are insufficient funds in the client's account they will be contacted and told to deposit additional funds (that is referred to as a margin call) into their accounts (FLETCHER, 2003:17; SAFEX, 2007:8).

Contrary to the past days of the Marketing Boards there is no longer any pan-seasonal/pan-territorial pricing[29] or one single spot price for the country as a whole. This is because there are multiple points of delivery (for example a modification for the transport cost is done for each delivery point) and each point generates its own spot price (SAFEX, 2006:17). Since all the SAFEX prices are Randfontein-based (that is this means that if a producer can deliver or a miller/crusher can accept delivery at Randfontein) they will receive or pay the SAFEX price for the delivery month contract.

Since the delivery usually takes place at multiple points across the various producing regions, all the spot prices will be a SAFEX adjusted price. For example, if the transport costs between Randfontein and the silo (that is the producer's choice) is R80.00 per ton, the delivery price for the producer will be equal to the Randfontein price (that is the delivery month contract price) minus the determined R80.00 per ton transport cost (that is a location differential). The buyer will, therefore, collect the commodity from the relevant silo at the SAFEX price minus the R80.00 per ton transport cost. Therefore, it is evident that the SAFEX futures prices are indeed the prices for every delivery month (GRAINSA, 2007:12; SAGIS, 2006:26; SAFEX, 2007:8).

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[29] *The Maize, Wheat, and Oilseed Board set a buying price for the product regardless of when or where it was delivered. The result was that the transport cost of farmers further away from the market was subsidised by those closer to the market, while no producer had an incentive to store the product. This had an enormous impact on liquidity management by the monetary authorities, when the entire crop was purchased within a couple of weeks every production season (SAFEX, 2006:1; SAFEX, 2007:8).*

4.5.3 Formation of sunflower prices

For the sunflower seed to sunflower oil value chain in South Africa the following five main levels were identified. The sunflower seed producers (that is at farm level), crushers of sunflower seed, refineries of crude sunflower oil, wholesalers and retailers, and finally the consumers. Table 4-13 indicates the supply chain from sunflower seed to sunflower oil for the month of July 2003 in South Africa. The farm gate price for July 2003 was derived from the SAFEX average nearby contract price that was lagged by three months. This is because statistical tests done by the National Agricultural Marketing Council (NAMC) proved that the level of correlation between the SAFEX price of sunflower seed and the consumer price of sunflower oil (that is 750ml) is the highest when the SAFEX price is lagged by three months (NAMC, 2007:238). This means that it takes approximately three months from when the crushers buy the sunflower seed until the oil appears on the shelf.

A number of sunflower industry role players also argued in favour of the inclusion of a three month lag period between the SAFEX sunflower seed price and the consumer price. This is simply because of the period of time that is necessary for the processing of the oil, as well as the need for basic hedging strategies (Coetzer, 2006:1; Killian, 2006:1; Berg, 2006:1). As a result, the SAFEX price of approximately R1,717.00 per ton reflected in Table 4-13 was actually the average monthly nearby contract price traded on SAFEX for the month of April 2003.

The price of R9,996.25 per ton reflected in Table 4-13 as the sunflower oil retail price was derived from the price of a 750ml bottle of the "cheapest cooking oil". After taking into account factors such as the density of the product, it was calculated that approximately 1,454 bottles (that is 750ml) of cooking oil represent one ton of oil (NAMC, 2007:239; SAGIS, 2006:26). It is subsequently important to note that two possible sources for the supply of crude oil to the local refineries are included in the framework. The first source of supply of crude oil is imports. Table 4-13 clearly signifies the calculation of the South African import parity price for crude sunflower oil. It was R5,137.75 per ton for July 2003. The second source of supply is the local crushers. The estimates for the local crushing costs, possible crushing margin and the crushers' realisation are presented in segment *B2* of Table 4-13.

Table 4-13 Sunflower seed to sunflower oil supply chain in South Africa

	Units	Example (Jul-2003)
(A) Farmers		
Farmgate Price	Rand per Ton (Seed)	R 1 576.00
Transport Cost: Farm Gate to Silo	Rand per Ton (Seed)	R 106.00
Handling & Storage Cost: Costs of Farmer	Rand per Ton (Seed)	R 35.00
SAFEX (Nearby Contract)	**Rand per Ton (Seed)**	**R 1 717.00**
(B) Supply of Crude Oil		
(1) Imports of Crude Oil		
Sunflower Crude Oil, Argentina FOB	US-Dollar per Ton (Oil)	$539.00
Freight	US-Dollar per Ton (Oil)	$40.00
Insurance	US-Dollar per Ton (Oil)	$6 47
Duty	US-Dollar per Ton (Oil)	$53.90
Discharge and Clearing Transport	US-Dollar per Ton (Oil)	$27.00
Exchange Rate	Rand/US-Dollar	R 7.53
Sunflower Crude Oil, Factory (Durban)	Rand per Ton (Oil)	R 5 017 75
Transport: Durban to Reef	Rand per Ton (Oil)	R 120.00
Sunflower Crude Oil Price, Factory (Reef)	**Rand per Ton (Oil)**	**R 5 137.75**
(2) Local Supply of Crude Oil: Crushing Activity		
Transport Cost: Silo to Crushing Plant	Rand per Ton (Seed)	R 86.00
Handling Cost: Costs of Crusher	Rand per Ton (Seed)	R 35 00
Storage Costs: Costs of Crusher	Rand per Ton (Seed)	R 100.00
Interests Paid on Investment	Rand per Ton (Seed)	R 140.00
Price Crushers Pay for Seed	Rand per Ton (Seed)	R 2 078.00
Fixed Costs	Rand per Ton (Seed)	R 65.00
Variable Costs	Rand per Ton (Seed)	R 120.00
Total Costs of Crushing	Rand per Ton (Seed)	R 185.00
Oilcake Price	**Rand per Ton (Oilcake)**	**R 900.00**
Crude Oil Contribution (39% extraction from one ton of seed, multiplied by the Oil Price)	Rand per Ton (Oil)	R 2 003.72
Cake Contribution (42% cake from one ton of seed, multiplied by the Seed Price)	Rand per Ton (Oilcake)	R 378.00
Costs of Seed	Rand per Ton (Seed)	R 2 078.00
Crushing Margin	Rand per Ton (Seed)	R 303.72
Total Crushing Costs	Rand per Ton (Seed)	R 185.00
Manufacturers Realisation (Crushing)	Rand per Ton (Seed)	R 118.72
(C) Refinement Activity		
Sunflower Crude Oil Price, Factory (Reef)	Rand per Ton (Oil)	R 5 137.75
Interests Paid on Investment	Rand per Ton (Oil)	R 58.00
Fixed Costs	Rand per Ton (Oil)	R 188.00
Variable Costs	Rand per Ton (Oil)	R 180.00
Total Costs of Refinement	Rand per Ton (Oil)	R 426.00
Total Costs Before Refinement Loss		R 5 563.75
Total Costs of Refined Sunflower Oil (Excluding Packaging)	**Rand per Ton**	**R 5 918.88**
(D) Packaging Activity		
Interests Paid on Investment	Rand per Ton (Oil)	R 65.00
Fixed Costs	Rand per Ton (Oil)	R 120 00
Variable Costs	Rand per Ton (Oil)	R 270.00
Total Costs of Packaging	Rand per Ton (Oil)	R 455.00
Distribution Costs	Rand per Ton (Oil)	R 250.00
Total Costs of Suunflower Oil (Including Packaging)		R 6 623.88
Manufacturer-to-Retail Margin (Pure Sunflower Oil)		R 3 372.37
Sunflower Oil Retail Price	**Rand per Ton (Oil)**	**R 9 996.25**

Source: NAMC, 2007:240; AFMA, 2007:25; SAGIS, 2006:26.

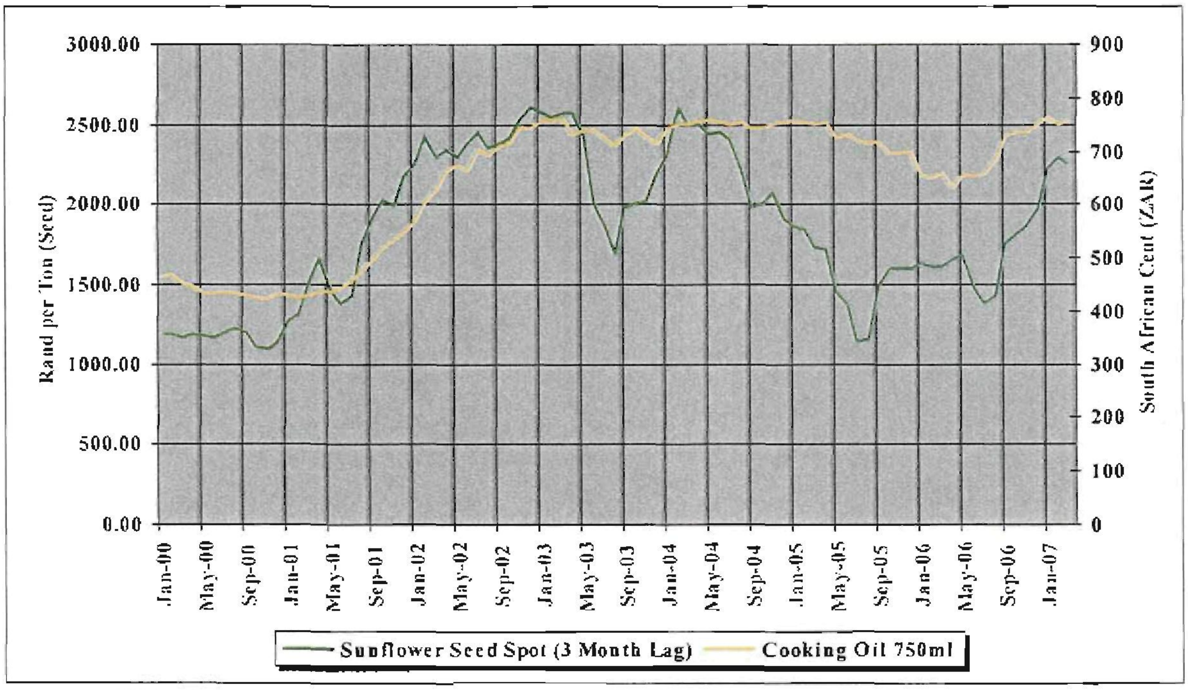
The crushing margin of sunflower seed for July 2003 was R303.72 per ton. It is calculated by deducting the costs of the sunflower seed at the crusher's door (R2,078.00 per ton during July 2003) from the income generated by the sales of the oil (R2,003.72 = 0.39 x R5,137.75). As well as the sales of the oilcake/meal (R378.00 = 0.42 x R900.00 per ton during July 2003) that were extracted from a ton of sunflower seed. For the purpose of these calculations an average extraction rate of approximately 39% is used for oil and 42% is used for oilcake/meal. Consequently, one ton of raw sunflower seed produces on average 390 kilograms of crude oil and 420 kilograms of sunflower oilcake/meal (AFMA, 2007:25; NAMC, 2007:241; SAGIS, 2006:26). The total crushing costs in South Africa for July 2003 were estimated at more or less R185.00 per ton. That ultimately implies that the crushers' realisation was estimated at R118.72 per ton (R303.72 – R185.00) of sunflower seed.

It is imperative to keep in mind that the general value of sunflower oil is derived from the import parity price of crude oil. It is equally important to note that during specific periods in the year the local (that is the South African) price of crude sunflower oil trades below the import parity price levels (Coetzer, 2006:1; Killian, 2006:1). On the other hand, it was decided that for the purposes of these general calculations a higher price of crude oil will reflect the "worse case" scenario. That is because the crude sunflower oil is regarded as the raw material and the higher the price of the raw material that enters the value chain, the slighter are the possibilities of making profit. Notably if the retail prices of sunflower oil are kept at a stable level (NAMC, 2007:241).

The sunflower seed to sunflower oil supply chain calculations in Table 4-13 reflect the worst-case scenario for the value chain. The overall costs of refinement of sunflower oil during the 2003/04 production season were approximated at R426.00 per ton. The total packaging costs plus distribution costs were estimated at R655.00 per ton (oil). The total costs of refined sunflower oil (that is without packaging) including the refinement losses for July 2003 of 6% were estimated at R5,918.88 per ton. Hence, if the packaging costs and the distribution costs are added to this value, the total cost of sunflower oil before it enters the wholesale and retail sector was R6,623.88 per ton of oil (GRAINSA, 2007:12; AFMA, 2007:25).

Figure 4-16 represents the relationship between the retail price of sunflower oil in South Africa and the sunflower seed spot price traded on SAFEX (that is the price quoted at the Randfontein depot). The manufacturer-to-retail margin mentioned in Table 4-13 is calculated by deducting the total costs of sunflower oil from the retail price of sunflower oil. Table 4-13 reports a manufacturer-to-retail margin of approximately R3,372.37 per ton (R9,996.25 – R6,623.88).

Figure 4-16 South African sunflower seed and sunflower oil prices



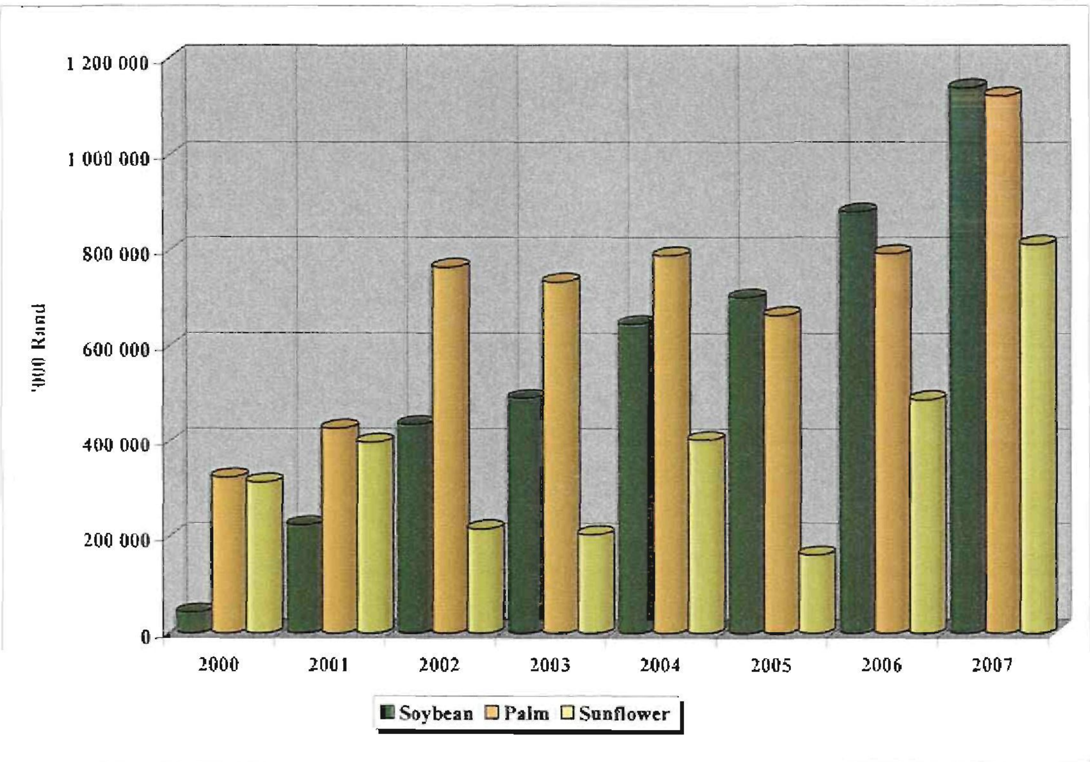
Source: SAGIS, 2006:26; SAFEX, 2006:17; Oilworld, 2007:18

Within this margin or "price gap" lies the total costs of administration and marketing of the retailers and wholesalers as well as the profits of the wholesalers, retailers and refineries. Compared to the miller-to-retail margin not many assumptions are initially made to obtain the manufacturer-to-retail margin. Therefore, a definite level of importance is placed on this measurement (Flaskerud, 2004:17; NAMC, 2007:241).

During the periods November 2000 - December 2001 and November 2003 - February 2004, the price gap between the world price of sunflower oil and soybean oil increased significantly. This was because of a sharp increase in the price of crude sunflower oil, as previously mentioned. The manufacturer-to-retail margin became negative during these periods, and with the soybean crude oil price more than $200.00 per ton cheaper than the crude oil price of sunflower, the South African refineries started substituting sunflower oil with soybean oil. Consequently, the imports of soybean oil increased sharply (SAGIS, 2006:26; SAGIS, 2007:19). The fact that the retail price that was used for the purpose of these calculations reflects the price of the "cheapest cooking oil" on the shelf (and not pure sunflower oil) means that it reflects the price of blended oil. Pure sunflower oil is always sold at a premium and this premium can be as high as 30% in some markets (FAPRI, 2005:248; NAMC, 2007:242; SAGIS, 2006:26).

The NAMC of South Africa identified an inverse relationship between the manufacturer-to-retail margin and the level of soybean imports. Every time the manufacturer-to-retail margin decreases the total level of soybean crude oil imports increase (NAMC, 2007:242). Figure 4-17 illustrates that the annual importation of all the major crude vegetable oils (that is sunflower, soybean and palm) and oilcake/meal (that is sunflower, soybean and palm kernel) in South Africa has increased. These results suggest that the refineries had to blend different oils into the final product to maintain a positive manufacturer-to-retail margin. The regulations on food safety and product standards in South Africa require that sunflower oil that is labelled as "pure sunflower oil" must contain no less than 90% pure sunflower oil (Coetzer, 2006:1).

Figure 4-17 South African vegetable oil and oilcake/meal imports



Source: DTI, 2007:21

The price of crude oil entering the value chain (see Table 4-13 on page 116) is regarded as the "cost of raw material". During July 2003 the cost of raw material was approximately R5,137.75 per ton. That resulted in a percentage share of the final product of 51% (R5,137.75 ÷ R9,996.25 = 0.51). The share of raw material costs increased from 53% during 2000 to 71% in 2002 and this share decreased again to an average of 54% during 2003. The main contributing factor to this decrease in the share of the final good was the appreciation of the Rand/US-Dollar exchange rate. That subsequently led to lower import parity prices[30] (Parr, 2005:2; NAMC, 2007:243). As a result, the average conversion costs (as a percentage of the final value of the product) have remained comparatively constant over the past seven years (from approximately 14-19%) in South Africa. The common calculation of this import parity price is demonstrated in segment *B1* of Table 4-13.

4.5.3.1 Import parity pricing in South Africa

For non-tradable goods the notion of import parity pricing does not apply. This is because imports are impossible and an import parity price (IPP) cannot be determined (for example services like haircuts and fixed property are non-tradable) (Parr, 2005:2; SAGIS, 2007:27). Not only is fixed property non-tradable by definition in the balance of payments, but in reality it is impossible to substitute imported land for domestic land. However, on the other hand it is actually possible to have a haircut while one is overseas but the transaction is likely to be supplementary. For real-world examples of tradable goods the determinants of IPP are simply the components of the price as it has been built up. These might be listed (that is non-exhaustively) as the international price of the specific product, the Rand/US-Dollar exchange rate, the transportation costs, insurance, and tariffs (GRAINSA, 2007:3). It is one thing to add up all the components of a price determined according to IPP, but how does that price change over time owing to changes in one or more of its essential parts?

In respect of import parity pricing, the nature of the tradable product is influential. This is because the goods with a low value-to-volume ratio are relatively more expensive to transport. This is another way of saying that transport costs comprise a higher portion of the total IPP for the identified goods. Therefore, the IPP of low value-to-volume ratio goods is as a result more sensitive to a given change in the transport costs (Parr, 2005:3; SAGIS, 2007:27). However, assuming that the transport costs remain constant, low value-to-volume ratio goods are affected less severely by the changes in the international price of the product. This is because it represents a smaller part of the final price of a product priced at import parity, than it does for

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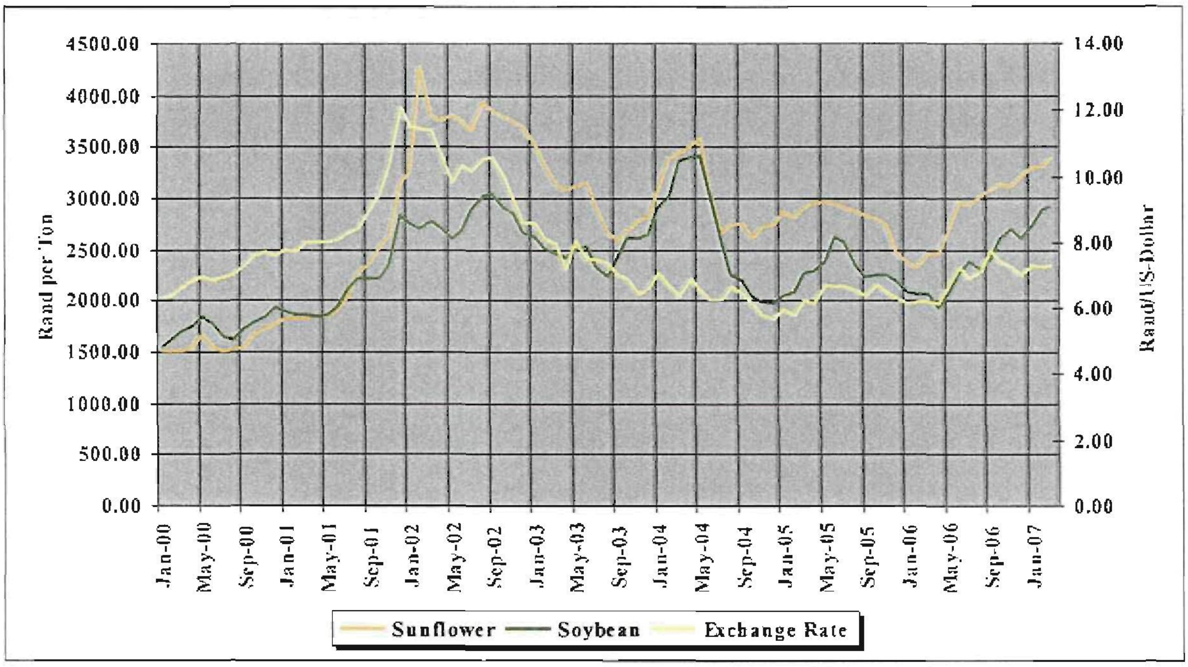
[30] *Import parity pricing is an international pricing policy adopted by the suppliers of an agricultural commodity for their sales to domestic customers. That is where the local price is set at the opportunity cost of a unit of an imported substitute good (Parr, 2005:2).*

high value-to-volume ratio goods. Changes in the Rand/US-Dollar exchange rate mainly impact the international price and any *ad valorem* tariff component of the price. This is a notably smaller part of the final IPP, than it is for high value-to-volume ratio goods (Parr, 2005:3; SAGIS, 2007:27).

Parr (2005:3) stated that the nature, level, and rate of tariff protection applied are also influential in determining how the IPP of a product is affected by a change in either the international price or the Rand/US-Dollar exchange rate. If either a zero tariff or a specific tariff is applied (for example R1.00 per unit imported) then neither a change in the international price nor a change in the Rand/US-Dollar exchange rate will affect the tariff component of a price set according to IPP. Figure 4-18 indicates the SAFEX import parity prices of sunflower and soybeans quoted at the Randfontein depot compared to the Rand/US-Dollar exchange rate.

Figure 4-18 Randfontein import parity prices quoted by SAFEX



Source: GRAINSA, 2007:3; SAFEX, 2006:17.

However, if a tariff is applied on an *ad valorem* basis (for example 10% of the value of imports) then any change in the international price or the Rand/US-Dollar exchange rate, will also affect the tariff component of the final IPP (Parr, 2005:3). It is important to remember that a price calculated according to the principle of import parity is a speculative price and it does not necessarily reflect the actual costs incurred by the supplier. In reality a supplier's costs might be less than the IPP. This is often the alleged reason why customers are unhappy about being charged an IPP (Parr, 2005:3; SAGIS, 2007:27).

However, an IPP might be lower than the costs incurred by a domestic supplier, in which case the customers might benefit from IPPs if the suppliers were constrained to price at or below the IPP. This situation would be unsustainable for the domestic manufacturers over the long run (SAGIS, 2007:27). To illustrate the benefits of import parity pricing for the consumers, the strength of the Rand has allowed imports of many goods to become available in South Africa at reduced prices, sometimes at the expense of the domestic suppliers (GRAINSA, 2007:3; Parr, 2005:3).

Pricing at import parity would allow the domestic suppliers to cover their costs and earn economic profits. However, it might not be possible for them to price at import parity if they face vigorous competition domestically (Parr, 2005:3; SAGIS, 2007:27). In that case it is expected that prices would be competed down to some level below import parity. These considerations lead naturally to the question of what product and market structures would be susceptible to import parity pricing? Parr (2005:3) suggested some criteria on this issue:

i. Products that are protected against imports by certain tariffs and other trade barriers (for example high rates of tariff protection, high specific tariffs, and restrictive quotas).
ii. Goods that are protected from imports by high transportation costs relative to the value of the product (that is goods with a low value-to-volume ratio).
iii. Products that are produced in locations geographically remote from trading partners (for example South Africa in general).
iv. Goods that are produced in locations with poorly developed, maintained and managed transport infrastructure (for example the South African rail services). This factor would only serve to magnify the susceptibility to import parity pricing of products with a low value-to-volume ratio.
v. Products that are produced in a domestic industry that is concentrated which leads to a situation where competition between domestic suppliers is either weak or non-existent.
vi. Goods that are produced in a domestic industry that has no intrinsic or initial comparative advantage. These products must be sheltered by IPPs in order to be able to compete with imports (that is international markets).

vii. Products that have a high imported content are primarily influenced by the international price and the Rand/US-Dollar exchange rate.

viii. Goods where the domestic supply is inadequate to fulfil the domestic demand. Thus the entire domestic output is priced at the marginal cost and in this case it would be the cost (that is the IPP) of the last imported unit.

There are many factors that contribute to the determination of a price charged at import parity levels. These factors are in turn variables that can and do change over time. For example, the South African experience since the 2000/01 production season has seen wildly fluctuating rates of exchange (see Figure 4-18) that have caused similar variations in import parity prices (Parr, 2005:3; SAGIS, 2007:27).

In turn, these changes in import parity prices have had different effects in different sectors of the economy. As previously mentioned, the prices of oilseeds can vary substantially from one season to the next. Even though sunflower seed is traded on SAFEX, the local price of sunflower seed is not only influenced by the supply and demand factors of sunflower seed alone, but also by the supply and demand factors of the international vegetable oil and protein feed market (FAPRI, 2005:248; NAMC, 2007:236; FAPRI, 2007:258).

The international vegetable oil prices act as parameters for the domestic seed and oil prices. Particularly the state of affairs in the Argentinean vegetable oil market has a momentous impact on the local market. This is because the Argentinean vegetable oil market has the same marketing period for sunflower seed as the South African producers (NAMC, 2007:236). For this reason the South African sunflower crude oil price (that is at the Reef) is to a large extent dependent on the Argentinean free on board (FOB)[31] price (that is for sunflower and soybean crude oil) and the European cost, insurance and freight (CIF)[32] price (that is for crude palm oil) (FAPRI, 2005:248; NAMC, 2007:236; BFAP, 2006:23). Therefore, it is evident that the crude vegetable oil prices of Argentina and Europe can be regarded as part of the IPP of crude

[31] *Free On Board or Freight on Board is a term commonly used when shipping goods to indicate who pays loading and transportation costs or the point where the responsibility and ownership of the goods transfers from shipper to buyer (Wikipedia, 2007:7).*

[32] *Cost, Insurance, and Freight is a common term in a sales contract that may be encountered in international trading when ocean transport is used. When a price is quoted CIF, it means that the selling price includes the cost of the goods, freight or transport costs, and also the cost of marine insurance (Wikipedia, 2007:7).*

vegetable oil in Rand terms. If an entity looks to import substitutes for sunflower oil, the cheapest products are usually soybean and palm oil. As a last resort South Africa will import sunflower oil, but soybean and palm oil are the cost-effective substitutes for sunflower oil (see Figure 4-17). Although these vegetable oils are primarily imported from Argentina and Malaysia/Indonesia, the international accepted price of palm oil is the price indicated in Table 4-14 (Killian, 2006:1; Berg, 2006:1; Coetzer, 2006:1; FAPRI, 2007:258).

Table 4-14 International oilseed product prices

Commodity	Product	International Price	Unit
Sunflower Products	Seed	EU, CIF Amsterdam	US-Dollar per Ton
	Oilcake/Meal	Argentina , CIF Rotterdam	US-Dollar per Ton
	Crude Oil	Argentine, FOB	US-Dollar per Ton
Palm Products	Kernel Oil	CIF Rotterdam	US-Dollar per Ton
	Crude Oil	CIF Europe	US-Dollar per Ton
	Kernel Meal	21/23%, CIF Rotterdam	US-Dollar per Ton
Soybean Products	Seed	Argentine , CIF Rotterdam	US-Dollar per Ton
	Oilcake/Meal	Argentina, CIF Rotterdam	US-Dollar per Ton
	Crude Oil	Argentine, FOB	US-Dollar per Ton

Source: FAPRI, 2005:49; FAPRI, 2007:99

The importation of sunflower seed compared to sunflower oil will be very expensive and only happens on singular occasions (Berg, 2006:1). Obviously the determination of the import parity level of an agricultural commodity is vital to the examination of the international price of the specific commodity. Soybean oil prices are primarily determined by the Chicago Board of Trade (CBOT)[33]. The Argentinean FOB prices are derived from the USA prices and the general demand and supply dynamics between the USA and Argentina will determine the price level. However, the Argentinean prices have been cheaper than the USA prices of late (Berg, 2006:1; FAPRI, 2005:49; FAPRI, 2007:258). Table 4-14 indicates the international accepted price quotes for sunflower, palm, and soybean products.

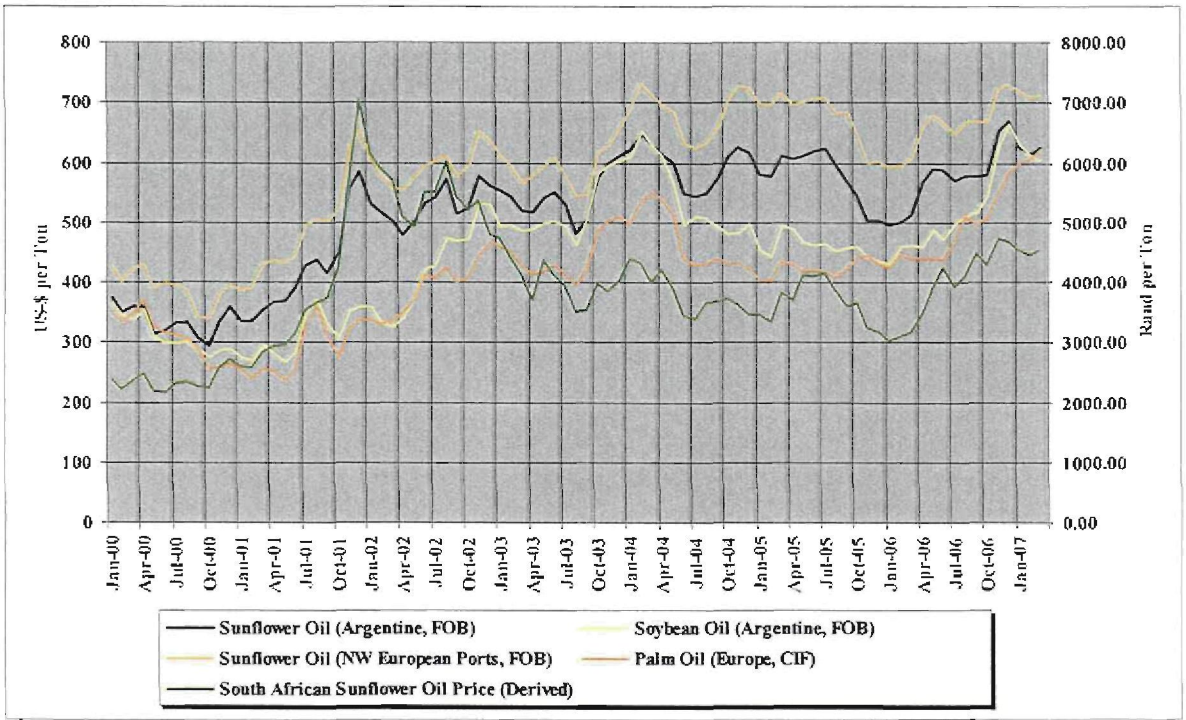
As previously mentioned, South Africa is a net importer of vegetable oil and that implies that the local price is traded close to import parity levels (FAPRI, 2005:248; BFAP, 2006:23; NAMC, 2007:236). If a refinery can import crude vegetable oil from Argentina, Malaysia, or Indonesia

[33] *The Chicago Board of Trade, established in 1848, was the world's oldest futures and options exchange. More than 50 different options and futures contracts were traded by over 3,600 CBOT members through open outcry and e-Trading. Volumes at the exchange in 2003 were a record breaking 454 million contracts. However, on 12 July 2007, the CBOT merged with the Chicago Mercantile Exchange (CME) and CME Group was created. As a result, the CBOT ceased to exist as an independent entity (ECONLIB, 2006:17; Wikipedia, 2007:7).*

at a lower price than that of the locally produced oil supplied by the crushers, the refineries will simply decide to import the oil. This is the reason why more than 60% of all the sunflower oil refineries in South Africa are close to the Durban harbour (GRAINSA, 2007:12; NAMC, 2007:236). South Africa is not a major role player when it comes to the international oilseed production and trade industries. As a result, South Africa is regarded as a price taker in the global oilseed industry (SAFEX, 2006:17; SAGIS, 2007:27).

The rapid increase in the price of sunflower oil during November 2000 - December 2001 and November 2003 - February 2004 in Figure 4-19 was not only caused by the depreciation in the Rand/US-Dollar exchange rate, but it also coincided with a drastic increase in the FOB price of Argentinean sunflower oil and the North-West European ports sunflower oil FOB price. That resulted in the opening of a gap between the soybean oil and sunflower oil prices (Figure 4-19). Traditionally the sunflower oil world prices have traded at an estimated premium of $20 per ton over the world prices of soybean oil. However, the fact that the gap between the sunflower and soybean oil was as high as $222 per ton during December 2001 - January 2002 influenced the overall purchasing behaviour of the crushers and the refineries in South Africa significantly (GRAINSA, 2007:12; SAFEX, 2006:17; SAGIS, 2007:27).

Figure 4-19 International and South African sunflower oil prices

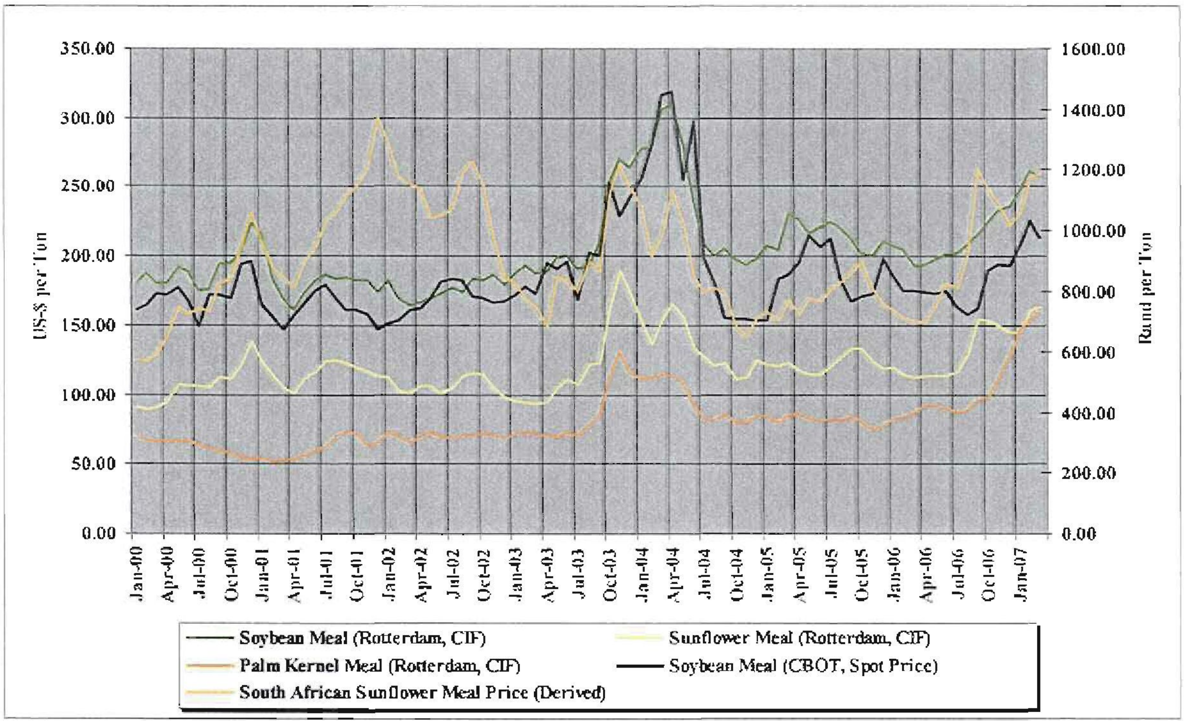


Source: EconStats, 2007:18; Oilworld, 2007:18.

When considering the international sunflower market, it becomes obvious that sunflower crude oil and not sunflower seed is imported and that the overall price an oilseed processor is willing to pay for sunflower seed should additionally be derived from the IPP of sunflower crude oil. Also keeping in mind the prices of other vegetable oils, that can serve as substitutes for sunflower oil, such as soybean and palm oil (FAPRI, 2005:248; NAMC, 2007:236). Figure 4-19 compares the South African sunflower oil price in Rand per ton to the Argentine and the North-West European ports' sunflower oil price, the Argentine soybean price and the Europe palm oil price.

Despite the fact that more than 250,000 metric tons of sunflower oilcake/meal is produced locally, sunflower oilcake/meal is regarded as a by-product and the prices are very volatile. A viable substitute for sunflower oilcake/meal is soybean oilcake/meal and Coetzer (2006:1) indicated that rapeseed products can be used as substitutes for sunflower products. However, it is too expensive and, therefore, not a cost-effective substitute for sunflower products (Berg, 2006:1; Killian, 2006:1).

Figure 4-20 International and South African sunflower oilcake/meal prices



Source: AFMA, 2007:25; Oilworld, 2007:18; SAFEX, 2006:17.

Figure 4-20 presents the international protein feed prices in US-Dollar per ton and the South African sunflower oilcake/meal price in Rand per ton. The sunflower oilcake/meal price in South Africa is derived from the soybean oilcake/meal price after the relative protein content and the final consumption value of the oilcake/meal is taken into consideration (NAMC, 2007:238). Due to the absence of a formally traded sunflower oilcake/meal price in South Africa, the oilcake/meal formula[34] can serve as a guideline in the determination of local sunflower oilcake/meal prices. However, the level of oilseed prices in the first quarter of 2003 verifies that the formula does not always provide an accurate estimation of what the local price of oilcake/meal ought to be (SAGIS, 2006:26; SAFEX, 2006:17 GRAINSA, 2007:12). For the first three months of 2003 sunflower meal traded at an average price of R800.00 per ton, while the formula to a certain extent suggests an average level of R1,270.00 per ton. It was simply local demand and supply conditions of oilcake/meal that dictated this low price.

4.5.4 Conclusion

Section 4.5 discussed SAFEX and inspected the structure and history of the South African futures market. The futures contracts available on SAFEX and the general formation of the sunflower seed futures prices in South Africa were additionally examined in this section. The factors that influence the futures price of an agricultural commodity are the supply and demand of a commodity, weather patterns, international currency fluctuations, and whether or not there is an active cash market for the specific agricultural commodity.

The factors that influence the formation of sunflower prices in South Africa identified in this section were the production of sunflower seed and soybeans, and the crushing of oilseeds. Additional vegetable oil factors identified in this section were the refining of crude vegetable oil, and the retail price of sunflower oil. The IPP of sunflower and soybean products, the Rand/US-Dollar exchange rate, and the transportation and insurance costs associated with the commodities were supplementary factors that were identified in section 4.5. The importation of vegetable oil and the supply and demand factors of the international vegetable oil and protein feed markets were the final factors identified as influential to the formation of sunflower prices in South Africa.

[34] *Firstly, the soybean oilcake/meal price has to be adjusted to take into account the different protein contents of sunflower (that is 38% protein) and soybean oilcake/meal (that is 47% protein). As a result, the soybean oilcake/meal price has to be divided by 0.47 and multiplied by 0.38. The second step is to multiply this adjusted oilcake/meal price by 0.65. The reason for this is that the industry specialists regard the final consumption value of sunflower oilcake/meal to be approximately 65% of the value of soybean oilcake meal (AFMA, 2007:25; NAMC, 2007:236).*

Certain crucial information about the potential factors that influence the price of sunflower in South Africa was reinforced by this section. The overall sunflower seed to sunflower oil value chain placed the whole supply and demand sequence in South Africa into perspective. The potential factors identified in this section will be discussed in the concluding section of this chapter, and be incorporated as potential (that is dependent or independent) variables in the various South African sunflower price models in *Chapter 5*.

4.6 Conclusion

Chapter 4 examined the South African sunflower market and identified the factors that influence the demand and supply of sunflower seed, sunflower oil and sunflower oilcake/meal in South Africa. Table 4-15 summarises all the influential factors that have been identified throughout *Chapter 3* and *Chapter 4*. Within each section of both chapters clearly defined factors for that specific section were identified and tabulated. To ease the identification process of the potential factors that influence the price of sunflower in South Africa, Table 4-15 is arranged into four key groups.

The factors in Group A focus primarily on the production of sunflower seed, oil, and oilcake/meal in the international and South African sunflower industries. The main production factors identified throughout *Chapter 4* that influence the supply of sunflower products in South Africa are the annual area of sunflower seed and soybeans harvested, the total oilseed crushing capacity in South Africa, and the yield of the sunflower and soybean plants (refer Table 4-15, Group A).

The factors identified in Group B are the consumption factors that influence the demand for sunflower seed, oil, and oilcake/meal internationally and in South Africa. The principle consumption factors identified in *Chapter 4* that influence the demand for sunflower products in South Africa are the increased consumption of protein feed (that is sunflower, palm, and soybean oilcake/meal), the increased demand for vegetable oil (that is sunflower, palm, and soybean oil) for human and industrial utilisation, and the international trade of sunflower products (that is the importation of supplementary and complementary oilseed products due to higher demand) (refer Table 4-15, Group B).

Table 4-15 Factor comparison of *Chapter 3* and *Chapter 4*

Identified Influential Factors	Section 3.2	Section 3.3 and Section 3.4							Section 3.5	Section 4.3	Section 4.4	Section 4.5	Group
Region (Subdivision)	**Globe**	**CIS**	**ARG**	**EU-25**	**BR**	**CHI**	**USA**	**ROW**	**Globe**	**Seed**	**Oil & Meal**	**SAFEX**	
Area Harvested	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑		☑	A
Competing Crop (Rapeseed)				☑									A
Competing Crop (Soybeans)				☑			☑	☑		☑		☑	A
Crushing Capacity of Oilseeds		☑								☑	☑	☑	A
Export Taxes		☑											A
Government Policies and Support Programs									☑			☑	A
Input Prices (Production)									☑	☑			A
Storage Costs									☑			☑	A
Transportation Costs									☑		☑	☑	A
Weather Conditions							☑	☑	☑	☑			A
Yield of the Sunflower Plant	☑	☑			☑	☑		☑	☑	☑		☑	A
Per Capita Spending (Income)	☑									☑			B
Protein Feed (Beef, Poultry and Dairy Industries)	☑	☑	☑	☑		☑	☑	☑		☑	☑	☑	B
Protein Feed (Human Consumption)	☑	☑	☑	☑		☑	☑	☑		☑	☑	☑	B
Soybeans Demand (Substitute Oilseed)									☑	☑	☑	☑	B
Sunflower Seed Demand (Domestic Price)	☑								☑	☑	☑	☑	B
Trade of Sunflower Oilcake/Meal		☑	☑	☑	☑	☑		☑	☑	☑	☑	☑	B
Trade of Sunflower Oil		☑	☑	☑	☑	☑		☑	☑	☑	☑	☑	B
Vegetable Oil (Bio-Etanol and Bio-Diesel)	☑	☑		☑		☑	☑	☑		☑		☑	B
Vegetable Oil (Human Consumption)	☑			☑		☑		☑		☑	☑	☑	B
Import Parity Price of Soybeans										☑	☑	☑	C
Import Parity Price of Sunflower Seed										☑	☑	☑	C
International Palm Oil Prices				☑				☑	☑	☑	☑	☑	C
International Soybean Oilcake/Meal Prices		☑	☑	☑		☑	☑	☑	☑	☑	☑	☑	C
International Soybean Oil Prices				☑		☑	☑	☑	☑	☑	☑	☑	C
International Sunflower Oilcake/Meal Prices		☑	☑	☑	☑	☑		☑	☑	☑	☑	☑	C
International Sunflower Oil Prices		☑	☑	☑	☑	☑		☑	☑	☑	☑	☑	C
Brent Crude Oil Price										☑			D
Macro-Economic Forces									☑	☑			D

Source: Table 4-15 was derived from the information in *Chapter 3* and *Chapter 4*

Table 4-16 Potential factors that influence the price of sunflower in South Africa

Division	Identified Factors (*Chapter 3* and *Chapter 4*)	Potential Influential Factor
Production and Consumption	- Area harvested of sunflower seed (opening stock of sunflower seed). - Yield of sunflower seed per hectare (deliveries of sunflower seed). - Importation of sunflower seed. - Amount of processed sunflower seed in South Africa (excluding sunflower seed crushed for oil and oilcake/meal). - Amount of sunflower seed withdrawn by the South African grain industries. - Amount of sunflower seed released to the end consumers. - Amount of sunflower seed held for replanting purposes. - Exporting of whole grain sunflower seed to neighbouring countries (if enough sunflower seed is produced to meet the local demand).	South African Sunflower Seed (Closing Stock)
	- Area harvested of soybeans (opening stock of soybeans). - Yield of sunflower seed per hectare (deliveries of soybeans). - Importation of soybeans - Amount of processed soybeans in South Africa (excluding soybeans crushed for oil and oilcake/meal). - Amount of soybeans withdrawn by the South African grain industries - Amount of soybeans released to the end consumers. - Amount of soybeans held for replanting purposes. - Exporting of whole grain soybeans to neighbouring countries (if enough soybeans are produced to meet the local demand)	South African Soybeans (Closing Stock)
	- Utilisation of sunflower seed for the production of sunflower oil and oilcake/meal.	South African Processed Sunflower
	- Utilisation of soybeans for the production of soybean oil and oilcake/meal.	South African Processed Soybeans
	- Sunflower seed processed for consumption is determined by the demand (average income per capita).	South African Cooking Oil Price (750ml)
	- Weather conditions (rainfall and drought).	Free State Province Rainfall
		North-West Province Rainfall
	- Importation of vegetable oil and oilcake/meal to meet the growing South African demand.	Soybean Oil & Oilcake Imports
		Sunflower Oil & Oilcake Imports
		Palm Oil & Oilcake Imports
Trade	- Import parity price of sunflower seed (Randfontein depot in South Africa).	SAFEX Sunflower Import Parity Price
	- Import parity price of soybeans (Randfontein depot in South Africa).	SAFEX Soybean Import Parity Price
	- International sunflower oilcake/meal price (importation of complementary protein feed).	Sunflower Meal: Argentine , CIF Rotterdam
	- International sunflower oil price (importation of complementary vegetable oil).	Sunflower Crude Oil: Argentine, FOB
	- International palm oil price (importation of substitute vegetable oils).	Crude Palm Oil: CIF Europe
	- International palm kernel oilcake/meal price (importation of substitute protein feed).	Palm Kernel Meal: 21/23%, CIF Rotterdam
	- International soybean oilcake/meal price (importation of substitute protein feed).	Soybean Meal: Argentina, CIF Rotterdam
	- International soybean oil price (importation of substitute vegetable oils).	Soybean Crude Oil: Argentine, FOB
Macro-Economic	- Rand/US-Dollar exchange rate.	Rand/US-Dollar Exchange Rate
	- Brent crude oil price per barrel.	Brent Crude Oil Price per Barrel

Source: Table 4-16 was derived from the information in *Chapter 3* and *Chapter 4*.

Group C in Table 4-15 represents the factors that mainly focus on the trade of oilseeds and its products on an international and South African scale. The chief factors that influence the trade of sunflower products are the international vegetable oil prices (that is sunflower, palm, and soybean oil prices) and the international oilcake/meal prices (that is sunflower, palm, and soybean oilcake/meal prices) (refer Table 4-15, Group C).

The final group in Table 4-15 is Group D. This group centres on the factors that influence the production, consumption, and trade of agricultural crops as an integrated industry around the world. The Rand/US-Dollar exchange rate is identified as the only key influential macroeconomic factor to the global oilseed industry (refer Table 4-15, Group D).

With all the influential production, consumption, trade, and macroeconomic factors of sunflower products identified, it is essential for the empirical study section of this dissertation to organise the different identified factors into potential factors that influence the price of sunflower in South Africa. Table 4-16 utilises the information that is provided in the various groups (that is A, B, C and D) of Table 4-15 and arranges the identified influential factors into a production and consumption division, a trade division and a macroeconomic division. The third column of Table 4-16 indicates the potential factors that will be considered as influential to the price of sunflower in South Africa.

The data properties of these potential influential factors will be discussed in the next chapter and more clarity will be provided on the source and frequency of the data. The potential influential factors will be analysed in the empirical study section of this dissertation as independent variables to the price of sunflower (that is the dependent variable) in South Africa. The key factors that influence the price of sunflower in South Africa will be included in the South African sunflower price models' research and development process.

The first section of the next chapter (*Chapter 5*) will perform a literature re-evaluation on a number of related agricultural commodity price modelling studies. *Chapter 5* will also discuss the data properties of the potential factors that have been identified as influential to the price of sunflower in South Africa. However, the most important section of *Chapter 5* will be the econometric study of this dissertation. This section will be utilised to identify the influential price factors of sunflower in South Africa and will construct the SASPM.

5

Empirical Study

5.1 Introduction

Researchers and traders alike are interested in gaining an understanding of commodity prices. Although the academic society is primarily concerned with satisfying their intellectual curiosity, there is nothing to prohibit academic research from being used to create wealth. At present modern trading companies are increasingly making use of econometric techniques to explain commodity prices, and to enhance their forecasting capability. Regardless of the fact that forecasting is nothing but a simple simulation exercise, there is no uniformly accepted scientific methodology to generate price forecasts (Kaltsas, 2000:273). Structural model development in the 1970s (that is based on supply and demand equations) was abandoned in favour of Box-Jenkins techniques in the 1980s and the early 1990s. However, recently commodity forecasting has been based on Bayesian models and the use of qualitative models.

Forecasting literature has largely ignored recent developments in the theory of integrated commodity markets. According to this theory, commodity markets are integrated in the sense that price movements are transmitted across spatially dispersed markets and across different commodities (Kaltsas, 2000:273). The development of econometric techniques, economic theory, and the computational capacity of computers has encouraged agricultural economists and policy analysts to work at better understanding and predicting movements in prices and government policies. This will result in an improvement in the prediction of the quantities demanded and supplied due to the various changes in the market conditions of a specific commodity.

"The strength of agricultural economics rests on its capacity to combine theory, quantitative methods, and data to do useful analysis of problems faced by society" (Tomek, 1993:75).

The availability of a sunflower price modelling system during the existence of the Marketing Boards in South Africa could have provided extremely useful information for the evaluation and the quantification of the impacts of unusual agricultural and macroeconomic policies. Particularly during a time when the main focus of the Marketing Board was on the implementation of agricultural policies and subsidies (Meyer, 2005:36; NDA, 2006:13; AGRISA, 2006:12). Their decision making processes could have been greatly improved if a price modelling system had been initiated and developed. However, virtually all the price modelling work that was conducted during that time focused exclusively on single equation estimations of demand and supply (AGRISA, 2006:12). The recent depreciation of the Rand can be used to demonstrate this as a range of questions are raised regarding the impacts of this depreciation on consumers, and the input on the different markets within the broad economy. Given the current standing of sunflower price modelling work in South Africa, these questions can be answered by analysing the impact of the depreciation of the Rand on consumers and producers independently and not by solving contemporaneous systems of equations (NAMC, 2007:20).

This chapter divided into four sections. Section 5.2 provides an overview of the literature relating to the different studies on the agricultural industry in respect of this dissertation. Section 5.3 examines the data properties of all the potential factors that were identified in the previous chapters (that is the dependent and independent variables). Section 5.4 presents the econometric study of the identified factors (that is the development of the different price models of sunflower in South Africa) and the results of the different South African sunflower price models (SASPM). The final section describes the conclusions reached in this chapter.

5.2 Related studies on the agricultural industry

5.2.1 Introduction

The systematic process of global integration carries with it broad implications for farmers and their related industries in many parts of the world and impacts the global economy directly. As a result, the assessment of agricultural trade policies and their impact are bound to be complex and are often supported by quantitative policy analyses. Therefore, the development of global agricultural price models is considered to be well established and has become an integrated part of world economies and economic reviews (Meyer, 2005:36; NDA, 2006:13).

The following studies on the agricultural industry will subsequently be reviewed to gain a thorough understanding of agricultural price model development.

5.2.2 Roberts and Fackler (1999)

Schwartz (1997) provided an integrated framework for the modelling of futures prices. This framework incorporated arbitrage relationships and allowed futures contracts of all maturities to be used simultaneously in the estimation of model parameters. This approach avoided some of the problems that occurred in trying to get the futures prices to fit the assumptions of "off-the-shelf" time series models. However, the most obvious of these was the roll-over problem that occurred at a contract's maturity (Roberts and Fackler, 1999). The more subtle and often simply ignored problems were the complex relationships that arose due to the maturity structure of futures and the convergence of futures to spot prices at maturity. However, these effects were incorporated into the price model structure in Schwartz's (1997) approach and for this reason do not require special attention.

One important extension to Schwartz's (1997) price model for agricultural commodities was the incorporation of seasonal effects into the model (Roberts and Fackler, 1999). All the price model parameters can be made to be seasonal functions of time, and with the exception of the mean reversion speed parameters, this extension only changes the definition of the $A(t)$ term in the futures price function. The specific seasonal function used allowed the mean of the convenience yield to vary over the year. In an application to wheat futures, this was clearly warranted by the results presented by Roberts and Fackler (1999).

5.2.3 Westcott and Hoffman (1999)

Westcott and Hoffman (1999) signified that maize and wheat crops have prominent roles in the USA's agricultural sector as important sources of cash receipts and farm income to producers. Additional roles include linkages within the agricultural sector among various crops, linkages between crops and livestock, and as major crops in the global agricultural trade. Information that affects the market conditions and the prices for maize and wheat is particularly important. Subsequently, the agricultural sector of the USA has become more market oriented under the agricultural policy changes of the last 10 - 15 years. As a result, the maize and the wheat prices are carefully watched throughout much of the agricultural sector.

Westcott and Hoffman's (1999) technical bulletin examined some of the factors that affect the USA's farm-level prices for maize and wheat. They developed price determination models for these crops by using an annual framework. The models were built on two types of factors that influence the maize and wheat prices. The first factor type is the market supply and demand conditions and the second factor type incorporated government policy variables (Westcott and Hoffman, 1999). Westcott and Hoffman (1999) utilised a stocks-to-use ratio formulation to capture the effects of market supply and demand factors on price determination. This formulation was augmented by factors that represent the changing role of agricultural policies (that is the government price support and stockholding programs). The wheat price model also reflected the influence of international market conditions and they were represented by the stocks-to-use ratio for four major competitors. Additionally, the role of wheat feeding and competition with maize for protein feed utilisation in the summer quarter affected the pricing of wheat (Westcott and Hoffman, 1999).

The model's properties indicated the relative sensitivity of prices to changes in the different independent variables. Statistical evaluation measures of the price models specified first-class performance. This is particularly the case given the large range of maize and wheat prices over the sample period that were used to estimate the model (1975 - 1996) as well as the changing nature of the influence of government programs on price determination (Westcott and Hoffman, 1999). The relatively simple structure of the estimated price models and their small data requirements lent themselves to be used in price-forecasting applications. This was done in conjunction with a comprehensive market analysis of supply and demand conditions. These models have been implemented into the United States Department of Agriculture's (USDA) short-term market analysis and their long-term baseline projection activities. In these applications the models provided an analytical framework for the forecasting of the prices and a vehicle for making consistency checks among the USDA's supply, demand, and price forecasts (Westcott and Hoffman, 1999).

5.2.4 Kaltsas (2000)

Kaltsas (2000) argued in his paper that recent advances in the market integration literature can be used to explain and to forecast the changes in the international cotton prices. Kaltsas's (2000) theoretical model was based on the existence of a geographically integrated oligopolistic cotton market. The exogenous shocks were captured by the co-movements in the agricultural commodity prices and the structural variables were determined by historical factors. The USA plays a central role in the formation of world prices. Hence, by utilising the supply and demand balance in the USA and in the rest of the world, Kaltsas (2000) justified past fluctuations and made mathematical predictions of the future level of international prices. This implies that policy programs in dominant markets may determine the price movements to a certain extent and that the accuracy of the forecasts depends on the successful prediction of the structural variables and the deflator. Ultimately, the importance of Kaltsas's (2000) results must not be overemphasised given the small range of observations and the existence of structural changes within this period.

5.2.5 Booth and Ciner (2001)

Booth and Ciner (2001) investigated alternative explanations of long-term co-movements among the prices of agricultural commodity futures contracts. The long-term interdependency of these prices can exist because of common economic fundamentals, or herd behaviour by market participants. An analysis of the Tokyo Grain Exchange futures prices supports the common economic fundamentals hypothesis (Booth and Ciner, 2001).

Co-integration tests indicated that the prices of four commodity futures traded on the Tokyo Grain Exchange did not move together in the long run. This finding by Booth and Ciner (2001) was in contrast to the Chicago Board of Trade's findings and implied that market participants did not become bearish and bullish on all contracts without plausible economic reason. Moreover, taken by themselves, the Tokyo Grain Exchange's maize and soybean prices are co-integrated. Since both of these commodities are grown in the USA, this relationship is consistent with the agricultural commodity futures' long-run co-movements. This was in response to common economic fundamentals and not herding behaviour attributed to traders (Booth and Ciner, 2001).

5.2.6 Kobzev (2002)

Kobzev (2002) established that excessive marketing cost and certain ineffective instruments of state agricultural policy negatively impact domestic agricultural production. This is the primary cause of distortional effects both at a national, and a regional level. This will subsequently lead to a redistribution of economic wealth between various economic agents and cause substantial losses in the total social welfare. Although Ukraine's agricultural potential greatly exceeds the present level of agricultural production, the described ineffective mechanisms and policies remain a bottleneck for agricultural reform in the Ukraine (Kobzev, 2002). Along with the negative redistribution effect at the national level, the excessive marketing costs, and the export duty forms the foundation for the redistribution of social welfare across the regions. Due to the lower domestic prices the main production oblasts[35] implicitly subsidised the oblasts with large volumes of consumption (Kobzev, 2002).

Kobzev (2002) signified that the elimination of excessive marketing costs would lead to a considerable increase in the social welfare in the main wheat production areas of Odesa, Vinnycya, Kherson, and Khmelnytsky oblasts. This was also true for the main sunflower seed producing areas, to be exact the Donetsk, Dripropetrovsk, Zaporizhya, Kharkiv, and Odesa oblasts. With a lower domestic price these oblasts subsidised the oil processing enterprises in the rest of the country (Kobzev, 2002). The practice of regional bans on the movement of agricultural commodities created a serious impediment to the efficiency of regional agricultural trade in the Ukraine. The introduction of a regional ban (even in only one of Ukraine's oblasts) resulted in the redistribution of producer and consumer surpluses in many other regions of the nation. The reduction in producer surplus exceeded the increase in consumer surplus, which subsequently lead to substantial losses to national welfare as a whole (Kobzev, 2002).

5.2.7 Deaton and Laroque (2003)

Deaton and Laroque (2003) proposed a statistical model of commodity prices that was based on Sir Arthur Lewis' account. That is where the price of tropical produce is held down by the existence of unlimited supplies of labour in tropical countries. In Deaton and Laroque's (2003) version of the model prices were stationary around a long-run trend, production was co-integrated with world income and the rate of growth of supply responded to deviations of price from its long-run equilibrium. Deaton and Laroque (2003) have fitted this model to long-run data for six commodities (that is cocoa, coffee, copper, rice, sugar, and tin) over some subset of the years 1900 - 1987 (that is annual data).

[35] *The word "oblast" is a loanword in English. However, it is nevertheless often translated as "area", "zone", "province" or "region" (Wikipedia, 2007:7).*

Their final assessment of the model was mixed and their results can certainly be interpreted in a Lewis framework. The deviation of long-run demand from long-run supply exerted upward pressure on both the price and the production. Except for one commodity (that is tin), the rate of growth of supply responded positively to the deviations of price from its long-run value (Deaton and Laroque, 2003). However, only for coffee and cocoa were these long-run supply effects significantly different from zero. In spite of the enormous growth of world income during the 20^{th} century, the associated increase in the supply has been forthcoming without an increase in the real price of these commodities. As Lewis predicted, increases in the real commodity prices must wait for the elimination of poverty in the tropics (Deaton and Laroque, 2003).

However, it should also be noted that Deaton and Laroque have not succeeded in providing any crucial evidence that would convert a sceptic to the Lewis story. The lack of long-run trend in commodity prices was a remarkable fact that was consistent with the Lewis' account. As far as Deaton and Laroque's model is concerned, they utilised their insight in constructing the model so that its success cannot be counted as any additional support for their formulation.

One source of difficulty was that the reversion of prices to their long-run base was very slow. Even a century of data was not enough to give clear results on either the stationarity of prices or the co-integration of the production and the output. In other words, the empirical evidence was never very clear in rejecting alternatives. Deaton and Laroque saw that the mechanical application of standard unit root tests would lead to the conclusion that prices are integrated processes. That is something that can easily be interpreted in terms of the low power of such tests, especially against slow mean reversion. Nevertheless, Deaton and Laroque were left without any direct statistical support for the model from the time-series tests.

Deaton and Laroque's more detailed results, while consistent with the Lewis model, suffered from a lack of statistical significance. The overall regressions of the models came mostly from the univariate time-series representations that are of little interest in the current context. The exceptions were cocoa and coffee (that is the two commodities whose production was confined to the tropics) and for which the Lewis model is most obviously consistent with the data. For all the commodities the price equations fit well, but only because Deaton and Laroque (2003) were working in levels and regressing prices with lags.

As in their work on speculative storage, their explanation of the autocorrelation of prices was essentially an assumed autoregressive process. The production and world income equations were essentially auto-regressions in first-differences and the terms of interest played a relatively minor role. Deaton and Laroque spent a great deal of time trying to dissect these results further, in order to find a crucial piece of evidence that would either support the model (by being hard to interpret without it) or refute it. However, as is often the case with economic time series, it is hard to find clear cut evidence that would convince a true sceptic (Deaton and Laroque, 2003).

5.2.8 Labys (2005)

Labys (2005) stated that the twentieth century has only been the latest spectator to the impacts and the importance of commodity price fluctuations. He said that it is reasonably well known that the commodity price records came down to the present from the ancient civilisations of India, Mesopotamia, Egypt, Greece, and Rome. Formal research on the relationships between agricultural demand, supply, and the prices in a market context only began early in this century (Labys, 2005). This research not only evolved in sophistication, but also extended to mineral and energy commodities. At the beginning of the century some of the earliest work took place on the application of statistical methods to price series.

The purpose of Labys' paper was to review how this progress has contributed to analysing the commodity markets, the prices, and to solve the price forecasting problems (that is concentrating on the more recent advances in econometric modelling and time series analysis). Attention was also paid to spatial developments that have various implications for regional price modelling. Labys attempted to review the major issues involved in the modelling and the forecasting of commodity prices. It should be noted that a considerable legacy exists concerning the research that has taken place in the 20^{th} century.

Labys nevertheless stated that there are still many problems that must be solved. This is due to the fact that time series methods are evolving so rapidly that it is difficult to track their frequent applications to price analysis (Labys, 2005). However, because of the importance of, and the active interest in primary commodity markets and prices, there is no doubt that research in this area will continue to develop and to improve (Labys, 2005).

5.2.9 Conclusion

Table 5-1 is a comparison between the related agricultural commodity price modelling studies discussed in section 5.2 of this dissertation and the potential influential factors identified in *Chapter 3* and *Chapter 4*.

Table 5-1 Comparison of related commodity price modelling studies

Identified Influential Factors	Roberts and Fackler (1999)	Westcott and Hoffman (1999)	Kaltsas (2000)	Booth and Ciner (2001)	Kobzev (2002)	Deaton and Laroque (2003)	Labys (2005)	Potential Influential Factors
Domestic Price of Base Commodity					☑	☑	☑	☑
Economic Fundamentals				☑			☑	☑
Government Policy Programs		☑	☑		☑		☑	☑
Market Demand Conditions		☑	☑	☑		☑	☑	☑
Market Supply Conditions		☑	☑	☑			☑	☑
Marketing Cost					☑			☑
Seasonal Effects	☑							☑
Social Welfare (Per Capita Income)					☑	☑	☑	☑
Substitute Commodities		☑					☑	☑

Source: Information in section 5.2 of *Chapter 5*.

Kobzev (2002), Deaton and Laroque (2003), and Labys (2005) indicated the importance of the domestic price of the base agricultural commodity (for example the various South African sunflower prices) in the modelling of commodity prices. Booth and Ciner (2001) and Labys (2005) discussed the importance of the incorporation of various economic fundamentals (for example macroeconomic forces like the Brent crude oil price and the Rand/US-Dollar exchange rate) into the price modelling of agricultural commodities. Westcott and Hoffman (1999), Kaltsas (2000), Kobzev (2002), and Labys (2005) signified that government policy programs (for example border control and import/export tariffs) are vital in the development of agricultural commodity price modelling methodologies.

Westcott and Hoffman (1999), Kaltsas (2000), Booth and Ciner (2001), Deaton and Laroque (2003), and Labys (2005) focused on the importance of market demand (that is the consumption) conditions in the preparation of a commodity price model. Westcott and Hoffman (1999), Kaltsas (2000), Booth and Ciner (2001), and Labys (2005) utilised the market supply (that is the production) conditions within their studies to aid the development of their various agricultural commodity price modelling methodologies. Kobzev (2002) incorporated marketing costs into his agricultural commodity price model and Roberts and Fackler (1999) confirmed the significance of seasonal effects (for example rainfall and drought patterns) in agricultural commodity price modelling. Kobzev (2002), Deaton and Laroque (2003), and Labys (2005) indicated the importance of social welfare (for example per capita income in a country) in the modelling of commodity prices. Westcott and Hoffman (1999) and Labys (2005) discussed the influence of substitute agricultural commodities on the modelling of agricultural prices.

As indicated from the related agricultural commodity price modelling studies cited in section 5.2, little has been done to investigate the factors that influence the price of sunflower on a global and South Africa level. Similarly, little has been done to construct a series of models that can explain future South African sunflower price fluctuations. Structural econometric models can be used to enhance and support intermediate economic intelligence and forecasting inputs. However, in general they can provide a means by which alternative agricultural and macroeconomic policies can be evaluated and quantified. Van Tongeren, Van Meijl, and Surry (2000:26) stated that no price model can serve all purposes (for example encompassing all aspects of price model specification and variable inclusion). Therefore, it is undeniably vital to identify the potential factors that influence the South African sunflower price.

The potential influential factors identified in Table 4-16 in *Chapter 4* were evaluated in comparison with the identified influential factors of the related agricultural studies discussed in section 5.2. As specified in Table 5-1 the potential factors that influence the price of sunflower in South Africa (in association to the related studies) are satisfactory in the development of a series of agricultural (that is sunflower) commodity price models.

The next section will examine the data properties of the potential influential factors to aid the identification of the dependent and independent variables for the econometric section of this dissertation.

5.3 Data properties

5.3.1 Sources

The first step in the data properties progression of this dissertation is to identify the sources of the data (and their proxies). The feasibility and credibility of the data utilised will naturally be supported by the institution or the organisation that provided the data. Table 5-2 specifies the different potential factors identified in *Chapter 4* (see Table 4-16), the different sunflower prices quoted by the South African Futures Exchange (SAFEX), and the sources of the data that will be utilised for the econometric study of this dissertation (see Table 5-2 for more clarification on the different sources of the data). The acronyms for each potential factor (that will be utilised for the rest of the empirical study) and the frequencies of the data are, furthermore, provided in Table 5-2. The data was captured into *Microsoft® Office Excel®* and assessed by utilising the *E-Views®* econometric forecasting and *SPSS Statistics®* software.

Table 5-2 Data properties of the potential influential factors

Data Name	Extracted In	Acronym	Frequency	Data Source
Dependent Variables				
SAFEX Sunflower Prices				
SAFEX Sunflower Spot Price	ZAR per Ton	SAFEXSSP	Monthly Data	GRAINSA
SAFEX Sunflower First Futures Price	ZAR per Ton	SAFEXS1P	Monthly Data	GRAINSA
SAFEX Sunflower Second Futures Price	ZAR per Ton	SAFEXS2P	Monthly Data	GRAINSA
SAFEX Sunflower Third Futures Price	ZAR per Ton	SAFEXS3P	Monthly Data	GRAINSA
Independent Variables				
Production and Consumption				
Free State Province Rainfall	Millimetres	FSPR	Monthly Data	SAWS
North-West Province Rainfall	Millimetres	NWPR	Monthly Data	SAWS
South Africa - Cooking Oil 750ml Price	ZAR Cent	SACOP	Monthly Data	SAGIS
South Africa Processed Soybeans	'000 Tons	SAPSB	Monthly Data	SAGIS
South Africa Processed Sunflower	'000 Tons	SAPSUN	Monthly Data	SAGIS
South Africa Soybeans - Closing Stock	'000 Tons	SASBC	Monthly Data	SAGIS
South Africa Sunflower Seed - Closing Stock	'000 Tons	SASUNC	Monthly Data	SAGIS
South African Palm Oil and Oilcake Imports	ZAR '000	SAPI	Monthly Data	DTI
South African Soybean Oil and Oilcake Imports	ZAR '000	SASBI	Monthly Data	DTI
South African Sunflower Oil and Oilcake Imports	ZAR '000	SASUNI	Monthly Data	DTI
Trade				
Crude Palm Oil: CIF Europe	USD per Ton	POE	Monthly Data	Oilworld
Palm Kernel Meal: 21/23%, CIF Rotterdam	USD per Ton	PKMROTT	Monthly Data	Oilworld
SAFEX Soybean Import Parity Price	ZAR per Ton	SBIPP	Monthly Data	GRAINSA
SAFEX Sunflower Import Parity Price	ZAR per Ton	SUNIPP	Monthly Data	GRAINSA
Soybean Crude Oil: Argentine, FOB	USD per Ton	ARGSBO	Monthly Data	Oilworld
Soybean Meal (Oilcake): Argentine, CIF Rotterdam	USD per Ton	ARGSBM	Monthly Data	Oilworld
Sunflower Crude Oil: Argentine, FOB	USD per Ton	ARGSUNO	Monthly Data	Oilworld
Sunflower Meal (Oilcake): Argentine, CIF Rotterdam	USD per Ton	ARGSUNM	Monthly Data	Oilworld
Macro Economic				
Brent Crude Oil Price per Barrel	USD	BCOP	Monthly Data	EconStats
Rand/US-Dollar Exchange Rate	ZAR for 1USD	RDER	Monthly Data	SARB

Source: South African Reserve Bank; EconStats; Oilworld; South African Grain Information Service;
South African Weather Service; Grain South Africa; The South African Department of Trade and Industry (2007).
Note: ZAR (South African Rand); USD (US-Dollar).

5.3.2 Frequencies

The second step in the data properties progression of this dissertation is to identify the frequency of the data. The data utilised is an important aspect of agricultural commodity price modelling. High frequency data (for example weekly and daily data) should be a source of useful information for anyone interested in analysing agricultural and economic activity in the current, incomplete month (SARB, 2007:16; STATSSA, 2007:16). Nonetheless, should agricultural forecasters with monthly price models use these high frequency data to improve their monthly forecasts? Few researchers in this area would disagree that the best way (that is in theory) to use these data is to develop a single model that relates to data of all frequencies. However, the development of such a comprehensive model is very complicated (Miller and Chin, 1996:17).

Alternatively, agricultural researchers have tried to shift to a weekly/daily model. This implies that they have to construct weekly/daily values of the data that is only available on a monthly basis (for example the international agricultural commodity prices provided by Oilworld). This method turns out to be helpful in updating forecasts of the current month based on incoming weekly/daily data. However, it is not helpful in forecasting for much longer horizons (Miller and Chin, 1996:17; SARB, 2007:16; STATSSA, 2007:16). Therefore, the data utilised in this study is monthly data stretching from January 2000 to March 2007 (see Table 5-2). That is 87 data points per identified potential factor (that is the dependent and independent variables).

The sources of the different potential influential factors and the frequencies of the data have been identified. As a result, it is important to discuss the properties of each potential factor's data. However, prior to any assumptions made about the data, it is important to standardise the data (that is to normalise the data) (Van Heerden, 2003:100).

5.3.3 Standardisation

To standardise the data actually means to transform the data to ensure that apples are indeed compared to apples and not oranges. The data utilised in this study is extremely diverse (see Table 5-2). It ranges from prices that are quoted in Rand per ton to prices quoted in US-Dollar per ton, from millimetres to actual monthly (that is Rand and cent) values. As a result, it is crucial to position the data on a standard scale and to capture a more descriptive price model for South African sunflower with better results.

Another fundamental reason why the standardisation of the data is so critical is to reduce unnecessary seasonal patterns, which can ultimately distort the results of the fitted model (Kutner, Nachtsheim, Neter, and Li, 2005:271). With the aid of the *Microsoft® Office Excel®* software package the data utilised (that is for each potential factor identified) in this dissertation is standardised by using the natural logarithm function. See *Appendix B* for the standardised dependent variables' graphs.

5.3.4 Correlation

The fourth step in the transformation of the data in this dissertation is to review the correlation of the standardised data to uncover inherent patterns as to the type and strength of the relationship amongst the variables. The correlation matrix of all the dependent and independent variables is a useful starting point for correlation analysis. While a strong linear association between the dependent variables and each of the independent variables is highly desirable, a strong linear association between the independent variables is highly undesirable. It is primarily suggestive of the presence of collinearity (multicollinearity) in the regressions (Field, 2005:1).

Appendix C shows the correlation matrix between the twenty independent variables identified in Table 5-2. The following highly significant correlations are observed in *Appendix C.*

i. **ARGSBM** is highly correlated with ARGSUNM and PKMROTT.
ii. **ARGSBO** is highly correlated with ARGSUNO, PKMROTT, POE, and SACOP.
iii. **ARGSUNM** is highly correlated with ARGSBM and PKMROTT.
iv. **ARGSUNO** is highly correlated with ARGSBO, PKMROTT, POE, SACOP, SAPI, SBIPP, and SUNIPP.
v. **FSPR** is highly correlated with NWPR and *vice versa.*
vi. **PKMROTT** is highly correlated with ARGSBM, ARGSBO, ARGSUNM, ARGSUNO, and POE.
vii. **POE** is highly correlated with ARGSBO, ARGSUNO, PKMROTT, and SACOP.
viii. **SACOP** is highly correlated with ARGSBO, ARGSUNO, POE, SAPI, SBIPP, and SUNIPP.
ix. **SAPI** is highly correlated with ARGSUNO, SACOP, and SUNIPP.
x. **SBIPP** is highly correlated with ARGSUNO, SACOP, and SUNIPP.
xi. **SUNIPP** is highly correlated with ARGSUNO, SACOP, SAPI, and SBIPP.

As previously mentioned, significant correlations (that is bold and highlighted in *Appendix C*) indicate collinearity between most of the independent variables and multicollinearity tends to affect parameter estimations (Field, 2005:2). One method to address this problem is to reduce the independent variables via a process of factor analysis.

5.3.5 Factor analysis

As indicated above, a remedial measure for multicollinearity is to form one or several composite indices based on the highly correlated independent variables, with an index being a linear combination of the correlated independent variables. The methodology of factor analysis provides composite indices that are uncorrelated (Kutner *et al.*, 2005:432). Often, a few of these composite indices capture most of the information contained in the independent variables. These few uncorrelated composite indices are then used in the regression analysis as independent variables instead of the original highly correlated independent variables.

There are several ways to conduct factor analysis and the choice of method depends on a large array of factors (Field, 2005:3). However, the Maximum Likelihood extraction method (that is a factor analysis extraction method) was utilised for this dissertation. This was due to the fact that principle component and factor analyses often yield similar results and because of the improved interpretability of the results through rotation (Field, 2005:3). Rotation maximises the loading of each independent variable on one of the extracted factors while minimising the loading on all other factors. The factor extraction was done in conjunction with *SPSS Statistics*® software.

5.3.5.1 Factor extraction

SPSS Statistics® listed the eigenvalues associated with each linear factor before extraction, after extraction, and after rotation (see Table 5-3). Before extraction, *SPSS Statistics*® has identified twenty linear factors within the data set. It is important to note that there should be as many eigenvectors as there are independent variables and, therefore, will be as many factors as independent variables. The eigenvalues associated with each factor represent the variance explained by that particular linear factor and *SPSS Statistics*® displays the eigenvalue in terms of the percentage of variance explained (Field, 2005:6).

In Table 5-3 *Factor 1* explains 39.16% of total variance. It is clear that the first few factors explain relatively large amounts of the variance (especially *Factor 1*) whereas subsequent factors explain only small amounts of variance. Consequently, *SPSS Statistics*® extracted all the significant factors with eigenvalues greater than one and identified four factors. The eigenvalues associated with these factors are again displayed and the percentage of variance explained in the columns labelled "Extraction Sums of Squared Loadings."

The values in this part of Table 5-3 are the same as the ones before extraction, except that the values for the discarded factors are ignored. Hence, Table 5-3 is blank after the fourth factor.

Table 5-3 Total variance of factors explained

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	7.83	39.16	39.16	6.82	34.10	34.10	6.08	30.39	30.39
2	3.72	18.61	57.77	3.15	15.75	49.86	3.15	15.74	46.13
3	2.51	12.56	70.34	3.13	15.66	65.52	2.86	14.30	60.43
4	1.55	7.74	78.07	1.09	5.47	70.99	2.11	10.56	70.99
5	1.06	5.29	83.36						
6	0.75	3.77	87.13						
7	0.73	3.66	90.79						
8	0.46	2.29	93.08						
9	0.33	1.63	94.70						
10	0.25	1.24	95.94						
11	0.21	1.07	97.01						
12	0.13	0.67	97.68						
13	0.13	0.65	98.33						
14	0.09	0.44	98.78						
15	0.07	0.36	99.13						
16	0.07	0.33	99.46						
17	0.06	0.28	99.74						
18	0.03	0.12	99.86						
19	0.02	0.08	99.95						
20	0.01	0.05	100.00						

Source: The data obtained from the sources in Table 5-2 was analysed by using the *SPSS Statistics®* software and captured in *Microsoft Office Excel®*.

In the final part of Table 5-3 (labelled "Rotation Sum of Squared Loadings") the eigenvalues of the factors after rotation are displayed. Rotation has the effect of optimising the factor structure and one consequence for these data is that the relative importance of the four factors is equalised (Field, 2005:7). Before rotation, *Factor 1* accounted for considerably more variance than the remaining three (that is 39.16% compared to 18.61%, 12.56%, and 7.74%). However, after extraction it accounted for only 30.39% of variance compared to 15.74%, 14.30%, and 10.56% respectively. At this stage *SPSS Statistics®* has extracted four factors.

Table 5-4 signifies the rotated factor matrix of the independent variables with the four factors that were extracted with the Maximum Likelihood extraction method. Factors were established based on the loadings indicated in Table 5-4 and loadings greater than 0.5 were identified (that is bold and highlighted). Two independent variables (PKMROTT and SAPSB) loaded on more than one factor. PKMROTT and SAPSB must, therefore, be excluded from the final regression analyses of the SASPM. This is due to the high intra-factor loadings of PKMROTT and SAPSB (see Table 5-4).

Table 5-4 Rotated factor matrix of the independent variables

	Factor 1	Factor 2	Factor 3	Factor 4
ARGSBM	0.265	0.142	**0.902**	0.182
ARGSBO	**0.781**	0.092	0.462	0.303
ARGSUNM	0.241	0.108	**0.787**	0.038
ARGSUNO	**0.904**	0.051	0.242	0.178
BCOP	0.326	-0.031	0.204	**0.701**
FSPR	-0.040	**0.896**	-0.136	-0.106
NWPR	-0.078	**0.922**	-0.082	-0.110
PKMROTT	**0.550**	**0.178**	**0.646**	**0.291**
POE	**0.759**	0.092	0.441	0.326
RDER	0.151	-0.080	-0.403	**-0.836**
SACOP	**0.920**	0.007	0.202	0.246
SAPI	**0.759**	-0.108	0.137	0.046
SAPSB	**0.049**	**-0.318**	**-0.118**	**0.422**
SAPSUN	-0.218	**-0.575**	-0.097	-0.078
SASBC	0.402	**-0.595**	-0.066	0.184
SASBI	**0.537**	-0.097	-0.012	0.019
SASUNI	-0.053	0.414	0.141	-0.014
SASUNC	-0.059	**-0.652**	-0.266	-0.153
SBIPP	**0.813**	-0.051	0.367	-0.428
SUNIPP	**0.958**	-0.008	0.042	-0.244

Source: The data obtained from the sources in Table 5-2 was analysed by using the *SPSS Statistics®* software and captured in *Microsoft Office Excel®*.
Note: See Table 5-2 for the acronym definitions.

PKMROTT is a significant element of both *Factor 1* and *Factor 3* with SAPSB a significant element of both *Factor 2* and *Factor 4*. Based on the information provided in Table 5-4 the four new extracted factors will be renamed and discussed.

5.3.5.1.1 South African vegetable oil imports

Factor 1 is the first factor and according to the loadings in Table 5-4 it incorporates eight of the identified independent variables, which are specified in Table 5-2. The independent variables are ARGSBO, ARGSUNO, POE, SACOP, SAPI, SASBI, SBIPP, and SUNIPP. All the independent variables identified in *Factor 1* are in fact influential factors that relate to the importation of vegetable oil in South Africa. As a result, *Factor 1* will be renamed: "South African vegetable oil imports (SAVOI)."

The data that will be utilised for SAVOI throughout the remainder of this empirical study is an average of all the identified independent variables for *Factor 1* (see Table 5-4). This average will be calculated on the standardised data of ARGSBO, ARGSUNO, POE, SACOP, SAPI, SASBI, SBIPP, and SUNIPP.

5.3.5.1.2 South African oilseed supply and demand

The second factor is *Factor 2,* and according to the loadings in Table 5-4 it includes six of the identified independent variables signified in Table 5-2. The independent variables are FSPR, NWPR, SAPSUN, SASBC, SASUNI, and SASUNC. The independent variables identified in *Factor 2* are influential factors that relate to the demand and supply of oilseed in South Africa. Therefore, *Factor 2* will hence forth be known as: "South African oilseed supply and demand (SAOSD)."

The data that will be utilised for SAOSD throughout the remainder of the empirical study is an average of all the identified independent variables for *Factor 2* (see Table 5-4). This average will be calculated on the standardised data of FSPR, NWPR, SAPSUN, SASBC, SASUNI, and SASUNC.

5.3.5.1.3 International oilcake/meal prices

Factor 3 is the third factor and according to the loadings in Table 5-4 it incorporates two of the identified independent variables, which are specified in Table 5-2. The independent variables are ARGSBM and ARGSUNM. All the independent variables identified in *Factor 3* are in fact influential factors that relate to the international oilcake/meal prices. As a result, *Factor 3* will be renamed: "International oilcake/meal prices (IOMP)."

The data that will be utilised for IOMP throughout the remainder of this empirical study is an average of all the identified independent variables for *Factor 3* (see Table 5-4). This average will be calculated on the standardised data of ARGSBM and ARGSUNM.

5.3.5.1.4 Macroeconomic factors

The fourth and final factor is *Factor 4* and according to the loadings in Table 5-4 it includes two of the identified independent variables signified in Table 5-2. The independent variables are BCOP and RDER. The independent variables identified in *Factor 4* are influential factors that relate to global macroeconomic conditions. Therefore, *Factor 4* will hence forth be known as: "Macroeconomic factors (MEF)."

The data that will be utilised for MEF throughout the remainder of the empirical study is an average of all the identified independent variables for *Factor 4* (see Table 5-4). This average will be calculated on the standardised data of BCOP and RDER.

5.3.6 Stationarity

The data utilised in this study has been identified as potential factors that influence the price of sunflower in South Africa. The potential factors (that is dependent and independent variables) were identified in *Chapter 3* and *Chapter 4*. The sources and frequencies of the factors' data have been provided, data have been standardised, and factor extraction was performed.

The next step in the transformation of the data is to review the stationarity of the factors' and dependent variables' data. It is imperative to determine whether or not the data used for a specific study is in fact, stationary or non-stationary. A time series is said to be stationary if the mean and auto-covariances of the time series do not depend on time (EVIEWS, 2004:332). If non-stationary variables were to be included into a regression analysis, the estimation results might be spurious (Phillips, 1986:33).

The formal method to test for stationarity of a series is the unit root test. As a result, the Augmented Dickey-Fuller (ADF) unit root test is implemented to determine the stationarity status of the data. The ADF-unit root test of the *E-Views* ® econometric forecasting software includes a constant in the test regression and employs a default test lag length of eleven.

Table 5-5 ADF-unit root test results

Data Name	Level		1st Differences	
	t-Statistic	Prob.	t-Statistic	Prob.
Dependent Variables				
SAFEXSSP	-2.4667	0.1272	-5.5532	0.0000
SAFEXS1P	-2.2765	0.1819	-6.7946	0.0000
SAFEXS2P	-2.1678	0.2195	-7.6315	0.0000
SAFEXS3P	-1.5971	0.4797	-7.9513	0.0000
Independent Variables				
IOMP	-2.6746	0.0827	-6.6527	0.0000
MEF	-1.6790	0.4382	-11.7409	0.0001
SAOSD	-5.6216	0.0000	-12.0342	0.0001
SAVOI	-2.0652	0.2592	-9.1188	0.0000

Source: ADF-test results obtained from *E-Views*®.
Note: See 5.3.5.1 for the acronym definitions.

Table 5-5 depicts the results of the ADF-unit root test conducted at current level and first differences. It is clear from Table 5-5 that only one of the eight time series passes the level ADF-unit root test at the 5% level, namely SAOSD. However, non-stationary variables can be converted into growth rates (that is natural logarithm first differences) in order to ensure stationarity of the data. An additional advantage of natural logarithm first differences is that it generally addresses the problem of heteroscedasticity of the data (Carlson, 1987:65;

Ramanathan, 2002:133). The natural logarithm growth rate formula utilised in this dissertation incorporates the standardised data discussed in 5.3.3. It is clear from the first differences results in Table 5-5 that all the dependent and independent variables pass the ADF-unit root test at the 5% level of statistical significance. The transformed data will subsequently be utilised throughout the remainder of the empirical study.

5.3.7 Conclusion

The initial preparations of the dependent and independent variables' data for the South African sunflower price models are complete. Of the twenty factors identified throughout the literature study of this dissertation, two were eliminated (that is PKMROTT and SAPSB) and four principle factors were identified in the factor extraction section of this chapter (that is IOMP, MEF, SAOSD, and SAVOI). Consequently, it would be appropriate to commence the econometric study section with the development of the different SASPM.

Section 5.4 will develop the four individual sunflower price models for South Africa and as a result there may be cases of information duplication. However, this is due to the fact that the four models are based on the same regression analysis structure and should be kept in mind when interpreting the results of the SASPM.

5.4 South African sunflower price models

5.4.1 Preliminary regression analyses

To further investigate the data identified in this dissertation and to establish the validity of multiple regression analyses, regressions on the original data are estimated by utilising the ordinary least squares (OLS) regression methodology. These "test analyses" are necessary to analyse and identify the various problems that must be addressed throughout the remainder of the econometric study. Hence, the importance of doing test regression analyses for the different South African sunflower price models. All the independent variables (that is the factors extracted in 5.3.5.1) were regressed separately against the dependent variables to determine whether or not autocorrelation, structural breaks, or cointegration are present in the data. Table 5-6 is a summary of the preliminary test regression results and an interpretation of the results will follow shortly (see *Appendix D*, *Appendix E*, and *Appendix F* for test regression results).

Table 5-6 Test regression analyses findings

Regression Analyses			
Model	**Autocorrelation**	**Structural Breaks**	**Cointegration**
SASSPM	Present	Not-present	Present
SASFFPM	Present	Not-present	Present
SASSFPM	Present	Not-present	Present
SASTFPM	Present	Not-present	Present

Source: *Appendix D*, *Appendix E* and *Appendix F*.

5.4.1.1 Autocorrelation

The results obtained from the preliminary OLS test regressions in *Appendix D* indicate that all the SASPM have low Durbin-Watson statistics and as a result indicate the presence of serial correlation (that is autocorrelation) in all the SASPM. This is a common finding in time series regressions where the residuals are correlated with their own lagged values. Serial correlation violates the standard assumption of regression theory that disturbances are not correlated with other disturbances. One of the problems associated with serial correlation is that OLS is no longer efficient among linear estimators (EVIEWS, 2004:307).

Furthermore, since prior residuals help to predict current residuals, advantage of this information can be taken in order to form a better prediction of the dependent variable. However, an additional problem identified is that standard errors (that is computed by using the textbook OLS formula) are not correct and are generally understated. Consequently, if there are lagged dependent variables on the right-hand side, OLS estimates are biased and inconsistent (EVIEWS, 2004:307). A biased estimation of the standard errors could lead to incorrect hypothesis tests and incorrect conclusions (Choudhury, Hubata, and St. Louis, 1999:342).

Autoregressive (AR) models are a method that can be utilised to estimate autocorrelated observations. An autoregressive model refers to a model where the explanatory variables include one or more lagged values of the dependent variable or, if the error terms are auto-correlated, one or more lagged values of the error terms (EVIEWS, 2004:308; Seddighi, Lawler, and Katos, 2000:118).

5.4.1.2 Structural breaks

The CUSUM of squares test of *E-Views*® provides a plot of the dependent variables against time and a pair of 5% critical lines. Movement outside the critical lines is suggestive of parameter or variance instability. *Appendix E* illustrates the CUSUM of squares test results of the initial

SASPM test regressions. The CUSUM of squares graphs indicate that there are no structural breaks within the stationary factors' data. The cumulative sum of squares is generally within the 5% significance lines, suggesting that the residual variance is fairly stable (see *Appendix E*). As a result of the CUSUM of squares test results, the inclusion of dummy variables into the final SASPM regression estimations are not necessary.

5.4.1.3 Cointegration

The final test performed on the preliminary OLS test regressions was the Johansen cointegration test (see *Appendix F* for the Johansen cointegration test results). The purpose of the cointegration test is to determine whether a group of non-stationary series are cointegrated or not. It is for that reason important to note that this test for cointegration will only be valid if non-stationary data is utilised (EVIEWS, 2004:542). As a result, the Johansen cointegration tests were conducted on the standardised factors' data (refer paragraph 5.3.5.1) and not the stationary factors' data (refer paragraph 5.3.6).

The Johansen cointegration test results indicate the presence of cointegration in all the SASPM (see *Appendix F*) and, therefore, a vector error correction model (VECM) must be applied. A VECM is a restricted vector autoregression (VAR) designed for use with non-stationary series that are known to be cointegrated. The VECM has cointegration relations built into the specification so that it restricts the long-run behaviour of the endogenous variables to converge to their cointegrating relationships while allowing for short-run adjustment dynamics (EVIEWS, 2004:551). The cointegration term is known as the "error correction term" since the deviation from long-run equilibrium is corrected gradually through a series of partial short-run adjustments.

Consequently, the VAR-space in *E-Views*® will be utilised to determine the lag length and cointegration results that is necessary for the estimation of a VECM. Each sunflower price model's VECM will be discussed individually in the next section.

5.4.2 Final regression analyses

The structural approach to time series modelling uses economic theory to model the relationship among the variables of interest. Unfortunately, economic theory is often not rich enough to provide a dynamic specification that identifies all of these relationships. Furthermore, estimation and inference are complicated by the fact that endogenous variables may appear on both the left and right sides of equations. These problems lead to alternative, non-structural approaches to modelling the relationship among several variables (EVIEWS, 2004:523).

The VAR is commonly utilised for forecasting systems of interrelated time series and for analysing the dynamic impact of random disturbances on the system of variables. The VAR approach sidesteps the need for structural modelling by treating every endogenous variable in the system as a function of the lagged values of all of the endogenous variables in the system.

As a result, the VAR-space will be utilised to aid and explain the relationship between the selected independent variables and the different prices of sunflower in South Africa quoted by SAFEX. These prices are the SAFEX sunflower spot price (SAFEXSSP), SAFEX sunflower first futures price (SAFEXS1P), SAFEX sunflower second futures price (SAFEXS2P), and SAFEX sunflower third futures price (SAFEXS3P) (see Table 5-2).

The SASPM will consist of four different price models. The South African sunflower spot price model (SASSPM), the South African sunflower first futures price model (SASFFPM), the South African sunflower second futures price model (SASSFPM), and the South African sunflower third futures price model (SASTFPM). That is one model for each of the individually quoted SAFEX sunflower prices.

5.4.2.1 South African sunflower spot price model

The methodology utilised in the final regression analyses of the SASSPM included various regression estimation procedures. First of all, due to the presence of cointegration and autocorrelation that was established in the preliminary regression analyses (see paragraph 5.4.1), a VAR-space VECM should be calculated in *E-Views*®. However, before a VAR-space VECM can be calculated, the stationarity of the current level standardised data must be identified to aid the VAR-space development. According to the ADF-unit root tests conducted in paragraph 5.3.6, the only stationary data set is the SAOSD. As a result, this factor's data should be included into the VAR-space calculation as an exogenous variable. The remaining factors (that is the independent variables) and the dependent variables will, therefore, be included as endogenous variables.

Subsequent to the VAR-space estimation in *E-Views*®, certain tests had to be conducted on the initial results. These tests are the VAR lag length order selection and VAR Johansen cointegration tests. *Appendix G* depicts the results of the VAR lag length order selection tests and the optimum lag length for the SASSPM's VAR-space VECM is one, two, or three. *Appendix H* indicates the findings of the VAR Johansen cointegration tests. Consequently, the SASSPM has a linear and quadratic trend in its data. Hence, with an optimum lag length of one to three and a linear data trend, Table 5-7 indicates the VECM estimates with a linear data trend.

Table 5-7 VECM estimates of the SASSPM (Linear)

Linear Data Trend (i.e. Intercept - No Trend)			
Cointegrating Eq.	**CointEq1**	**Std. Error**	**t-Statistic**
SAFEXSSP(-1)	1.0000		
IOMP(-1)	0.9477	-0.3025	3.1327
MEF(-1)	0.3138	-0.2867	1.0948
SAVOI(-1)	-1.0420	-0.1388	-7.5060
C	-5.2771		
Error Correction	**D(SAFEXSSP)**		
Variable	**Coefficient**	**Std. Error**	**t-Statistic**
CointEq1	-0.0070	-0.0377	-0.1850
D(SAFEXSSP(-1))	0.4315	-0.1206	3.5774
D(SAFEXSSP(-2))	0.1234	-0.1297	0.9510
D(SAFEXSSP(-3))	-0.0498	-0.1219	-0.4085
D(IOMP(-1))	0.2270	-0.1272	1.7855
D(IOMP(-2))	0.1096	-0.1429	0.7673
D(IOMP(-3))	-0.1930	-0.1386	-1.3927
D(MEF(-1))	0.0337	-0.1220	0.2765
D(MEF(-2))	-0.2704	-0.1257	-2.1519
D(MEF(-3))	-0.0598	-0.1221	-0.4900
D(SAVOI(-1))	-0.0143	-0.0392	-0.3648
D(SAVOI(-2))	-0.0315	-0.0358	-0.8798
D(SAVOI(-3))	-0.0008	-0.0275	-0.0297
C	0.1452	-0.0615	2.3596
SAOSD	-0.0281	-0.0124	-2.2676
Summary Statistics			
R-Squared	0.4083	Log Likelihood	125.0249
Adj. R-Squared	0.2865	Akaike AIC	-2.6512
Sum Sq. Resids	0.2389	Schwarz SC	-2.2141
S.E. Equation	0.0593	Mean Dependent	0.0113
F-Statistic	3.3517	S.D. Dependent	0.0702

Source: The standardised data obtained from 5.3.3 was analysed by using the *E-Views*® program and captured in *Microsoft Office Excel*®.
Note: See 5.3.5.1 for the acronym definitions

The coefficient results of the SASSPM with a linear data trend are provided in Table 5-7. The coefficients in Table 5-7 have the expected signs and the significant variables identified are the SAFEXSSP(-1), IOMP(-1), and MEF(-2). As a result, the present month's SAFEXSSP has a strong positive relationship with the previous month's SAFEXSSP (weight of 43.15%) and IOMP (weight of 22.70%), and a strong negative relationship with the MEF (weight of 27.04%)

of two months ago. Consequently, the R-squared signifies a goodness-of-fit of 40.83%. However, it should be kept in mind that the values are in natural logarithm growth rate form and it will have an influence on the R-squared (see paragraph 5.3.3).

Misspecification tests were performed on the residual values of the SASSPM with a linear data trend to confirm the suitability of the regression. These misspecification tests included Jarque-Bera's test for normality, Breusch-Godfrey's test for autocorrelation, and White's heteroskedasticity test. According to the test results in Table 5-9, the SASSPM with a linear data trend passed all the misspecification tests. Breusch-Godfrey's test cannot reject the null hypothesis of no serial correlation in the residuals. As a result, the residual values indicate the absence of serial correlation.

Table 5-8 VECM estimates of the SASSPM (Quadratic)

Quadratic Data Trend (i.e. Intercept - Trend)			
Cointegrating Eq	**CointEq1**	**Std. Error**	**t-Statistic**
SAFEXSSP(-1)	1.0000		
IOMP(-1)	-0.1297	-0.3569	-0.3633
MEF(-1)	-1.0655	-0.4910	-2.1699
SAVOI(-1)	-1.1857	-0.1413	-8.3923
@TREND(00:01)	0.0143		
C	4.4765		
Error Correction	**D(SAFEXSSP)**		
Variable	**Coefficient**	**Std. Error**	**t-Statistic**
CointEq1	-0.0364	-0.0426	-0.8541
D(SAFEXSSP(-1))	0.4361	-0.1199	3.6373
D(SAFEXSSP(-2))	0.1375	-0.1299	1.0580
D(SAFEXSSP(-3))	-0.0297	-0.1182	-0.2510
D(IOMP(-1))	0.2101	-0.1292	1.6263
D(IOMP(-2))	0.1146	-0.1396	0.8209
D(IOMP(-3))	-0.1879	-0.1376	-1.3659
D(MEF(-1))	0.0164	-0.1215	0.1351
D(MEF(-2))	-0.2780	-0.1252	-2.2199
D(MEF(-3))	-0.0740	-0.1236	-0.5985
D(SAVOI(-1))	-0.0417	-0.0468	-0.8904
D(SAVOI(-2))	-0.0489	-0.0396	-1.2359
D(SAVOI(-3))	-0.0088	-0.0285	-0.3091
C	0.1431	-0.0627	2.2812
@TREND(00:01)	-0.0002	-0.0003	-0.5973
SAOSD	-0.0261	-0.0123	-2.1145
Summary Statistics			
R-Squared	0.4179	Log Likelihood	125.7011
Adj. R-Squared	0.2875	Akaike AIC	-2.6434
Sum Sq. Resids	0.2350	Schwarz SC	-2.1771
S.E. Equation	0.0592	Mean Dependent	0.0113
F-Statistic	3.2063	S.D. Dependent	0.0702

Source: The standardised data obtained from 5.3.3 was analysed by using the *E-Views*® program and captured in *Microsoft Office Excel*®.
Note: See 5.3.5.1 for the acronym definitions.

Jarque-Bera's test cannot reject the null hypothesis of normally distributed residuals, thus the residuals of the SASSPM are normally distributed. The final misspecification test is White's heteroskedasticity test and it indicates that the null hypothesis of no heteroskedasticity cannot be rejected. Consequently, the residuals of the SASSPM with a linear data trend indicate a constant variance and the absence of heteroskedasticity (see Table 5-9).

Table 5-8 indicates the VECM estimates with a quadratic data trend (see *Appendices G* and *H* for the VAR lag length order selection and the VAR Johansen cointegration tests respectively). The coefficient results of the SASSPM with a quadratic data trend are provided in Table 5-8. As with the previous model, the coefficients have the expected signs and the significant variables identified are the SAFEXSSP(-1), IOMP(-1), and MEF(-2). Therefore, the present month's SAFEXSSP has a strong positive relationship with the previous month's SAFEXSSP (weight of 43.61%) and IOMP (weight of 21.01%), and a strong negative relationship with the MEF (weight of 27.80%) of two months ago. The R-squared signifies a goodness-of-fit of 41.79%. However, as previously mentioned, it should be kept in mind that the values are in natural logarithm growth rate form and it will have an influence on the R-squared (see paragraph 5.3.3).

Table 5-9 Misspecification tests of the SASSPM

Linear Data Trend (i.e. Intercept - No Trend)			Quadratic Data Trend (i.e. Intercept - Trend)		
VECM Residual Serial Correlation LM Tests			VECM Residual Serial Correlation LM Tests		
Lags	LM-Stat.	Prob.	Lags	LM-Stat.	Prob.
1	16.7853	0.3996	1	9.2715	0.9018
2	8.2253	0.9419	2	13.9388	0.6033
3	16.0546	0.4492	3	12.8089	0.6867
4	15.6990	0.4742	4	16.5281	0.4168
VECM Residual Normality Test			VECM Residual Normality Test		
Jarque-Bera	df	Prob.	Jarque-Bera	df	Prob.
2.9031	2	0.2342	2.6722	2	0.2629
VECM Residual Heteroskedasticity Test			VECM Residual Heteroskedasticity Test		
Chi-Sq	df	Prob.	Chi-Sq	df	Prob.
289.8074	280	0.3308	313.9927	300	0.2777

Source: The standardised data obtained from 5.3.3 was analysed by using the *E-Views®* program and captured in *Microsoft Office Excel®*.

As with the SASSPM with a linear data trend, misspecification tests were performed on the SASSPM with a quadratic data trend. These included Jarque-Bera's test for normality, Breusch-Godfrey's test for autocorrelation, and White's heteroskedasticity test. The misspecification test results in Table 5-9 is a confirmation that the SASSPM with a quadratic data trend passed all the tests. Breusch-Godfrey's test cannot reject the null hypothesis of no serial correlation in the residuals. As a result, the residual values signify the absence of serial correlation. Jarque-Bera's test cannot reject the null hypothesis of normally distributed residuals, thus the residuals of the SASSPM are normally distributed. The final misspecification test is White's heteroskedasticity test and it signifies that the null hypothesis of no heteroskedasticity cannot be rejected. Consequently, the residuals of the SASSPM with a quadratic data trend signify a constant variance and the absence of heteroskedasticity (see Table 5-9).

The SASSPM's results confirm that changes in the historical spot price of sunflower in South Africa, changes in the international oilcake/meal prices, and changes in macroeconomic factors have significant effects on the development of the spot price of sunflower in South Africa.

5.4.2.2 South African sunflower first futures price model

The methodology utilised in the final regression analyses of the SASFFPM included a range of regression estimation procedures. As with the previous model, due to the presence of cointegration and autocorrelation that was established in the preliminary regression analyses (see paragraph 5.4.1), a VAR-space VECM should be calculated in *E-Views*®.

However, before a VAR-space VECM can be calculated, the stationarity of the current level standardised data must be identified to aid the VAR-space development. According to the ADF-unit root tests conducted in paragraph 5.3.6, the only stationary data set is the SAOSD. Consequently, this factor's data should be included into the VAR-space calculation as an exogenous variable. The remaining factors (that is the independent variables) and the dependent variables will, therefore, be included as endogenous variables. Subsequent to the VAR-space estimation in *E-Views*®, certain tests had to be conducted on the original results. These tests are the VAR lag length order selection and VAR Johansen cointegration tests. *Appendix G* signifies the results of the VAR lag length order selection tests and the optimum lag length for the SASFFPM's VAR-space VECM is one, two or three. As with the previous model, *Appendix H* indicates the findings of the VAR Johansen cointegration tests. As a result, the SASFFPM has a quadratic trend in its data. Hence, with an optimum lag length of one to three and a quadratic data trend, Table 5-10 indicates the VECM estimates with a quadratic data trend.

The coefficient results of the SASFFPM with a quadratic data trend are provided in Table 5-10. The coefficients have the expected signs and the significant variables identified are the SAFEXSSP(-1), IOMP(-1), and MEF(-2). As a result, the present month's SAFEXSSP has a strong positive relationship with the previous month's SAFEXSSP (weight of 38.87%) and

IOMP (weight of 23.20%), and a strong negative relationship with the MEF (weight of 31.54%) of two months ago.

Table 5-10 VECM estimates of the SASFFPM (Quadratic)

Quadratic Data Trend (i.e. Intercept - Trend)			
Cointegrating Eq:	**CointEq1**	**Std. Error**	**t-Statistic**
SAFEXS1P(-1)	1.0000		
IOMP(-1)	-0.2629	-0.3502	-0.7508
MEF(-1)	-1.2067	-0.4866	-2.4801
SAVOI(-1)	-1.1956	-0.1391	-8.5931
@TREND(00:01)	0.0155		
C	5.5692		
Error Correction:	**D(SAFEXS1P)**		
Variable	**Coefficient**	**Std. Error**	**t-Statistic**
CointEq1	-0.0561	-0.0494	-1.1355
D(SAFEXS1P(-1))	0.3887	-0.1224	3.1770
D(SAFEXS1P(-2))	-0.0386	-0.1247	-0.3093
D(SAFEXS1P(-3))	0.1235	-0.1144	1.0798
D(IOMP(-1))	0.2320	-0.1493	1.5542
D(IOMP(-2))	0.0773	-0.1600	0.4832
D(IOMP(-3))	-0.0530	-0.1570	-0.3378
D(MEF(-1))	0.0344	-0.1418	0.2428
D(MEF(-2))	-0.3154	-0.1455	-2.1678
D(MEF(-3))	0.1080	-0.1467	0.7364
D(SAVOI(-1))	-0.0212	-0.0546	-0.3880
D(SAVOI(-2))	-0.0885	-0.0452	-1.9578
D(SAVOI(-3))	-0.0183	-0.0332	-0.5523
C	0.1297	-0.0722	1.7968
@TREND(00:01)	-0.0001	-0.0003	-0.4407
SAOSD	-0.0237	-0.0142	-1.6708
Summary Statistics			
R-Squared	0.3639	**Log Likelihood**	113.6187
Adj. R-Squared	0.2215	**Akaike AIC**	-2.3523
Sum Sq. Resids	0.3145	**Schwarz SC**	-1.8860
S.E. Equation	0.0685	**Mean Dependent**	0.0108
F-Statistic	2.5556	**S.D. Dependent**	0.0776

Source: The standardised data obtained from 5.3.3 was analysed by using the *E-Views®* program and captured in *Microsoft Office Excel®*.
Note: See 5.3.5.1 for the acronym definitions.

Consequently, the R-squared signifies a goodness-of-fit of 36.39%. However, as previously mentioned, it should be kept in mind that the values are in natural logarithm growth rate form and it will have an influence on the R-squared (see paragraph 5.3.3).

However, to confirm that the final regression estimation is adequate, misspecification tests were performed on the residual values of the SASFFPM. These tests included Breusch-Godfrey's test for autocorrelation, Jarque-Bera's test for normality, and White's heteroskedasticity test. The misspecification test results in Table 5-11 confirm that the SASFFPM (with a quadratic data trend) passed two of the three tests.

Table 5-11 Misspecification tests of the SASFFPM

Quadratic Data Trend (i.e. Intercept - Trend)		
VECM Residual Serial Correlation LM Tests		
Lags	**LM-Stat**	**Prob.**
1	8.2920	0.9397
2	14.8921	0.5326
3	8.8926	0.9178
4	17.1355	0.3769
VECM Residual Normality Test		
Jarque-Bera	**df**	**Prob.**
5.5602	2	0.0620
VECM Residual Heteroskedasticity Test		
Chi-Sq	**df**	**Prob.**
318.9724	300	0.2160

Source: The standardised data obtained from 5.3.3 was analysed by using the *E-Views®* program and captured in *Microsoft Office Excel®*

Breusch-Godfrey's test cannot reject the null hypothesis of no serial correlation in the residuals. As a result, the residual values signify the absence of serial correlation. Jarque-Bera's test rejects the null hypothesis of normally distributed residuals, thus the residuals of the SASFFPM are not perfectly normally distributed. The final misspecification test is White's heteroskedasticity test and it signifies that the null hypothesis of no heteroskedasticity cannot be rejected. Consequently, the residuals of the SASFFPM specify a constant variance and the absence of heteroskedasticity (see Table 5-11).

The SASFFPM estimation confirms that changes in the historical first futures price of sunflower in South Africa, changes in the international oilcake/meal prices, and changes in macroeconomic factors have considerable effects on the development of the first futures price of sunflower in South Africa.

5.4.2.3 South African sunflower second futures price model

The methodology utilised in the final regression analyses of the SASSFPM included various regression estimation procedures. First of all, due to the presence of cointegration and autocorrelation that was established in the preliminary regression analyses (see paragraph 5.4.1), a VAR-space VECM should be calculated in *E-Views®*. However, before a VAR-space VECM can be calculated, the stationarity of the current level standardised data must be identified to aid the VAR-space development. According to the ADF-unit root tests conducted in paragraph 5.3.6, the only stationary data set is the SAOSD. As a result, this factor's data should be included into the VAR-space calculation as an exogenous variable. The remaining factors (that is the independent variables) and the dependent variables will, therefore, be included as endogenous variables.

Subsequent to the VAR-space estimation in *E-Views*®, certain tests had to be conducted on the initial results. These tests are the VAR lag length order selection and VAR Johansen cointegration tests. *Appendix G* signifies the results of the VAR lag length order selection tests and the optimum lag length for the SASSFPM's VAR-space VECM is one or two. *Appendix H* indicates the findings of the VAR Johansen cointegration tests and consequently, the SASSFPM does not specify the occurrence of cointegration within the VAR-space. However, due to the significant occurrence of autocorrelation (see paragraph 5.4.1) a new modelling methodology should be identified and implemented for the SASSFPM.

The simplest and most widely used model of serial correlation is the first-order autoregressive (AR(1)) model. The generalised multiple regression model, when its residuals follow a first-order autoregressive process, is specified as (EVIEWS, 2004:314):

$$y_t = \beta_0 + \beta_1 X_{t1} + \beta_2 X_{t2} + \ldots.. + \beta_{p-1} X_{t,p-1} + u_t$$
$$u_t = \rho u_{t-1} + \varepsilon_t$$

The parameter ρ is the first-order serial correlation coefficient and ε_t is another residual that is assumed to have a zero mean, be homoskedastic and is serially uncorrelated. The residual (ε_t) is the difference between the actual value of the dependent variable and a forecast made on the basis of the independent variables and the past forecast errors. In effect, the AR(1) model incorporates the residual from the past observation into the regression model for the current observation. Consequently, ε_t satisfies the assumptions of the least squares estimators (LSE). It is, however, important that the data utilised in the calculation of an AR(1) model is definitely stationary. Therefore, the stationary data (that is adjusted with first differences) discussed in paragraph 5.3.6 will be utilised (Choudhury *et al.*, 1999:342; Seddighi *et al.*, 2000:146).

The coefficient results of the SASSFPM estimation are provided in Table 5-12. These results indicate that the majority of the independent variables resulted in statistically significant p-values. *Appendix G* specifies the VAR lag length estimation results of the different SASPM. According to the VAR lag length results of the SASSFPM, lags ranging from one to two months should be considered. The majority of the criterions in *Appendix G* signify a lag length of two months, but different lag combinations were considered to obtain optimal results.

Table 5-12 First-order autoregression results of the SASSFPM

South African Sunflower Second Futures Price Model				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
DIOMP(-1)	0.2830	0.1561	1.8132	0.0737
DMEF(-2)	-0.1969	0.1337	-1.4725	0.1450
DSAVOI(-2)	-0.0483	0.0267	-1.8056	0.0749
SAOSD	-0.0290	0.0153	-1.8968	0.0616
C	0.1525	0.0757	2.0142	0.0475
AR(1)	0.1469	0.1125	1.3060	0.1954
Summary Statistics				
R-Squared	0.1636	**Mean Dependent Var**		0.0104
Adjusted R-Squared	0.1093	**S.D. Dependent Var**		0.0838
S.E. of Regression	0.0791	**Akaike Info Criterion**		-2.1666
Sum Squared Resid	0.4818	**Schwarz Criterion**		-1.9917
Log Likelihood	95.9121	**F-Statistic**		3.0120
Durbin-Watson Stat	1.9952	**Prob(F-statistic)**		0.0155
Inverted AR Roots	0.1500			

Source: The standardised data obtained from 5.3.3 was analysed by using the *E-Views®* program and captured in *Microsoft Office Excel®*.
Note: See 5.3.5.1 for the acronym definitions.

As indicated by the F-statistic and the probability of the F-statistic, the regression estimation is statistically significant at a 2% level. The R-squared and the adjusted R-squared indicates a goodness-of-fit of 16.36% and 10.93% respectively. Although the R-squared is not very high, it should be kept in mind that the values are in natural logarithm growth rate form (see paragraph 5.3.3). On the other hand, the Durbin-Watson statistic (1.99) signifies the absence of first-order serial correlation, but due to the utilisation of an AR(1) model further investigation on this issue is necessary (see Table 5-12).

The coefficient results of the SASSFPM are provided in Table 5-12. The coefficients have the expected signs and the significant variables identified are the IOMP(-1), SAVOI (-2), SAOSD, and C (statistically significant at a 7.5% level). As a result, the present month's SAFEXS2P has a strong positive relationship with the previous month's IOMP (weight of 28.30%) and the present month's C (weight of 15.25%). In contrast, the present month's SAFEXS2P has a negative relationship with the SAVOI (weight of 4.83%) of two months ago and the present month's SAOSD (weight of 2.90%).

Table 5-13 Misspecification tests of the SASSFPM

South African Sunflower Second Futures Price Model			
Breusch-Godfrey Serial Correlation LM Test			
Test Statistic	0.4189	Probability	0.6593
Obs*R-Squared	0.9169	Probability	0.6323
Jarque-Bera Test			
Test Statistic	3.7955	Probability	0.1499
White Heteroskedasticity Test			
Test Statistic	1.1321	Probability	0.3522
Obs*R-Squared	9.0509	Probability	0.3380

Source: The standardised data obtained from 5.3.3 was analysed by using the *E-Views®* program and captured in *Microsoft Office Excel®*.

Misspecification tests were performed on the SASSFPM and these tests included Breusch-Godfrey's test for autocorrelation, Jarque-Bera's test for normality, and White's heteroskedasticity test. According to the test results in Table 5-13, the SASSFPM passes all the misspecification tests. Breusch-Godfrey's test cannot reject the null hypothesis of no serial correlation in the residuals. As a result, the Durbin-Watson statistic estimation in Table 5-12 is valid and signifies the absence of serial correlation.

Jarque-Bera's test cannot reject the null hypothesis of normally distributed residuals, thus the residuals of the SASSFPM are normally distributed. White's heteroskedasticity test results signify that the null hypothesis of no heteroskedasticity cannot be rejected. As a result, the residuals of the SASSFPM indicate a constant variance and the absence of heteroskedasticity (see Table 5-13).

The SASSFPM results confirm that changes in the international oilcake/meal prices, changes in the South African vegetable oil imports, and changes in the supply/demand of oilseed in South Africa have noteworthy effects on the development of the second futures price of sunflower in South Africa.

5.4.2.4 South African third futures price model

The methodology utilised in the final regression analyses of the SASTFPM included a range of regression estimation procedures. As with the previous model, due to the presence of cointegration and autocorrelation that was established in the preliminary regression analyses (see paragraph 5.4.1), a VAR-space VECM have to be calculated in *E-Views®*. However, before a VAR-space VECM can be calculated, the stationarity of the current level standardised data must be identified to aid the VAR-space development. According to the ADF-unit root tests conducted in paragraph 5.3.6, the only stationary data set is the SAOSD. Consequently, this factor's data should be included into the VAR-space calculation as an exogenous variable. The remaining factors (that is the independent variables) and the dependent variables will, therefore, be included as endogenous variables.

Subsequent to the VAR-space estimation in *E-Views*®, certain tests had to be conducted on the original results. These tests are the VAR lag length order selection and VAR Johansen cointegration tests. *Appendix G* signifies the results of the VAR lag length order selection tests and the optimum lag length for the SASTFPM's VAR-space VECM is one or two. *Appendix H* indicates the findings of the VAR Johansen cointegration tests and as a result the SASSFPM does not specify the presence of cointegration within the VAR-space. However, due to the significant presence of autocorrelation (see paragraph 5.4.1) a new modelling methodology should be identified and implemented for the SASTFPM. As discussed in the previous model, the simplest and most widely used model of serial correlation is the AR(1) model.

The coefficient results of the SASTFPM estimation are provided in Table 5-14. These results indicate that the minority of the independent variables resulted in convincing p-values. *Appendix G* specifies the VAR lag length estimation results of the different SASPM. According to the VAR lag length results of the SASTFPM, lags ranging from one to two months should be considered. The majority of the criterions in *Appendix G* signify a lag length of two months, but different lag combinations were considered to obtain optimal results.

Table 5-14 First-order autoregression results of the SASTFPM

South African Sunflower Third Futures Price Model				
Factor	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
DIOMP(-2)	0.2898	0.1519	1.9079	0.0601
DMEF	0.1831	0.1330	1.3773	0.1724
DSAVOI(-2)	-0.0313	0.0269	-1.1611	0.2492
SAOSD(-2)	0.0217	0.0146	1.4846	0.1417
C	-0.0986	0.0724	-1.3617	0.1773
AR(1)	0.0988	0.1142	0.8654	0.3895
Summary Statistics				
R-Squared	0.1271	Mean Dependent Var		0.0104
Adjusted R-Squared	0.0705	S.D. Dependent Var		0.0789
S.E. of Regression	0.0761	Akaike Info Criterion		-2.2443
Sum Squared Resid	0.4458	Schwarz Criterion		-2.0694
Log Likelihood	99.1383	F-Statistic		2.2433
Durbin-Watson Stat	1.9894	Prob(F-statistic)		0.0583
Inverted AR Roots	0.1000			

Source: The standardised data obtained from 5.3.3 was analysed by using the *E-Views*® program and captured in *Microsoft Office Excel*®.
Note: See 5.3.5.1 for the acronym definitions.

As indicated by the F-statistic and the probability of the F-statistic, the regression estimation is statistically significant at a 5.8% level. The R-squared and the adjusted R-squared indicates a goodness-of-fit of 12.71% and 7.05% respectively. Although the R-squared is not very high, it should be kept in mind that the values are in natural logarithm growth rate form (see paragraph 5.3.3). Conversely, the Durbin-Watson statistic (1.98) signifies the absence of first-order serial correlation, but due to the utilisation of an AR(1) model further investigation on this issue is necessary (see Table 5-14).

Table 5-15 Misspecification tests of the SASTFPM

South African Sunflower Third Futures Price Model			
Breusch-Godfrey Serial Correlation LM Test			
Test Statistic	0.0483	Probability	0.9528
Obs*R-Squared	0.1068	Probability	0.9480
Jarque-Bera Test			
Test Statistic	0.5374	Probability	0.7682
White Heteroskedasticity Test			
Test Statistic	0.5518	Probability	0.8135
Obs*R-Squared	4.6726	Probability	0.7919

Source: The standardised data obtained from 5.3.3 was analysed by using the *E-Views*® program and captured in *Microsoft Office Excel*®.

The coefficient results of the SASTFPM are provided in Table 5-14. The coefficients have the expected signs and the significant variables identified are the IOMP(-2) (statistically significant at a 6.0% level) and MEF (statistically significant at a 17.24% level). As a result, the present month's SAFEXS3P has a strong positive relationship with the IOMP (weight of 28.98%) of two months ago and the present month's MEF (weight of 18.31%).

Misspecification tests were performed on the SASTFPM and these tests included Breusch-Godfrey's test for autocorrelation, Jarque-Bera's test for normality, and White's heteroskedasticity test. According to the test results in Table 5-15, the SASTFPM passes all the misspecification tests. Breusch-Godfrey's test cannot reject the null hypothesis of no serial correlation in the residuals. As a result, the Durbin-Watson statistic results in Table 5-14 is valid and signifies the absence of serial correlation. Jarque-Bera's test cannot reject the null hypothesis of normally distributed residuals, thus the residuals of the SASTFPM are normally distributed. White's heteroskedasticity test results signify that the null hypothesis of no heteroskedasticity cannot be rejected. Therefore, the residuals of the SASTFPM indicate a constant variance and the absence of heteroskedasticity (see Table 5-15).

The SASTFPM estimation confirms that changes in the international oilcake/meal prices have significant effects on the development of the third futures price of sunflower in South Africa.

5.4.3 Conclusion

Price models for the South African sunflower spot, first futures, second futures and third futures prices were regressed in conjunction with the results of vector error correction models (that is within the VAR-space), autoregressive models and the residual properties of each of the South African sunflower price models. *E-Views*® was utilised to quantify the SASPM and various misspecification tests were performed on the SASPM. These tests included Jarque-Bera's test for normality, Breusch-Godfrey's test for autocorrelation, and White's heteroskedasticity test. Consequently, the factors identified in the SASSPM, SASFFPM, SASSFPM, and the SASTFPM can be utilised to anticipate future changes in the development of sunflower prices in South Africa. A review of *Chapter 5* and the factors that influence the price of sunflower in South Africa will be examined in the concluding section of this chapter.

5.5 Conclusion

Chapter 5 presented the empirical study of this dissertation. Within this chapter a range of influential price factors identified in *Chapter 3* and *Chapter 4* were reinforced by some of the related studies that were done on the agricultural industry. These major factors included the domestic price of the base commodity within a region/country, domestic, and international economic fundamentals, market supply/demand conditions of a commodity in a region/country, and the supply/demand conditions of substitute commodities in a region/country.

The data properties of the identified potential influential factors (that is the dependent and independent variables) were identified and factor analysis was utilised to extract the appropriate information. The Maximum Likelihood extraction method in *SPSS Statistics*® yielded four principal factors: South African vegetable oil imports (SAVOI), South African oilseed supply and demand (SAOSD), international oilcake/meal prices (IOMP), and macroeconomic factors (MEF). As a result, these factors were utilised as independent variables throughout the remainder of *Chapter 5*.

Table 5-16 South African sunflower price model development review

Primary Price Model	Secondary Price Model	Tertiary Price Model	Extracted Factors				Influential Factors		
			Variable	Lag	Relationship	Weight (%)	Factor	Relationship	Weight
South African Sunflower Price Models (SASPM)	South African Sunflower Spot Price Model (SASSPM)	Linear Data Trend	SAFEXSSP	1	Positive	43.15	SAFEXSSP	Positive	1.000
			IOMP	1	Positive	22.70	ARGSBM	Positive	0.902
							ARGSUNM	Positive	0.787
			MEF	2	Negative	27.04	BCOP	Positive	0.701
							RDER	Negative	0.836
		Quadratic Data Trend	SAFEXSSP	1	Positive	43.61	SAFEXSSP	Positive	1.000
			IOMP	1	Positive	21.01	ARGSBM	Positive	0.902
							ARGSUNM	Positive	0.787
			MEF	2	Negative	27.80	BCOP	Positive	0.701
							RDER	Negative	0.836
	South African Sunflower First Futures Price Model (SASFFPM)	Quadratic Data Trend	SAFEXSIP	1	Positive	38.87	SAFEXSIP	Positive	1.000
			IOMP	1	Positive	23.20	ARGSBM	Positive	0.902
							ARGSUNM	Positive	0.787
			MEF	2	Negative	31.54	BCOP	Positive	0.701
							RDER	Negative	0.836
	South African Sunflower Second Futures Price Model (SASSFPM)	None	IOMP	1	Positive	28.30	ARGSBM	Positive	0.902
							ARGSUNM	Positive	0.787
			SAVOI	2	Negative	4.83	SACOP	Positive	0.920
							SUNIPP	Positive	0.958
			SAOSD	0	Negative	2.90	NWPR	Positive	0.922
							SASUNC	Negative	0.652
	South African Sunflower Third Futures Price Model (SASTFPM)	None	IOMP	2	Positive	28.98	ARGSBM	Positive	0.902
							ARGSUNM	Positive	0.787

Source: The data obtained from the sources in Table 5-2 was analysed by using the *SPSS Statistics®* and *E-Views®* software and captured in *Microsoft Office Excel®*.
Note: See Table 5-2 and 5.3.5.1 for the acronym definitions

Preliminary and final regression analyses constituted the econometric study of this chapter. Within the preliminary regression analyses a range of regression issues like autocorrelation, cointegration and structural breaks were identified and tested. The results of these tests indicated that none of the data used in the preliminary regression analyses had structural breaks, although the occurrence of autocorrelation and cointegration was observed. Vector autoregressions (that is the VAR-space) and first-order autoregressive models (that is AR(1) models) were utilised to determine lag orders and cointegration estimations, which were in turn used to develop vector error correction models (that is VECMs).

Table 5-16 is a summary of the VECMs within the VAR-space and the AR(1) models' results. It signifies the primary, secondary and tertiary price models with their corresponding extracted and influential sunflower price factors in South Africa. The "Extracted Factors" column indicates the factors that were extracted in paragraph 5.3.5.1, which were identified as influential independent variables in the regression estimations. This column additionally corroborates the lags incorporated in the regression estimations and the independent variables' relationships with the dependent variables within each price model. For example, the IOMP (with a lag of one month) has a positive relationship of approximately 22.70% with the dependent variable of the SASSPM with a linear data trend.

The SASSPM's results confirm that changes in the historical spot price of sunflower in South Africa, changes in the international oilcake/meal prices, and changes in macroeconomic factors have significant effects on the development of the spot price of sunflower in South Africa.

The SASFFPM estimation confirms that changes in the historical first futures price of sunflower in South Africa, changes in the international oilcake/meal prices, and changes in macroeconomic factors have considerable effects on the development of the first futures price of sunflower in South Africa.

The SASSFPM results confirm that changes in the international oilcake/meal prices, changes in the South African vegetable oil imports, and changes in the supply/demand of oilseed in South Africa have noteworthy effects on the development of the second futures price of sunflower in South Africa.

The SASTFPM estimation confirms that changes in the international oilcake/meal prices have significant effects on the development of the third futures price of sunflower in South Africa.

The "Influential Factors" column in Table 5-16 signifies the factors that influence the price of sunflower in South Africa. This column specifies the factor, relationship and weight of each influential factor on the extracted factor/variable. For example, the ARGSUNM price has a positive relationship with a weight of 0.787, with the IOMP. It is nonetheless important to note that only the factors with the largest weights relating to the extracted factor/variable are included in Table 5-16. The factors that influence the price of sunflower in South Africa will be summarised in the conclusion section of the next chapter.

Chapter 6 is the final chapter of this dissertation. As a result, this chapter will state the conclusion and examine the recommendations that were made for the identification of the factors that influence the price of sunflower in South Africa.

6

Conclusion and Recommendations

6.1 Introduction

South African farmers are exposed to adverse price risk when marketing their produce. As a result, this study focuses on the sunflower market in South Africa and in particular, the factors that influence the price of South African sunflower. This is done in order to construct and test a series of price models that explain some of the fluctuations in the spot and futures prices of sunflower in South Africa.

The first section of this chapter (section 6.2) provides the concluding remarks regarding the literature review and empirical study of this dissertation. The final section (section 6.3) describes the recommendations pertaining to the South African sunflower price and the development of sunflower price models in South Africa. The possibilities for future research are also addressed in this section.

6.2 Conclusion

Chapter 2 provided both historical and current background information regarding the sunflower plant and its cropping and, therefore, serves as a reference point and source of supplementary information for the remainder of this dissertation. Consequently, this chapter is an important source of the knowledge needed to lay a clearly defined foundation for the identification of the influential price factors of sunflower in South Africa. *Chapter 2* identified sunflower as a popular crop that performs well under drought conditions, especially when compared to other crops. However, sunflower is particularly sensitive to high soil temperatures during emergence. This is especially a problem in the sandy soil of the Western Free State and the North-West Province, often leading to poor or erratic plant density.

Another key yield-limiting factor identified in South Africa during the last decade, is the considerable acidification of large parts of the sunflower producing areas. As a result, large shortages of molybdenum frequently occur and are possibly one of the greatest production-limiting factors in South Africa.

Sunflower seed cannot be cultivated at all in some marginal areas of South Africa due to the sunflower crop's susceptibility to bird damage. However, the sunflower's drought tolerance and low average input cost (that is compared to other crops) are vital advantages of the sunflower plant which outweigh this disadvantage to some extent. Another advantage of the sunflower plant is the short growth season of the crop, which renders it suitable for farmers who make use of flexible crop rotation or crop free system.

In *Chapter 3* the international sunflower market was discussed in order to provide an advanced perspective of its workings. *Chapter 3* identified the general demand and supply factors that influence the production, consumption, and trade of sunflower products in the different regions/countries in the world. It is well known that changes in the supply and demand for a particular agricultural commodity influence the price of that commodity, but by analysing the factors that influence the balance of supply and demand for a particular agricultural commodity, the futures trader is conducting fundamental analysis.

In concurrence with fundamental analysis, the futures trader might also conduct a technical analysis of the market. When utilising technical analysis, a futures trader may use one or a combination of various analytical techniques to analyse the market. The point of departure of technical analysis is that the price of the commodity is a reflection of all the changes that took place in the general supply and demand for that particular agricultural commodity. Therefore, the commodity price should be examined and in a perfect market the spot and futures prices will behave as stochastic processes.

This is where the conditional expectation of the next price (given the current and preceding prices) is the current price and where the futures prices will provide the best available estimates of the subsequent actual prices. The difference in the pricing performance between the futures markets indicates the significance of stock on the price spread and the influence of expectations on the price level.

Chapter 4 examined the South African sunflower market and identified the factors that influence the general demand and supply of sunflower seed, oil, and oilcake/meal in South Africa. The deregulation of the South African agricultural market is the direct result of domestic and international pressures and led to various changes in the pricing system of agricultural commodities, including sunflower seed. Consequently, the prices of agricultural commodities (previously determined by government control boards) are now the result of several market forces. This open economy exposes South African farmers to the impact of global market forces. As a result, the management of price risk has become an important determinant of profitability in the agricultural market.

Although the South African agricultural market has developed over the past few years, South African farmers still have to face various problems. These problems include price transparency, price discovery, accessibility of markets, a general resistance to change, the lack of crucial information, and a changing market environment when marketing their products. An additional problem is the differences between markets in developed and developing countries. For example, small scale farmers in South Africa are faced with unique problems such as poor infrastructure and the cost of storage and transportation.

However, sunflower (seed, oil, and oilcake/meal) is a vital source of food in large parts of Southern Africa. The ability of sunflower farmers meet the demand for sunflower products in South Africa is of strategic importance. The management of price risk is, therefore, not only important to the producers of sunflower seed, but also to the suppliers of sunflower oil and oilcake/meal. Nonetheless, from the discussion of the factors that influence the price of sunflower in South Africa, the influence of the global sunflower market on the South African sunflower market is clearly noticeable.

In *Chapter 5* the empirical study was discussed. The primary objective of this chapter was to classify and develop the various South African sunflower price models. This process included the examination of related price modelling studies, preliminary regression, and final regression analyses. The theoretical framework choice, extent of regional and sectoral integration, selection of data sets, and estimation methodologies determine the applicability of agricultural price models. An important fact identified (that is necessary to develop a sunflower price model in South Africa) is that futures markets do not exhibit strong evidence of ineptitude. Consequently, futures markets are able to establish forward prices efficiently (that is predominantly as the expiry date approaches). It is, therefore, necessary to develop individual price models for the spot, first, second, and third futures prices of sunflower in South Africa, which can consecutively be utilised to identify the factors that influence the price of sunflower in South Africa.

Table 6-1 depicts a summarised comparison between the different South African sunflower price models developed in *Chapter 5* and the influential price factors that have been identified within the SASPM. The influential price factors in Table 6-1 are based on the principle factors that have been extracted by means of factor analysis in *Chapter 5*.

Table 6-1 Factors that influence the price of sunflower in South Africa

	South African Sunflower Price Models			
Influential Factors	**SASSPM**	**SASFFPM**	**SASSFPM**	**SASTFPM**
Brent Crude Oil Price per Barrel	☑	☑		
North-West Province Rainfall			☑	
Rand/US-Dollar Exchange Rate	☑	☑		
SAFEX Sunflower First Futures Price		☑		
SAFEX Sunflower Import Parity Price			☑	
SAFEX Sunflower Spot Price	☑			
South Africa - Cooking Oil 750ml Price			☑	
South Africa Sunflower Seed - Closing Stock			☑	
Soybean Meal Price: Argentina, CIF Rotterdam	☑	☑	☑	☑
Sunflower Meal Price: Argentine, CIF Rotterdam	☑	☑	☑	☑

Source: The data obtained from the sources in Table 5-2 was analysed by using the *SPSS Statistics*® and *E-Views*® software and captured in *Microsoft Office Excel*®.

The general objective of this dissertation was to identify the factors that influence the price of sunflower in South Africa. This objective was only achievable with the help of a specific objective which was to develop different models for the South African sunflower prices. With the South African sunflower price models in mind, the factors that influence the price of sunflower in South Africa are the following:

i. Macroeconomic factors include the Brent crude oil price per barrel and the Rand/US-Dollar exchange rate.
ii. South African oilseed supply and demand factors include the North-West Province rainfall and the closing stock of sunflower in South Africa.
iii. South African vegetable oil import factors include the sunflower import parity price quoted by SAFEX and South Africa's 750ml cooking oil price.
iv. International oilcake/meal price factors include the Argentinean soybean meal price and the Argentinean sunflower meal price.
v. South African sunflower prices include the spot price and the first futures price quoted by SAFEX.

The results of this dissertation confirm that macroeconomic factors are important for short-term price movements and one period futures movements, but not for more distant sunflower prices. However, for more distant prices (that is the second and third period prices) the international price movements of sunflower (seed, oil, and oilcake/meal), as well as the supply and demand conditions are primary influential factors for these prices. Based on this knowledge, this price information can be utilised to assess the potential outcomes of proposals made as part of future trade negotiations or simply to better inform the South African producers and consumers of sunflower seed, oil, and oilcake/meal of the driving factors of the South African sunflower price. In addition, this knowledge will facilitate the decision making behaviour of South African sunflower seed, oil, and oilcake/meal producers and consumers in the face of changing economic policies, trade policies, and world markets.

6.3 Recommendations

This dissertation reviewed both the international and domestic South African sunflower markets. It, furthermore, presented the importance of futures markets to both sunflower traders and consumers, and identified potential factors that influence the spot and futures prices of sunflower in South Africa. As a result, this dissertation provided a series of price models that explained the different South African sunflower prices. However, there are several issues regarding the modelling and application of such models that need to be addressed in future studies. Recommendations for future research include the following:

Firstly, the price model structure utilised in this dissertation was based on the level of knowledge, understanding and insight that the modeller has of the South African sunflower industry. Thus, the general structure of the different price models could be subject to bias. One of the recommendations to overcome preconceived notions in a price model is to develop individual regressions for each of the variables utilised in the price equation. For example, the factors included in the calculation of the import parity prices could be tested separately in a regression equation in order to establish the impact of each of these factors on the price of sunflower futures contracts in South Africa.

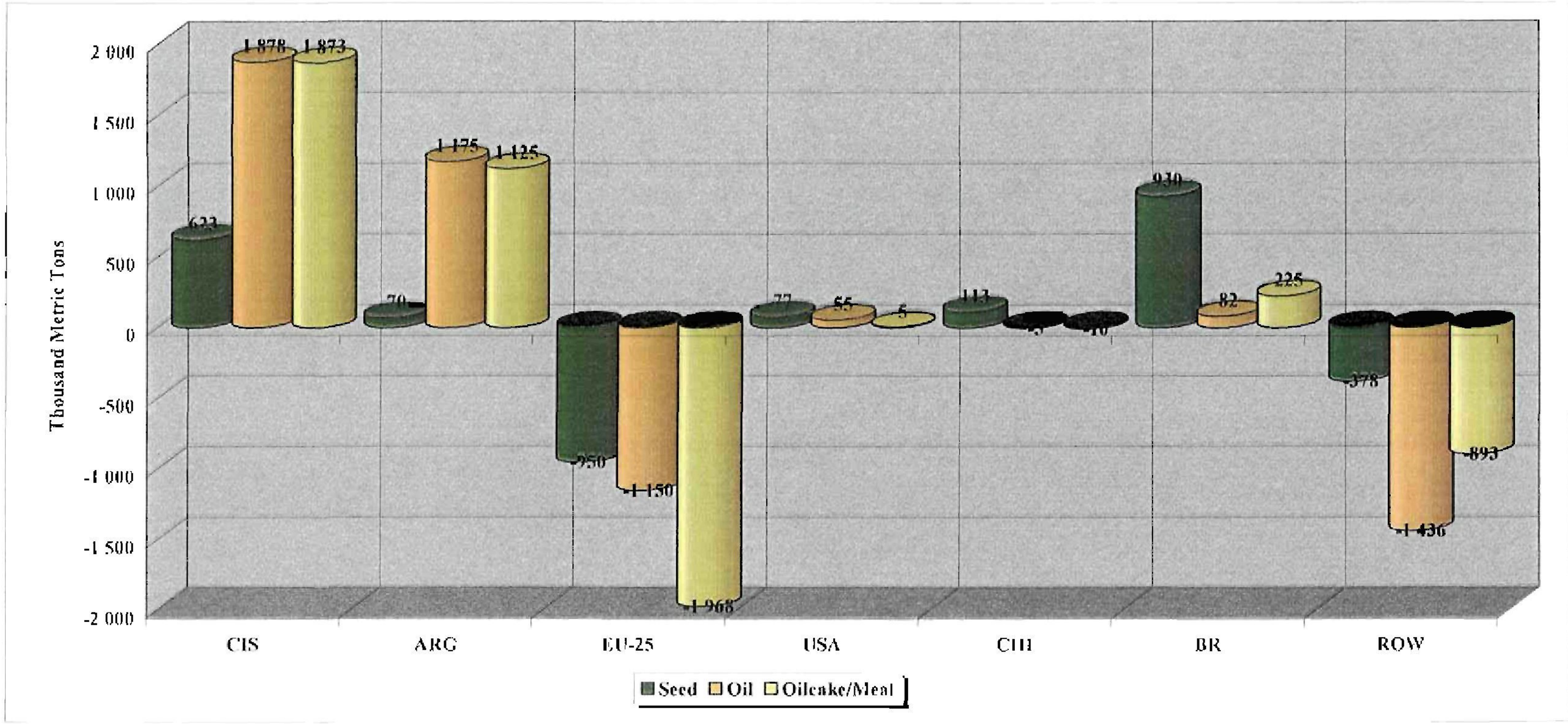
Secondly, these particular price models were not developed with the different intricacies within the livestock (that is the protein feed) and vegetable oil sector of South Africa. They only address the demand for protein feed by the livestock and the demand for vegetable oil (that is sunflower, soybean, and palm oil) in South Africa. For example, the differentials between the transportation and storage costs in the different protein feed production and consumption provinces/regions in South Africa might be investigated. This can be done in order to establish the impact of infrastructural differences on the demand for high protein feed. Subsequently, this could lead to how the basis of sunflower futures contracts might differ from one South African region to the next.

Thirdly, it was important to take the nature of the agricultural commodity being modelled into consideration by asking whether or not the relevant product is a homogenous agricultural commodity. Preferably a price model of this nature should include a variety of demographic variables (for example age, race, and education) into separate demand and supply estimations. For example, these demographic variables can then be utilised to determine their effect on the quantity consumed and the price of an agricultural commodity within a specific province/region in South Africa.

Finally, an extensive investigation should also be launched into the efficiency of the futures market for specific commodities in South Africa. This should be done regarding sunflower and soybean futures contracts in South Africa. Several possibilities for further investigation do still exist within the oilseed industry in South Africa and should be explored in future agricultural research.

Appendix

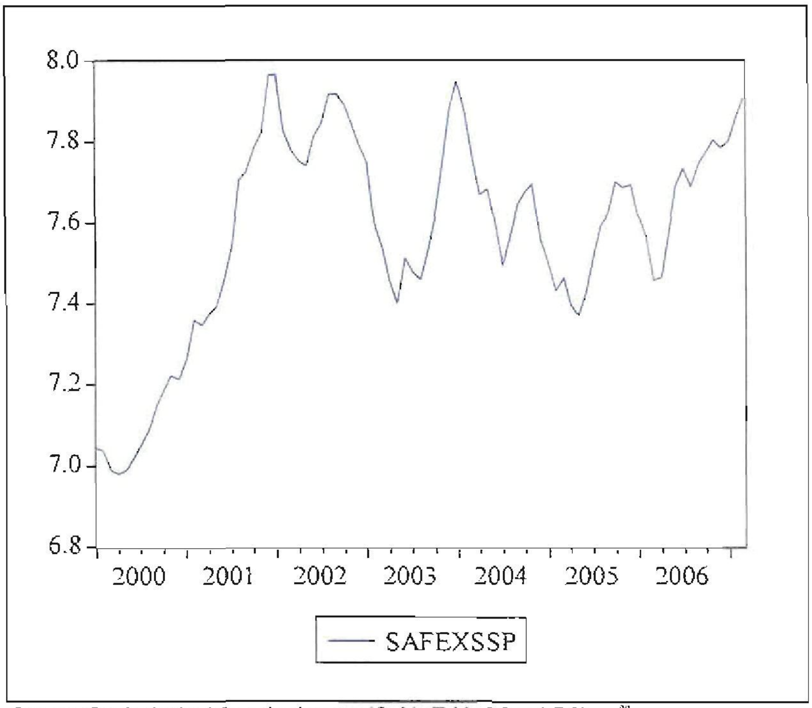
Appendix A: Net trade graph of sunflower products



Source: FAPRI, 2005:38; FAPRI, 2007:256.
Note: 2006/07 production season data.

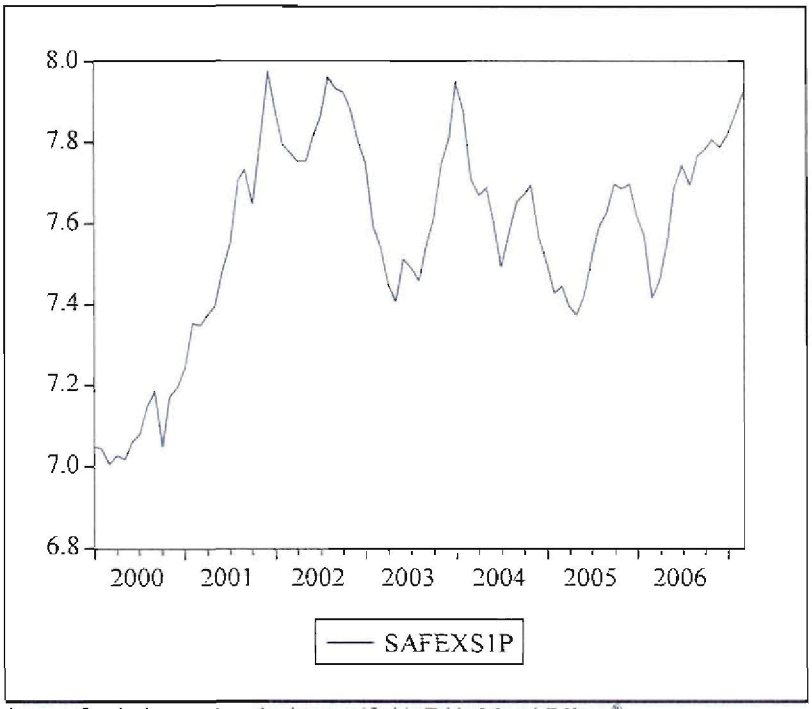
Appendix B: Standardised dependent variables

SAFEX sunflower spot price



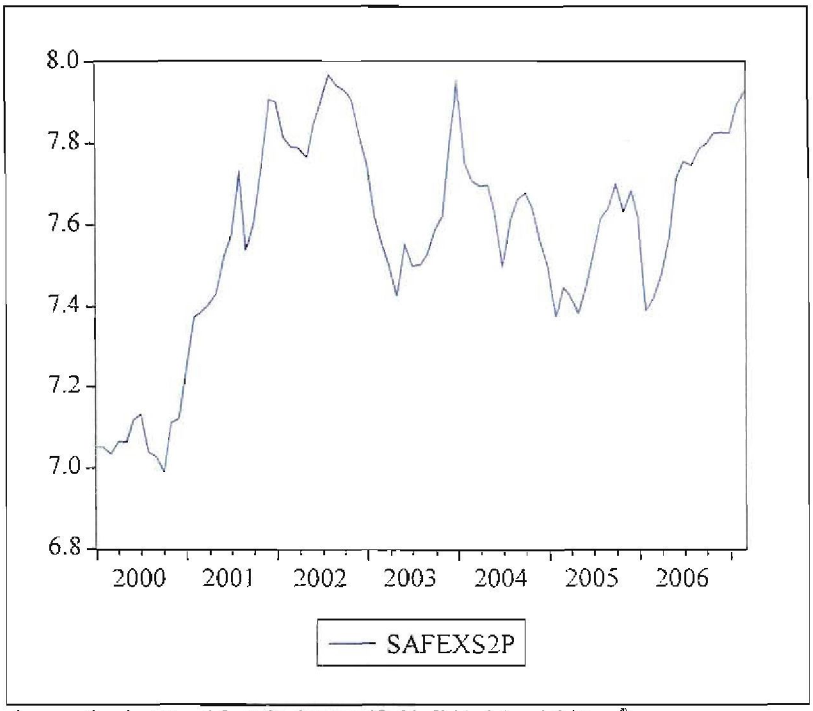
Source: Graph obtained from the data specified in Table 5-2 and *E-Views*®

SAFEX sunflower first futures price



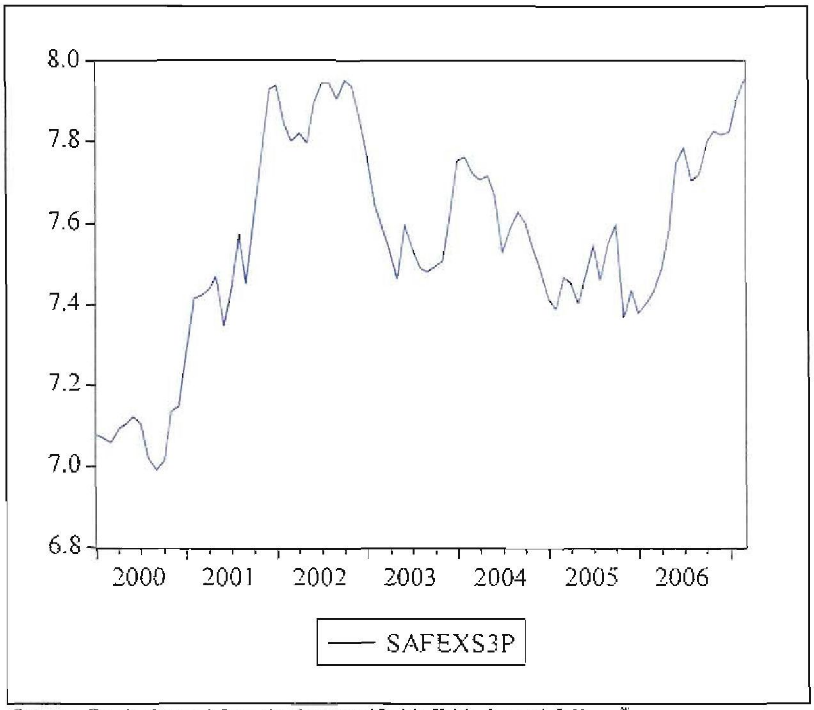
Source: Graph obtained from the data specified in Table 5-2 and *E-Views*®.

SAFEX sunflower second futures price



Source: Graph obtained from the data specified in Table 5-2 and *E-Views*®

SAFEX sunflower third futures price



Source: Graph obtained from the data specified in Table 5-2 and *E-Views*®

Appendix C: Correlation matrix of the independent variables

	ARGSBM	ARGSBO	ARGSUNM	ARGSUNO	BCOP	FSPR	NWPR	PKMROTT	POE	RDER	SACOP	SAPI	SAPSB	SAPSUN	SASBC	SASBI	SASUNC	SASUNI	SBIPP	SUNIPP
ARGSBM	1.000	0.678	0.827	0.501	0.403	-0.023	0.015	0.796	0.645	-0.510	0.476	0.321	-0.087	-0.232	0.003	0.142	0.155	-0.401	0.462	0.251
ARGSBO	0.678	1.000	0.535	0.875	0.502	-0.048	-0.034	0.847	0.965	-0.321	0.898	0.661	0.043	-0.230	0.260	0.362	0.077	-0.201	0.675	0.679
ARGSUNM	0.827	0.535	1.000	0.454	0.342	-0.010	0.010	0.739	0.509	-0.276	0.365	0.317	0.074	-0.273	0.130	0.193	0.225	-0.331	0.453	0.264
ARGSUNO	0.501	0.875	0.454	1.000	0.476	-0.036	-0.082	0.723	0.838	-0.107	0.921	0.722	0.086	-0.311	0.361	0.507	0.036	-0.220	0.740	0.839
BCOP	0.403	0.502	0.342	0.476	1.000	-0.122	-0.172	0.559	0.570	-0.613	0.471	0.345	0.652	-0.335	0.400	0.318	0.035	-0.286	0.034	0.167
FSPR	-0.023	-0.048	-0.010	-0.036	-0.122	1.000	0.866	0.008	-0.051	0.071	-0.081	-0.150	-0.283	-0.471	-0.528	-0.119	0.340	-0.524	-0.081	-0.028
NWPR	0.015	-0.034	0.010	-0.082	-0.172	0.866	1.000	0.046	-0.034	0.046	-0.111	-0.147	-0.338	-0.469	-0.571	-0.143	0.401	-0.518	-0.095	-0.058
PKMROTT	0.796	0.847	0.739	0.723	0.559	0.008	0.046	1.000	0.878	-0.384	0.679	0.534	0.161	-0.349	0.143	0.241	0.215	-0.333	0.546	0.479
POE	0.645	0.965	0.509	0.838	0.570	-0.051	-0.034	0.878	1.000	-0.316	0.859	0.646	0.143	-0.280	0.258	0.314	0.074	-0.194	0.640	0.653
RDER	-0.510	-0.321	-0.276	-0.107	-0.613	0.071	0.046	-0.384	-0.316	1.000	-0.184	0.059	-0.164	0.105	0.003	0.065	-0.024	0.327	0.338	0.335
SACOP	0.476	0.898	0.365	0.921	0.471	-0.081	-0.111	0.679	0.859	-0.184	1.000	0.721	0.042	-0.192	0.370	0.482	-0.071	-0.149	0.717	0.835
SAPI	0.321	0.661	0.317	0.722	0.345	-0.150	-0.147	0.534	0.646	0.059	0.721	1.000	0.208	-0.116	0.452	0.479	-0.043	0.035	0.650	0.723
SAPSB	-0.087	0.043	0.074	0.086	0.652	-0.283	-0.338	0.161	0.143	-0.164	0.042	0.208	1.000	-0.040	0.590	0.184	-0.035	0.170	-0.176	-0.057
SAPSUN	-0.232	-0.230	-0.273	-0.311	-0.335	-0.471	-0.469	-0.349	-0.280	0.105	-0.192	-0.116	-0.040	1.000	0.298	-0.144	-0.262	0.660	-0.150	-0.205
SASBC	0.003	0.260	0.130	0.361	0.400	-0.528	-0.571	0.143	0.258	0.003	0.370	0.452	0.590	0.298	1.000	0.399	-0.198	0.493	0.249	0.351
SASBI	0.142	0.362	0.193	0.507	0.318	-0.119	-0.143	0.241	0.314	0.065	0.482	0.479	0.184	-0.144	0.399	1.000	0.204	-0.128	0.425	0.527
SASUNC	0.155	0.077	0.225	0.036	0.035	0.340	0.401	0.215	0.074	-0.024	-0.071	-0.043	-0.035	-0.262	-0.198	0.204	1.000	-0.288	-0.014	-0.047
SASUNI	-0.401	-0.201	-0.331	-0.220	-0.286	-0.524	-0.518	-0.333	-0.194	0.327	-0.149	0.035	0.170	0.660	0.493	-0.128	-0.288	1.000	-0.046	-0.044
SBIPP	0.462	0.675	0.453	0.740	0.034	-0.081	-0.095	0.546	0.640	0.338	0.717	0.650	-0.176	-0.150	0.249	0.425	-0.014	-0.046	1.000	0.899
SUNIPP	0.251	0.679	0.264	0.839	0.167	-0.028	-0.058	0.479	0.653	0.335	0.835	0.723	-0.057	-0.205	0.351	0.527	-0.047	-0.044	0.899	1.000

Source: The data that was obtained from the sources in Table 5-2 was analysed by using the *E-Views*® and *SPSS Statistics*® software and captured in *Microsoft Office Excel*®.
Note: See Table 5-2 for the acronym definitions.

Appendix D: Test regression analyses results

South African sunflower spot price model

OLS Regression Results				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	0.0080	0.0076	1.0533	0.2953
IOMP	0.2057	0.1317	1.5622	0.1221
MEF	0.1422	0.1229	1.1576	0.2504
SAOSD	-0.0004	0.0123	-0.0334	0.9734
SAVOI	0.0070	0.0242	0.2907	0.7720
Summary Statistics				
R-Squared	0.0431	**Mean Dependent Var**		0.0101
Adjusted R-Squared	-0.0041	**S.D. Dependent Var**		0.0693
S.E. of Regression	0.0694	**Akaike Info Criterion**		-2.4406
Sum Squared Resid	0.3905	**Schwarz Criterion**		-2.2979
Log Likelihood	109.9438	**F-Statistic**		0.9126
Durbin-Watson Stat	1.1499	**Prob(F-Statistic)**		0.4607

Source: The SASSPM's test regression results obtained from *E-Views®*
Note: See 5.3.5.1 for the acronym definitions.

South African sunflower first futures price model

OLS Regression Results				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	0.0084	0.0084	1.0057	0.3175
IOMP	0.1928	0.1453	1.3267	0.1883
MEF	0.1796	0.1356	1.3248	0.1890
SAOSD	-0.0010	0.0136	-0.0755	0.9400
SAVOI	-0.0145	0.0267	-0.5409	0.5901
Summary Statistics				
R-Squared	0.0435	**Mean Dependent Var**		0.0102
Adjusted R-Squared	-0.0038	**S.D. Dependent Var**		0.0765
S.E. of Regression	0.0766	**Akaike Info Criterion**		-2.2435
Sum Squared Resid	0.4755	**Schwarz Criterion**		-2.1008
Log Likelihood	101.4713	**F-Statistic**		0.9201
Durbin-Watson Stat	1.4500	**Prob(F-Statistic)**		0.4564

Source: The SASFFPM's test regression results obtained from *E-Views®*
Note: See 5.3.5.1 for the acronym definitions.

South African sunflower second futures price model

OLS Regression Results				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	0.0075	0.0090	0.8354	0.4060
IOMP	0.1869	0.1559	1.1995	0.2338
MEF	0.2041	0.1455	1.4034	0.1643
SAOSD	-0.0136	0.0146	-0.9288	0.3557
SAVOI	0.0179	0.0287	0.6227	0.5353
Summary Statistics				
R-Squared	0.0523	Mean Dependent Var		0.0102
Adjusted R-Squared	0.0055	S.D. Dependent Var		0.0824
S.E. of Regression	0.0822	Akaike Info Criterion		-2.1032
Sum Squared Resid	0.5472	Schwarz Criterion		-1.9605
Log Likelihood	95.4361	F-Statistic		1.1165
Durbin-Watson Stat	1.6838	Prob(F-Statistic)		0.3545

Source: The SASSFPM's test regression results obtained from *E-Views*®
Note: See 5.3.5.1 for the acronym definitions

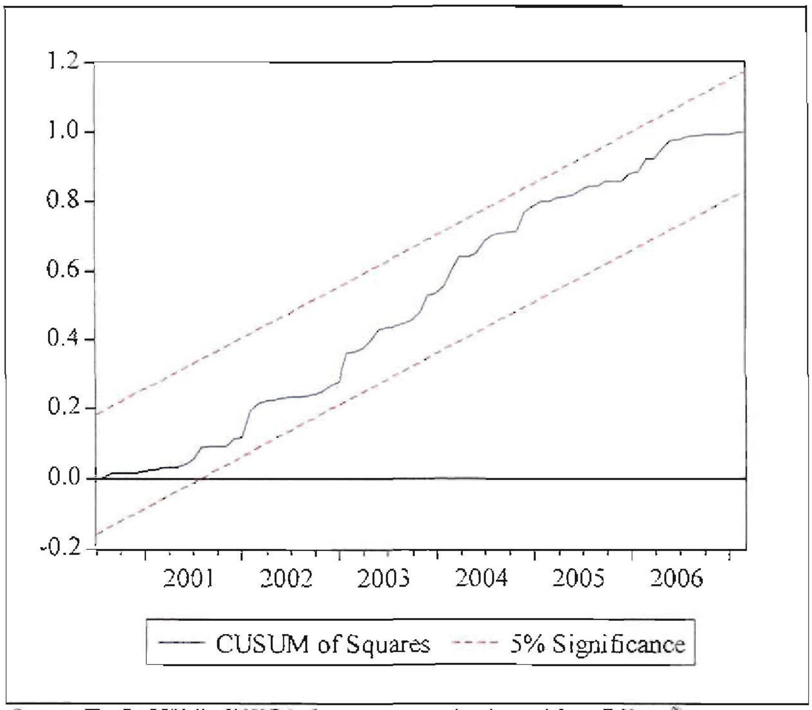
South African sunflower third futures price model

OLS Regression Results				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	0.0083	0.0084	0.9905	0.3249
IOMP	0.0451	0.1451	0.3109	0.7567
MEF	0.1743	0.1355	1.2865	0.2019
SAOSD	-0.0268	0.0136	-1.9668	0.0526
SAVOI	0.0251	0.0267	0.9402	0.3499
Summary Statistics				
R-Squared	0.0736	Mean Dependent Var		0.0102
Adjusted R-Squared	0.0279	S.D. Dependent Var		0.0776
S.E. of Regression	0.0765	Akaike Info Criterion		-2.2457
Sum Squared Resid	0.4745	Schwarz Criterion		-2.1030
Log Likelihood	101.5670	F-Statistic		1.6090
Durbin-Watson Stat	1.7329	Prob(F-Statistic)		0.1800

Source: The SASTFPM's test regression results obtained from *E-Views*®
Note: See 5.3.5.1 for the acronym definitions

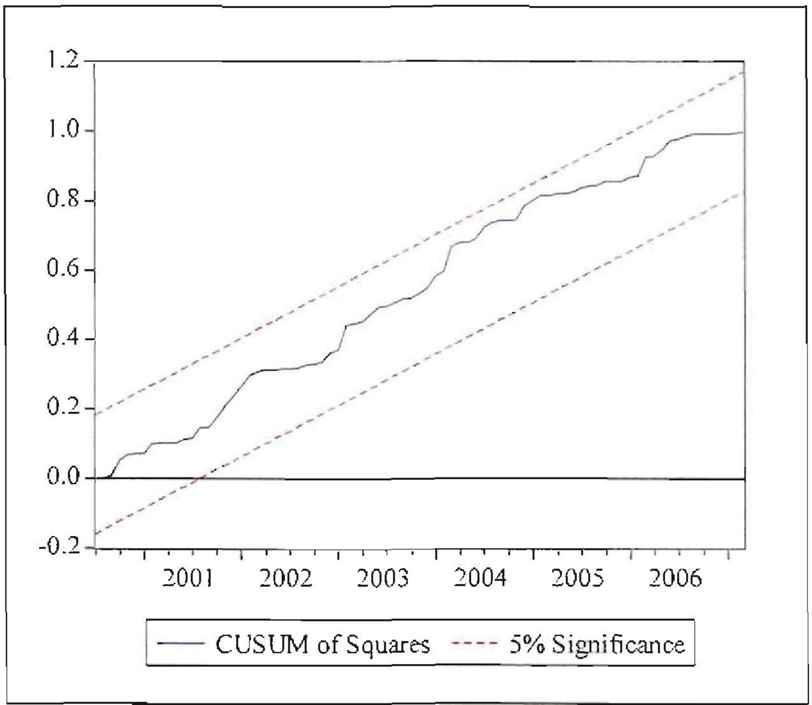
Appendix E: Structural breaks in the dependent variables

South African sunflower spot price



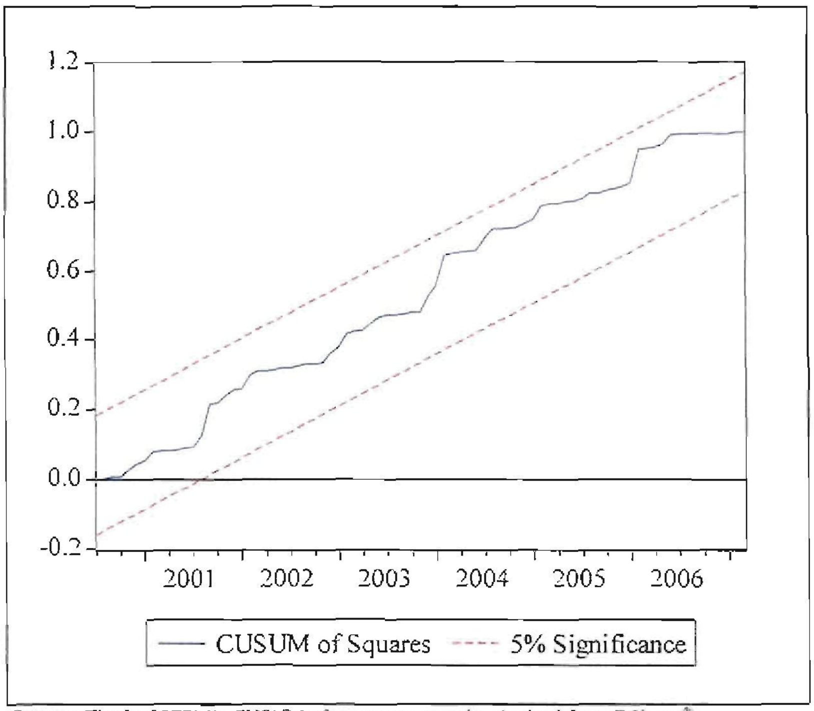
Source: The SASSPM's CUSUM of squares test results obtained from *E-Views*®.

South African sunflower first futures price



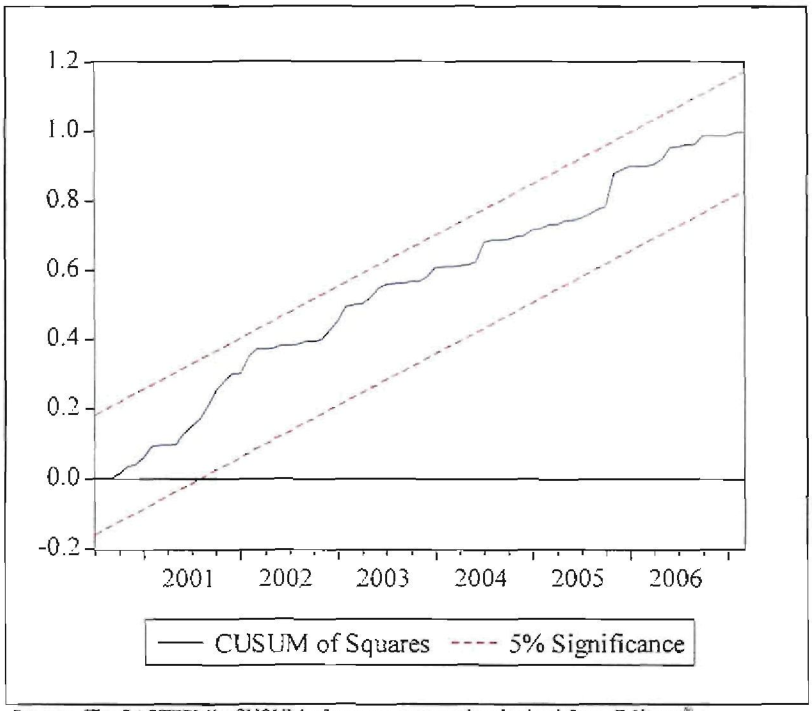
Source: The SASFFPM's CUSUM of squares test results obtained from *E-Views*®

South African sunflower second futures price



Source: The SASSFPM's CUSUM of squares test results obtained from *E-Views*®.

South African sunflower third futures price



Source: The SASTFPM's CUSUM of squares test results obtained from *E-Views*®.

Appendix F: Test regression cointegration results

SAFEX sunflower spot price and factors

Johansen Cointegration Test Results					
Data Trend	None	None	Linear	Linear	Quadratic
Test Type	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace	0	0	0	0	1
Max-Eig	1	0	0	0	0

Source: Johansen Cointegration test results obtained from *E-Views*®.
Note: Selected (5% level) number of cointegrating relations by model

SAFEX sunflower first futures price and factors

Johansen Cointegration Test Results					
Data Trend	None	None	Linear	Linear	Quadratic
Test Type	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace	1	0	1	0	1
Max-Eig	1	1	1	0	1

Source: Johansen Cointegration test results obtained from *E-Views*®.
Note: Selected (5% level) number of cointegrating relations by model

SAFEX sunflower second futures price and factors

Johansen Cointegration Test Results					
Data Trend	None	None	Linear	Linear	Quadratic
Test Type	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace	0	0	0	0	0
Max-Eig	1	0	0	0	0

Source: Johansen Cointegration test results obtained from *E-Views*®.
Note: Selected (5% level) number of cointegrating relations by model.

SAFEX third futures price and factors

Johansen Cointegration Test Results					
Data Trend	None	None	Linear	Linear	Quadratic
Test Type	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace	0	0	0	0	0
Max-Eig	1	0	0	0	0

Source: Johansen Cointegration test results obtained from *E-Views*®.
Note: Selected (5% level) number of cointegrating relations by model

Appendix G: VAR lag order estimation

South African sunflower spot price model

VAR Lag Order Selection Criteria						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	97.55117	NA	1.22E-06	-2.267118	-2.027174	-2.170989
1	346.2253	459.575	3.37E-09	-8.157602	**-7.437770***	-7.869216
2	373.654	47.91344	2.54E-09	-8.446937	-7.247216	**-7.966292***
3	390.3699	**27.50711***	**2.51E-09***	**-8.465060***	-6.785451	-7.792157
4	404.4737	21.78055	2.68E-09	-8.417055	-6.257558	-7.551894
5	417.9719	19.47845	2.94E-09	-8.353719	-5.714334	-7.2963
6	429.2852	15.1799	3.45E-09	-8.235069	-5.115796	-6.985392

Source: Lag length results obtained from *E-Views*®.
Notes: * Indicates the lag order selected by the criterion. LR: sequential modified LR test statistic (each test at 5% level). FPE: Final prediction error. AIC: Akaike information criterion. SC: Schwarz information criterion. HQ: Hannan-Quinn information criterion.

South African sunflower second futures price model

VAR Lag Order Selection Criteria						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	93.75807	NA	1.34E-06	-2.17109	-1.931146	-2.074961
1	334.1485	444.2659	4.58E-09	-7.851861	**-7.132029***	**-7.563475***
2	351.4799	**30.27509***	**4.44E-09***	**-7.885568***	-6.685847	-7.404923
3	365.2241	22.61706	4.75E-09	-7.828459	-6.148851	-7.155557
4	377.3327	18.6993	5.34E-09	-7.729942	-5.570445	-6.864781
5	387.7144	14.98126	6.32E-09	-7.587707	-4.948322	-6.530289
6	397.7295	13.43794	7.67E-09	-7.43619	-4.316917	-6.186514

Source: Lag length results obtained from *E-Views*®.
Notes: * Indicates the lag order selected by the criterion. LR: sequential modified LR test statistic (each test at 5% level). FPE: Final prediction error. AIC: Akaike information criterion. SC: Schwarz information criterion. HQ: Hannan-Quinn information criterion.

South African sunflower first futures price model

VAR Lag Order Selection Criteria						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	95.37063	NA	1.29E-06	-2.211915	-1.971971	-2.115786
1	334.4688	441.8777	4.54E-09	-7.859971	**-7.140138***	-7.571584
2	360.4151	45.32384	3.54E-09	-8.111775	-6.912054	**-7.631130***
3	378.9935	**30.57205***	**3.35E-09***	**-8.177050***	-6.497442	-7.504148
4	393.1242	21.82207	3.58E-09	-8.129726	-5.970229	-7.264565
5	405.9847	18.55816	3.98E-09	-8.050244	-5.410859	-6.992826
6	415.5217	12.79659	4.89E-09	-7.886626	-4.767353	-6.63695

Source: Lag length results obtained from *E-Views*®.
Notes: * Indicates the lag order selected by the criterion. LR: sequential modified LR test statistic (each test at 5% level). FPE: Final prediction error. AIC: Akaike information criterion. SC: Schwarz information criterion. HQ: Hannan-Quinn information criterion.

South African sunflower third futures price model

VAR Lag Order Selection Criteria						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	94.83708	NA	1.30E-06	-2.198407	-1.958463	-2.102278
1	338.1303	449.6305	4.14E-09	-7.952665	**-7.232833***	**-7.664278***
2	357.9674	**34.65220***	**3.77E-09***	**-8.049808***	-6.850087	-7.569163
3	372.0486	23.1716	4.00E-09	-8.00123	-6.321622	-7.328328
4	385.8275	21.27873	4.30E-09	-7.944999	-5.785502	-7.079838
5	396.0931	14.81376	5.12E-09	-7.799826	-5.160441	-6.742408
6	408.7712	17.0111	5.80E-09	-7.715727	-4.596454	-6.466051

Source: Lag length results obtained from *E-Views*®.
Notes: * Indicates the lag order selected by the criterion. LR: sequential modified LR test statistic (each test at 5% level). FPE: Final prediction error. AIC: Akaike information criterion. SC: Schwarz information criterion. HQ: Hannan-Quinn information criterion.

Appendix H: VAR cointegration test results

South African sunflower spot price model

Johansen Cointegration Test Results					
Data Trend	None	None	Linear	Linear	Quadratic
Test Type	No Intercept	Intercept	Intercept	Intercept	Intercept
	No Trend	No Trend	No Trend	Trend	Trend
Trace	0	0	0	0	1
Max-Eig	0	0	1	0	0

Source: Johansen Cointegration test results obtained from *E-Views*®.
Note: Selected (5% level) number of cointegrating relations by model.

South African sunflower first futures price model

Johansen Cointegration Test Results					
Data Trend	None	None	Linear	Linear	Quadratic
Test Type	No Intercept	Intercept	Intercept	Intercept	Intercept
	No Trend	No Trend	No Trend	Trend	Trend
Trace	0	0	0	0	1
Max-Eig	0	0	0	0	0

Source: Johansen Cointegration test results obtained from *E-Views*®.
Note: Selected (5% level) number of cointegrating relations by model.

South African sunflower second futures price model

Johansen Cointegration Test Results					
Data Trend	None	None	Linear	Linear	Quadratic
Test Type	No Intercept	Intercept	Intercept	Intercept	Intercept
	No Trend	No Trend	No Trend	Trend	Trend
Trace	0	0	0	0	0
Max-Eig	0	0	0	0	0

Source: Johansen Cointegration test results obtained from *E-Views*®.
Note: Selected (5% level) number of cointegrating relations by model.

South African sunflower third futures price model

Johansen Cointegration Test Results					
Data Trend	None	None	Linear	Linear	Quadratic
Test Type	No Intercept	Intercept	Intercept	Intercept	Intercept
	No Trend	No Trend	No Trend	Trend	Trend
Trace	0	0	0	0	0
Max-Eig	0	0	0	0	0

Source: Johansen Cointegration test results obtained from *E-Views*®.
Note: Selected (5% level) number of cointegrating relations by model.

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