Grain SA
Fertiliser Report

2011

EXECUTIVE SUMMARY

- **Introduction**

As a world market commodity, fertiliser prices are similarly formed to the prices of most global commodities and supply and demand factors that normally impact most commodity prices. The prices of the main fertiliser materials reached record levels during 2008 and again decreased sharply during the latter part of 2008. This volatility in fertiliser prices resulted in various questions being raised regarding whether this was due to fundamental reasons (for example supply and demand) that caused this occurrence or not.

Fertiliser as production input contributes on average between 30 % and 50 % to a grain and oilseed producers' variable production costs in South Africa. For this reason, the price that grain and oilseed producers pay for fertiliser is a vitally important determinant of the profitability of grain and oilseed production in South Africa.

As South Africa's agricultural industry operates in a free market, primary producers are price takers and cannot pass high fertiliser prices on to the next user of their produce. This in turn could make grain production unprofitable in South Africa, which in the long run could lead to food insecurity in the country. For this reason, it is of critical importance that fertiliser prices in South Africa are a reflection of the fundamental factors driving fertiliser prices both internationally and locally.

- **Objectives**

The primary objective of this study was to investigate the structure, conduct and performance of the fertiliser industry in South Africa. As mentioned above, if fertiliser prices are not a true reflection of market factors and are being distorted in some or other way, this could negatively affect the profitability and sustainability of grain and oilseed production in South Africa. A distortion of fertiliser prices in South Africa could therefore put pressure on the country to maintain and improve food security levels.

In order to achieve the primary objective of this study, the following secondary objectives were addressed:

Investigation into the international fertiliser market in terms of:

- The structure of the international fertiliser industry – what countries and companies are the largest producers of raw materials and ultimately fertilisers?
- The long-term supply and demand ratios for fertilisers on international markets.
- Current and historical factors that have an influence or drive fertiliser prices on international markets.

Investigation into the South African fertiliser market in terms of:

- The structure of the South African fertiliser industry – what companies are the largest producers or role-players in the local industry, market shares, profitability and performance etc.?
- Supply and demand in the local fertiliser industry – local production, imports, exports and use.
- Current and historical factors that have an influence or drive local fertiliser prices.
- The price transmission from international fertiliser prices to local fertiliser prices.
- The contribution of fertiliser costs to local grain and oilseed producers' total production costs and the ultimate effect of volatile fertiliser prices on the profitability of grain and oilseed production in South Africa.

- **International Fertiliser Industry**

From Chapter 2, it is clear that the sharp rise in international fertiliser prices in 2007 and 2008 was caused by a few global economic factors converging, causing a "perfect storm". The main conclusion from Chapter 2 is that it was both supply and demand-driven factors causing prices to increase sharply during 2007 and 2008. The most important factors that affected fertiliser prices can be summarised as follows:

- Nitrogen:
  - ✓ Low nitrogen inventories;
  - ✓ Higher demand for nitrogen driven by an increase in the area planted to grain crops;
  - ✓ The overall economic situation caused production costs of nitrogen to increase:
    - Brent crude oil prices influenced transport costs and freight rates;
    - Brent crude oil prices influenced the natural gas price which is the main feedstock for nitrogen fertiliser; and
  - ✓ China imposed export taxes which meant that its nitrogen was only available to the rest of the international market at higher prices.

- Phosphates:
  - ✓ Higher demand for phosphates due to high grain prices and larger areas planted to grain crops;
  - ✓ Prices of phosphate rock, sulphur and ammonia, which are the three primary materials used in producing DAP, increased significantly;
  - ✓ Brent crude oil prices resulted in rising cost of transport and freight rates; and
  - ✓ In contrast to nitrogen, phosphate stocks and DAP prices is not suggesting a strong relation. In fact, stock levels were significantly higher compared to the previous years at the time that prices were at record levels. One can however postulate that very low stock levels in 2006 and 2007 contributed to the increase in DAP prices, and that the industry subsequently reacted by producing more phosphate.

- Potassium:
  - ✓ The concentration within the potassium industry – only a few companies control the stock;
  - ✓ High demand caused by an increase in grain crop plantings; and
  - ✓ The start of the MOP price hike in 2007 coincided with a 10 year low in potassium stocks. Although stock levels rebounded in 2008, it was not enough to slow the MOP price increasing until end-2008;

As indicated above, there are potentially a myriad of complex and interrelated factors that could affect movements in fertiliser prices; but in most instances, the exact relation is not entirely clear. It is for this reason that it was decided to determine whether any statistically significant relation exists between the factors mentioned and the price movement of different fertilisers. The statistical analysis showed the following:

- The following factors, namely the prices of ammonia, natural gas, Brent Crude oil, Sulphur, Phosphate rock and the available stocks of the different fertiliser products can all be considered as supply side drivers and were all statistically significant. In other words, changes in these factors will have an impact on fertiliser prices. In terms of ammonia the natural gas price, the Brent Crude oil price and the ammonia stocks available were all statistical significant. In the case of potassium, the potassium stocks available proofed to be significant. With regards to DAP, the prices of ammonia, natural gas, Brent Crude oil, Sulphur and Phosphate rock were significant. The available stocks of DAP were also significant. In the case of Urea, the prices of ammonia, natural gas and Brent Crude oil also proofed to be statistical significant.

- On the demand side, only change in income measured by world GDP growth rate had a significant effect on the prices of the different fertiliser products.

- The results showed further that USA maize prices did not have a significant effect on fertiliser prices. However, one can postulate that the expansion of hectares towards grain production impacted on the demand for fertilisers. The increase in hectares planted is in turn derived from high grain prices that incentivised producers to plant more hectares.

- **Local Fertiliser Industry**

- Structure of the fertiliser industry in South Africa

In 2008, according Frost and Sullivan (2008), 86 % of the market share in terms of revenue in the fertiliser industry was shared between only three companies – at the time Sasol, Omnia and Yara. With Profert included, four companies shared 94 % of the market as far as revenue is concerned (note that in the process of writing this report, Yara has become Kynoch again and Sasol, as in 1992, decided to concentrate on wholesale production and to stop selling fertiliser as retailers). The constant restructuring of the fertiliser supply chain appears to have evolved in a sub-optimal manner; leading to practices in contravention of the Competition Act in South Africa. This was confirmed by several cases investigated by the Competition Commission and agreements have already been reached by some of the parties involved. In the one case, Sasol came to an agreement with the Competition Commission regarding its part in colluding with Yara and Omnia and its abuse of dominance in the fertiliser market. Other cases are still on-going.

This concentration within the industry can dramatically change with the agreement between Sasol and the Competition Commission that was reached in 2010. Sasol agreed to sell five of its regional blending plants and will in future only supply the market on a wholesale level from Sasol Nitro Secunda and three distribution centres within a 100 km radius of Secunda and Sasolburg.

- Domestic supply and trade

An increasing concern for local consumers of fertiliser is that according to statistics of the International Fertiliser Association (2010), South Africa is becoming more and more dependent on imports to satisfy the local fertiliser demand. In 1990, less than 20 % of fertiliser needs was imported; in 1999, 40 % of the demand was imported; and in 2008, over 65 % of South Africa's nutritional fertiliser needs was imported.

This situation presents a considerable risk for the agricultural industry (in particular the grain crop sub-sector) in that it could cause (i) more and higher price volatility spill over effects onto the South African market for fertilisers and (ii) possible shortages as a result of unforeseen global events that could affect global fertiliser availability.

- Domestic price trends

Due to the fact that South Africa imports over 60 % of its local fertiliser demand and that the local industry operates in the free market, international price trends will filter into the South African market.

Correlation estimates to determine the relationship between local and international prices showed that local fertiliser prices are highly correlated with their international fertiliser products. The strongest correlations were found for (i) international and local urea, (ii) international DAP and local MAP and (iii) international KCL and local KCL.

In order to determine a proxy for margins[1] in the fertiliser industry, an import parity price approach was used. The assumption underlying this approach is that import parity pricing will prevail in the case where South Africa is a significant importer of a particular product. The calculation is however more difficult to interpret in the case where the majority of a specific product is produced locally.

The results showed that when importing a product, the product itself costs approximately 50 % of the final price quoted on price lists (excluding average 12 % discount). The rest of the costs are made up by freight and inland transport cost (12 %); insurance; financing costs; discharging costs; and others (see calculation in Chapter 3). Included in these calculations is a margin, which is the difference between the import parity calculation and the average price on pricelists for the product. When considering an average discount of 12 % on the pricelist prices, a farm gate price could be determined. After taking an average 12 % discount into consideration, an average margin of 17 % was calculated for imported urea from January 2004 to date. With imported MAP, the margin was also 17 %; while a margin of 21 % was calculated for KCL. Without the discount, the margins for urea, MAP and KCL were 27 %, 27 % and 30 % respectively.

A price structure calculation for LAN showed that local LAN production is competitive with the imported product. When no discount on the list price was considered, a margin of 8 % was

[1] Margin in this context does not necessarily imply net profit, but is used to indicate a derived margin when taking into account as many as possible variables that could affect margins in the industry.

showed. When a discount of 12 % was considered however, the margin was negative (-5 %). This means that it would be cheaper to purchase LAN from local companies that manufacture LAN rather than to import it. This finding was expected because South Africa, through Sasol's ammonia production, can produce large quantities of LAN and can be competitive with international markets. Because all of South Africa's LAN is locally produced, it is difficult to make conclusions about the price structure and margins companies receive in the LAN market. Companies, however, as seen in the import parity calculations, can push their prices just below the import costs of LAN, and would still stay competitive.

A noteworthy issue that emerge from the analysis is the difference between the calculated margins between LAN and MAP. The reason is that the a priory expectation was that these margins will be more or less of the same order in light of the fact that both products are produced locally. The reason for this expectation is that South Africa is in fact a net exporter of phosphoric acid, the main raw material for MAP. The local price structures, within the whole phosphate chain, therefore require further investigation.

- **Price transmission between international and local fertiliser prices**

This study confirmed that there is a relation between local and international fertiliser prices. It is, however, important to better understand the nature of this relation. For example, is international price transmission symmetric or asymmetric? When price transmission is symmetric, it indicates that local prices respond similarly to both upward and downward movements in the international fertiliser prices. However, when price transmission is asymmetric, then it could be indicative of local prices reacting differently to increases in international fertiliser prices than to decreases. In order to analyse the nature of price transmission, econometric tools were used.

The results from the analysis show that price transmission between international and local fertiliser prices is incomplete. This means that changes in international fertiliser prices are not completely passed through to local fertiliser prices. It was found that much of the differences between international and local price changes was caused by non-policy factors, such as deficiencies in the market (market power); physical (transport and storage); commercial (market information); and institutional (credit and regulating laws) infrastructure. However, much of the price differences were also caused by factors such as the exchange rate.

The results further showed that price transmission between international and local prices is asymmetrical. In other words, local prices respond differently to upward movements in international prices than to downward movements. The results showed that local prices respond more quickly to international price increases or the depreciation of the value of the Rand than to international price decreases or the appreciation of the value of the Rand. This means that fertiliser companies react more quickly to changes in international fertiliser prices that put their profit under pressure (price increases) than to international price changes (price decreases) that stretch their profits. What was also found, was that there was statistical no significant relationship between a decrease in the international price of ammonia and the local price of LAN. This means that the local LAN price does not normally react to an international price decrease in ammonia.

This result can mean one of two things:

1. The local LAN price may not be reacting to a change in the international ammonia price because of the fact that South Africa is completely self-sufficient in terms of LAN. The question that comes to mind with this argument is, why does the LAN price not react to a decrease in the ammonia price, but reacts when the price increases? Another argument that comes to mind is that South Africa needs to import some of its ammonia to be able to satisfy the local demand and, therefore, part of the production costs of LAN may be on import parity.
2. The fact that the results show that the local LAN price mechanism is asymmetric in nature emphasises that the structure and conduct in this chain requires further investigation.

- **Recommendations to Government**

    - Due to the fact that the Competition Commission has already pointed out irregularities, monitoring of competition within the industry should be a permanent process. It is recommended that the Competition Commission should either continuously monitor the fertiliser industry or help to put mechanisms in place for industry role players to monitor the industry themselves.

    - South Africa's infrastructure that is used to produce primary fertiliser materials is very old and very expensive to replace. It is important to bear in mind that the trends show that South Africa is importing increasing amounts of fertiliser on an annual basis to satisfy the local demand. It is recommended that Government (in particular DTI and the IDC) consider mechanisms to revitalize the local fertiliser industry. The risks of being increasingly reliant on imports to satisfy local fertiliser demand should be sufficient motivation to engage in such an endeavour. To be solely dependent on imports can also have a negative effect on prices and therefore also the grain producers' ability to produce affordable food for the country.

- Multi-national fertiliser companies state that the high level of uncertainty prevailing in South Africa, and failure of Government to implement policies that are supposed to create a conducive business environment, constitutes a major challenge for them to make huge capital and long-term investments in the South African fertiliser industry.

- The results from the price transmission models in chapter 4 confirm that transport may be one of the major factors distorting local fertiliser prices. Transport is mainly done by road, because rail transport has become unreliable and has deteriorated significantly in the last decade. The rail infrastructure and capacity between Phalaborwa and Richards Bay also impedes on Foskor's ability to move enough phosphate rock to produce phosphoric acid and MAP more cost efficiently. Nationwide, the lack of an efficient rail transport system is also impeding on the transport of ammonia. This needs to be taken up with the National Department of Transport and Public Works.

- Information transparency within the fertiliser industry is a concern. Much can be done to make, especially price information, more transparent. It is therefore recommended that the National Agricultural Marketing Council consider mechanisms to increase the flow of information within the fertiliser industry.

- **Recommendations needing further investigation**

  - Anecdotal evidence suggests that co-ops and agribusiness demand a 3 % to 8 % commission on top of normal finance costs for transactions being financed through them, which was sold directly to the farmer by the fertiliser company. The composition and structure of this commission requires further analysis since it constitutes a significant additional cost to the farmer.

  - As mentioned above, the local price structure within the whole phosphate value chain requires further investigation.

  - The fact that results showed that the local LAN price mechanism are asymmetric in nature, emphasises that the structure and conduct in the local nitrogen chain also requires further investigation.

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Dr André Jooste (NAMC)
Corné Dempers (NAMC)
Corné Louw (Grain SA)
Nico Hawkins (Grain SA)
Petru Fourie (Grain SA)
Dr Zerihun Gudeta Alemu (Development Bank of Southern Africa)

Table of Contents

List of Tables

List of Figures

List of Boxes

List of Diagrams

Acronyms

AN	Ammonium Nitrate
AS	Ammonium Sulphate
BDI	Baltic Dry Index
CaCO3	Calcium Carbonate
Capex	Cape Explosives
CIS	Commonwealth of Independent Sates
DAP	Di-Ammonium Phosphate
DME	Department of Minerals and Energy
FOB	Free on Board
FOR	Free on Rail
FSSA	Fertiliser Society of South Africa
H	Hydrogen
IDC	Industrial Development Corporation
IFA	International Fertiliser Association
IGC	International Grains Council
IOF	Indian Ocean Fertiliser
K	Potassium
K_2O	Potassium Oxide
KCl	Potassium Chloride
LAN	Limestone Ammonium Nitrate
MAP	Mono-Ammonium Phosphate
MOP	Muriate of Potash
N	Nitrogen
OECD	Organisation for Economic Co-operation and Development
P	Phosphate
P_2O_5	Phosphorus Oxide
P_20_5	Phosphorous Pentoxide
SAFCO	South African Fertiliser Company
SSP	Single Super Phosphate
TSP	Triple Super Phosphate
USA	United States of America
USDA	United States Department of Agriculture
USGS	U.S. Geological Survey

CHAPTER 1

INTRODUCTION

1.1 Introduction

As a world market commodity, fertiliser prices are similarly formed to the prices of most global commodities and supply and demand factors that normally impact most commodity prices. The prices of the main fertiliser materials[2] reached record levels during 2008 and resulted in various questions being raised regarding whether this was due to fundamental reasons (for example supply and demand) that caused this occurrence or not. From September 2007 to September 2008, the international ammonia, urea, Di-Ammonium Phosphate (DAP) and Muriate Of Potassium (MOP) prices increased by 285 %, 118 %, 143 % and 257 % respectively. Over the same period, South African Limestone Ammonium Nitrate (LAN) (28), urea, Mono-Ammonium Phosphate (MAP) and Muriate Of Potash (MOP) prices increased by 138 %, 131 %, 175 % and 270 % respectively.

However, from September 2008 to September 2009, prices of both international and local fertiliser materials decreased significantly. International prices of ammonia, urea, DAP and MOP decreased by 70 %, 65 %, 70 % and 46 % respectively; while local prices of LAN (28), urea, MAP and MOP decreased by 52 %, 53 %, 67 % and 31 % respectively.

Fertiliser as production input contributes on average between 30 % and 50 % to a grain and oilseed producers' variable production costs in South Africa. For this reason, the price that grain and oilseed producers pay for fertiliser is a vitally important determinant of the profitability of grain and oilseed production in South Africa.

As South Africa's agricultural industry operates in a free market, primary producers are price takers and cannot pass high fertiliser prices on to the next user of their produce. This in turn could make grain production unprofitable in South Africa, which in the long run could lead to food insecurity in the country. For this reason, it is of critical importance that fertiliser prices in South Africa are a reflection of the fundamental factors driving fertiliser prices both internationally and locally.

[2] Main fertiliser materials refer to all feedstock used to produce fertiliser as well as fertiliser itself.

1.2 Problem statement and motivation

International and local fertiliser prices began a gradual increase from early 2007 until the beginning of 2008, after which prices increased substantially to peak during mid to end of 2008. International prices of ammonia, urea, DAP and potassium chloride in Rand terms increased by 229 %, 213 %, 380 %, 598 % respectively from January 2007 until their high point was reached in 2008 (Figure 1). Local prices (Figure 2) of LAN (28), urea, MAP and potassium chloride increased by 171 %, 172 %, 313 % and 271 % respectively from February 2007 until their peak was reached in 2008; with the exception of the peak price for local potassium chloride, which was only reached in January 2009.

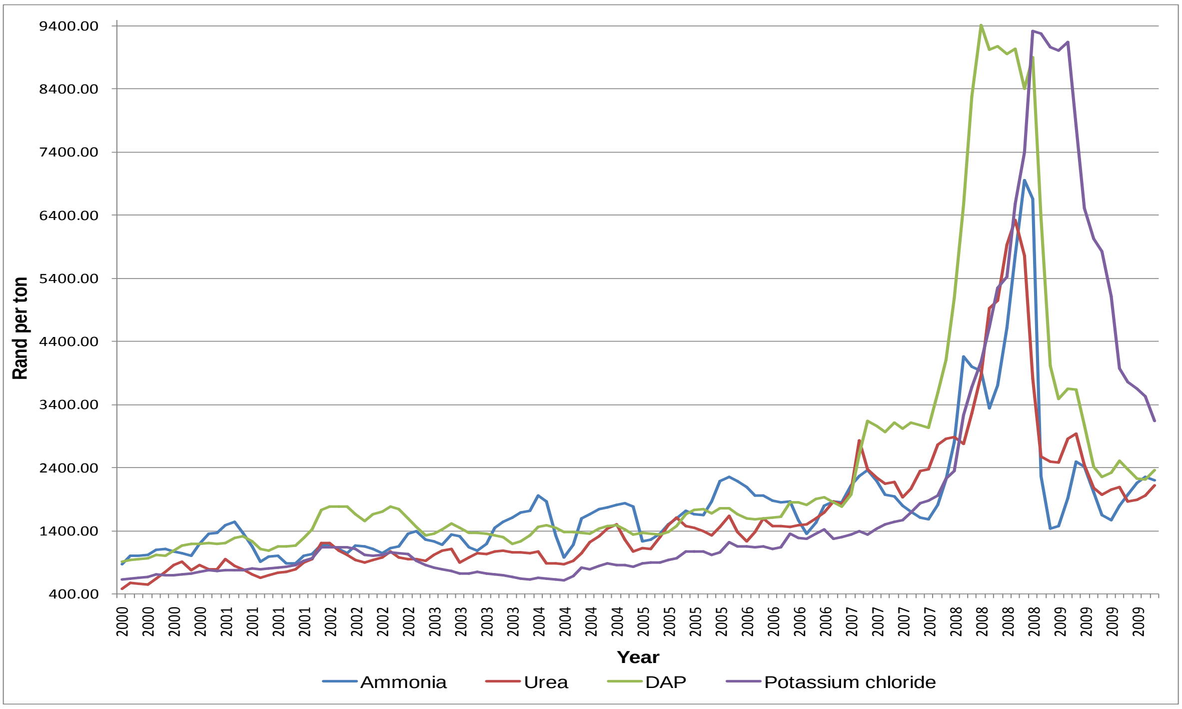

Figure 1: International fertiliser prices in Rand terms
Source: Grain SA, 2009

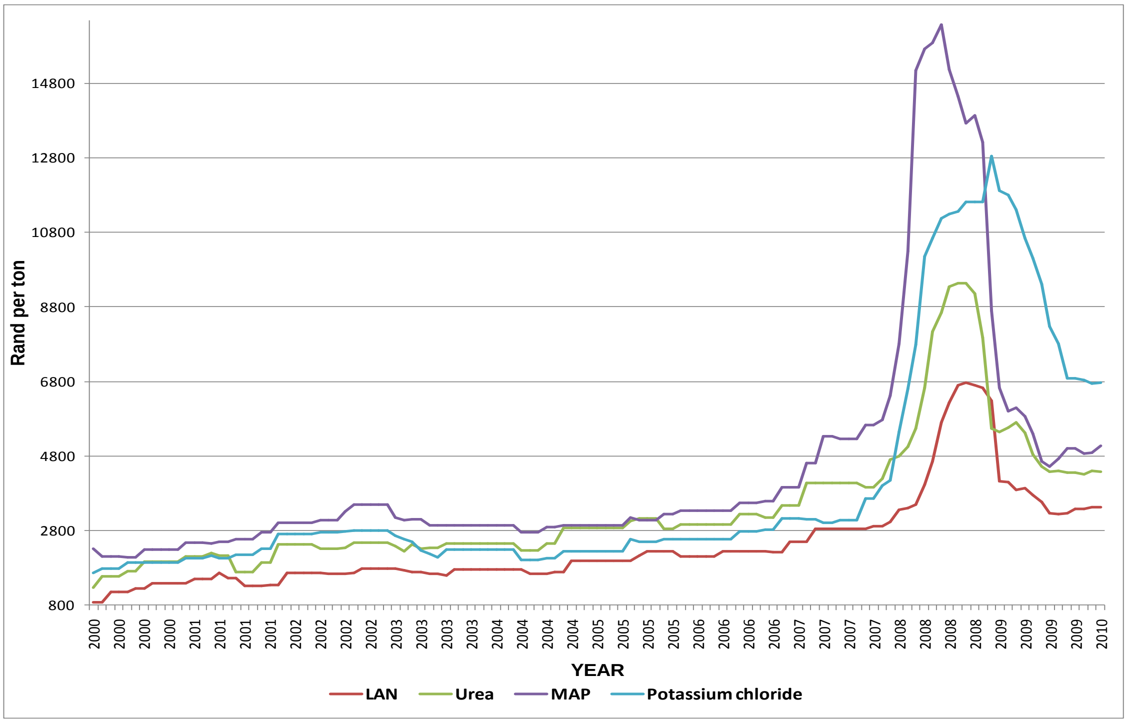

Figure 2: Local fertiliser prices in Rand terms
Source: Grain SA, 2009

According to the production cost figures of Grain SA, fertiliser costs in the 2008/09 production season contributed approximately 43 % to maize producers' total direct allocated production costs. This cost contribution is similar for other grain and oilseed producers. During the previous season (2007/08), it was estimated that fertiliser cost contributed approximately 34 % to grain and oilseeds producers' direct allocated production costs. This is the highest contribution to production costs relative to any other production input; and, therefore, a vitally important determinant in whether grain and oilseed farming in South Africa is profitable.

When fertiliser cost contributes 40 % to a grain and oilseeds producers' direct allocated costs, an increase of 15 % in fertiliser cost can mean a decrease in profit for the producer of 6 % (according to Grain SA's production cost figures, 2010), *ceteris paribus*. High fertiliser prices (relative to commodity prices) will therefore definitely influence the long-term profitability and sustainability of grain production in South Africa. Inability to produce on a sustainable basis would also impact on South Africa's food security situation and the country's economic activity in terms of the whole agricultural value chain (for example agro processing).

Within the ambit of the aforementioned, it is important to take note that the South African fertiliser industry currently only produces nitrate-based nitrogen and phosphate fertilisers locally, while all its urea and potassium needs are imported. Being a net importer and due to South Africa having an open economy, the local fertiliser industry is exposed to international markets and the uncertainty of the exchange rate.

At wholesale level, the South African fertiliser industry is dominated by four fertiliser companies; while at retail level, three companies dominate the market. This translates into market power, which could potentially result in the misuse of it. In fact, in 2009, Sasol admitted taking part in uncompetitive behaviour with Omnia and Yara from 1996 to 2004. In 2010, Sasol also settled with the Competition Commission regarding allegations of abuse of dominance in its fertiliser businesses.

However, above all, there is a poor understanding of the structure, conduct and performance of the fertiliser industry in South Africa. Because of the fact that fertiliser as production input is such an important determinant in whether a grain producer makes a profit, it is of critical importance to have a better understanding of the working and functioning of the fertiliser industry and price formation. Better understanding the industry will also capacitate Grain SA with regards to influencing policy and may improve the relationship between the producers and consumers of fertiliser. The latter mentioned refers to relationships that could have been damaged due to fertiliser companies being investigated by the competition authorities; one such company has already come forward with settlement agreements.

Against this background, it is clear that a transparent and competitive local fertiliser industry is needed to ensure a long term sustainable grain and oilseeds industry.

1.3 Objectives

The primary objective of this study is to investigate the structure, conduct and performance of the fertiliser industry in South Africa. As mentioned above, if fertiliser prices are not a true reflection of market factors and are being distorted in some or other way, this could negatively affect the profitability and sustainability of grain and oilseed production in South Africa.

In order to achieve the primary objective of this study, the following secondary objectives will be addressed:

Investigation into the international fertiliser market in terms of:

- The structure of the international fertiliser industry – what countries and companies are the largest producers of raw materials and ultimately fertilisers?

- The long-term supply and demand ratios for fertilisers on international markets.
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Investigation into the South African fertiliser market in terms of:

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- The contribution of fertiliser costs to local grain and oilseed producers' total production costs and the ultimate effect of volatile fertiliser prices on the profitability of grain and oilseed production in South Africa.

1.4. Outline

Chapter 2 – International fertiliser industry – This chapter presents a world outlook on the fertiliser industry and has the objective of recognising the factors that causes volatility in international fertiliser prices. The primary objective of the chapter is to study the structure of the international fertiliser industry and to look at the factors influencing international fertiliser prices.

Chapter 3 – Overview of the local industry – Chapter 3 focuses on the structure and market concentration in the local fertiliser industry. The chapter also delves into the factors that have an influence on the fertiliser market and looks into local price structures and price formation.

Chapter 4 – Price transmission between international and local fertiliser prices – This chapter analyses the various aspects surrounding the relationship between local and international fertiliser prices.

Chapter 5 – Conclusion and recommendations

CHAPTER 2

INTERNATIONAL FERTILISER INDUSTRY

2.1 Introduction

This chapter presents a world outlook for nitrogen, phosphate and potassium fertiliser in an effort to discover the reasons that caused fertiliser to reach record price levels during 2008. The primary objective of this chapter is thus to study the structure of the international fertiliser industry and to look in detail at the factors that influence international fertiliser prices. Each of the nutrients will be discussed by providing a short background followed by an investigation into the various factors influencing international fertiliser prices. Firstly, fertiliser net balance figures (nutrient value) for each of the nutrients (macro elements) are presented at global level; the international fertiliser prices will be linked with the balances in an attempt to determine the influence of stock levels on prices. Product trade will be examined and the influence of China's export taxes will be compared to the export volumes. Various macro economic factors and the leading role players in the international industry will be assessed. Other factors also under examination are companies that have the largest influence on the South African market and expected future production capacity possibilities.

2.1.1 Fertiliser mixtures

Fertilisers are generally divided into three main nutrients: nitrogen (N), phosphate (P), and potassium (K). The amount of fertiliser required by the producer depends on the crop planted as well as the concentration of nutrients that are available in the soil. The elements N, P and K normally do not exist in their pure form in fertiliser, and are thus mixed with various elements to form fertiliser mixes. Fertiliser is normally mixed with a ratio between N, P and K and then sold in ratio form. To determine the quantity of N, P and K in a fertiliser mixture, the example in Box 1 can be used as illustration.

Example of fertiliser mixtures:

Example: What does 2:3:2 (22) mean and how much N, P and K are in a bag of fertiliser?

Answer: In the form of a ready-made fertiliser mixture, such as 2:3:2 (22), the analysis found on the bag tells the producer the amount of nutrients being supplied. The three numbers on a bag of fertiliser indicates the parts of nitrogen, phosphate and potassium that is available to plants from that specific bag of fertiliser. In the above mixture, the product contains 2 parts nitrogen, 3 parts phosphate and 2 parts potassium. The total concentration of plant nutrients is shown in brackets after the mixture. Thus, 2:3:2 (22) means a concentration of 22 % plant nutrients in the ratio of 2N:3P:2K.

Because this ratio consists of seven parts, the concentration will be:

Concentration of N: 2/7 x 22 = 6,3 % or 63 g kg^{-1}

Concentration of P: 3/7 x 22 = 9,4 % or 94 g kg^{-1}

Concentration of K: 2/7 x 22 = 6,3 % or 63 g kg^{-1}

Thus, one ton of 2:3:2 (22) consists of 63 kg N, 94 kg P and 63 kg K.

So, what is the remaining 78 % of the contents of this bag? While brands vary, typically, the rest contains some micronutrients and filler material, which allows for even application of the nutrients across the fertilised area.

Box 1: Example of fertiliser mixtures

The N, P and K elements in fertiliser can consist of various raw materials and there are various ways N, P and K concentrations can be produced. Figure 3 shows the three elements with examples of certain concentrations. Urea, ammonium nitrate and ammonium sulphate are, for example, concentration with N being the main element, while Di-Ammonium Phosphate (DAP), triple super-phosphate and Mono-Ammonium Phosphate (MAP) are some concentrated products where is the main element P. The last element is K and some concentrations of potash, are for example, potassium chloride, potassium sulphate and potassium nitrate.

The three elements (NPK) with examples of different concentrations:

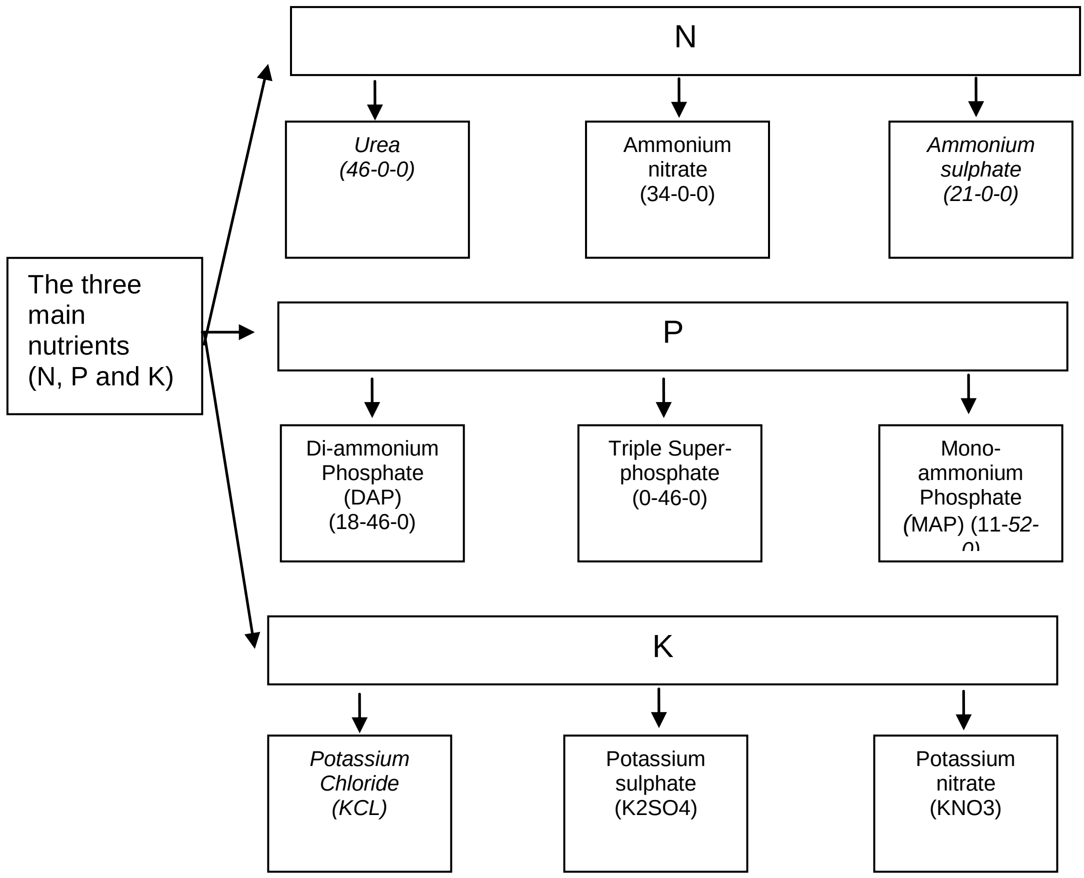

Figure 3: The three elements (NPK) with examples of different concentrations
Source: Own compilation

Box 2 shows the possible mixtures that can be used when certain main products are required in the soil.

Possible mixtures that can be used when certain elements are required

MAP or DAP - if no K is needed (supply some N but mostly P)

2:3:2 - if some K is needed as well as P and N

2:3:4 - if more K is needed as well as P and N

DAP together with KCl - if a lot of K is needed

Supers (superphosphate) - can also be used to supply P

LAN or Urea - these are used if more N is needed

Box 2: Various mixtures when certain elements are required

The detailed schematic presentation of the production of nitrogen, phosphate and potassium (although potassium is mined) can be found in Chapter 3.

2.2. Nitrogen background

There are two major forms of nitrogen; firstly ammonia based and secondly urea based. Ammonia contains 82 % nitrogen while urea contains 46 % nitrogen. Urea is also produced from ammonia (see Chapter 3, Diagram 3).

Ammonia may either be directly applied to the field, or it could be further used in processes that result in alternative nitrogen-based fertilisers, all of which are capable of providing essential nitrogen. It is the primary raw material of all nitrogen-based fertilisers; 80 % of the ammonia produced is used to fertilise agricultural crops.

Urea, on the other hand, is a manufactured, organic compound. It is made from ammonia and carbon dioxide. Urea is generally used in solid and liquid fertilisers and has relatively easy handling and storage characteristics, making it the most important solid nitrogen-fertiliser material worldwide (Eckert, 2009).

Natural gas is the main raw material input used to produce ammonia and accounts for 70 % to 90 % of its production cost. Natural gas will remain the major source of hydrogen for ammonia production as long as it is the cheapest. Ammonia is produced by combining nitrogen (N) with hydrogen (H) with the formula NH_3. The N is obtained from the atmosphere, while the H is obtained from natural gas. After this process is completed and ammonia is formed, ammonia (82 %) and urea (46 %) products are produced. Ammonia (NH_3) is normally encountered as a gas with a characteristic pungent odour. Ammonia, as used commercially, is often called anhydrous ammonia and this term emphasises the absence of water in the material. The chemical processes of ammonia and urea can be seen separately in Chapter 3 (Diagrams 2 and 3). Figure 4 shows a simple production process from natural gas to its basic nitrogen product.

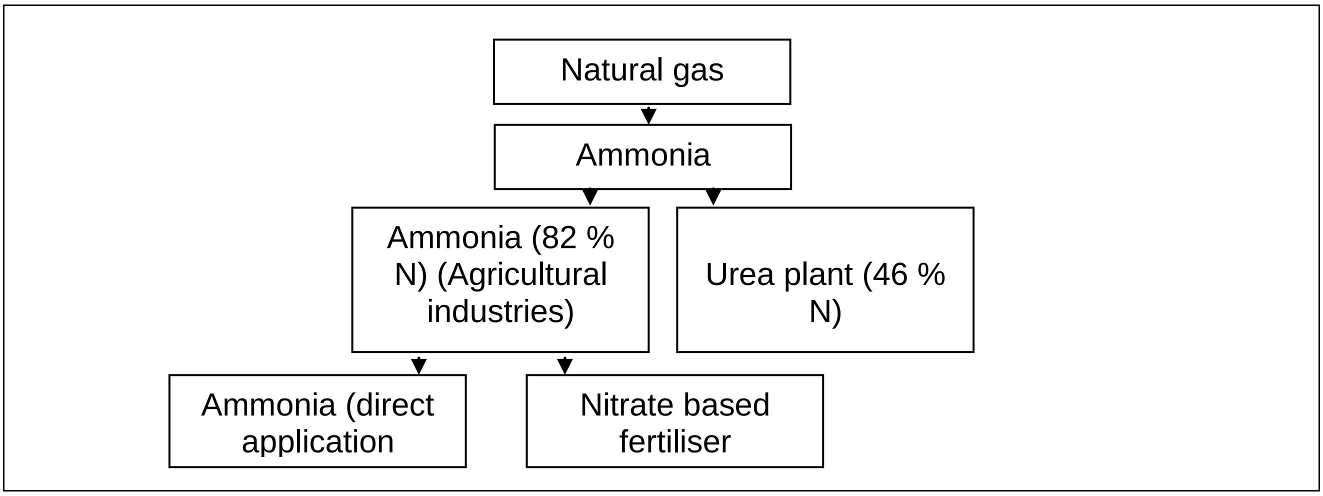

Figure 4: Simple production process flow from natural gas to its basic nitrogen product
Source: Own compilation

There are several large-scale ammonia and urea production plants worldwide. China is not only the biggest ammonia producer but also one of the largest consumers. China is also the largest urea producer and, together with India, produces more than half of the world's total ammonia.

2.2.1 Factors influencing ammonia and urea prices

In this sub-section, the international nitrogen market will be examined to explore possible factors that might have contributed to the significant increase in nitrogen fertiliser prices during 2008 and to help understand nitrogen fertiliser price fluctuations in future. The most commonly used nitrogen products, ammonia and urea, will be used as benchmarks. It is important to note that factors that influence the supply and therefore the production cost and price of nitrogen fertiliser are quite different to those for phosphate and potassium. For instance, nitrogen fertiliser is produced from energy while phosphate and potassium are mined.

2.2.1.1 Factors influencing the production cost, price and supply of nitrogen

a) World nitrogen production and consumption (stocks)

As mentioned, ammonia is the basic building block of the world nitrogen industry. It is also the intermediate product from which a wide variety of nitrogen-based fertilisers are produced. Figures 5 and 6 show the balances of ammonia and urea stocks compared to their international free on board (FOB) price based in the Middle East and Eastern Europe respectively. The data are provided on a quarterly basis, with the product price changing on a quarterly basis, while the data of the stock balances are kept constant during that specific year.

According to the International Fertiliser Industry Association (IFA, 2008), world physical ammonia **production** for 2008 was estimated at 156.2 million tons, which indicates an increase of 1.2 % from the previous year.

Increased global **demand** for fertiliser played a large part in placing upward pressure on fertiliser prices. Between January 2007 and mid-2008, commodity prices increased significantly while the growth in worldwide biofuel production diversified the use options of grains, sugarcane, soybeans and rapeseed, contributing to higher prices for biofuel feedstock's, particularly maize. High agricultural commodity prices encouraged producers to expand total crop hectares and therefore increased fertiliser use to enhance yields. This all increased global fertiliser demand which resulted in very low fertilisers stocks, as well as nitrogen, in the market (Huang, McBride & Vasavada, 2009).

Supply factors also contributed in driving fertiliser prices up, particularly for nitrogen. According to the Fertiliser Institute (2005), several ammonia plants have closed permanently or are idle, primarily as a result of the rise in natural gas prices and, as a result, significant production decrease.

Figure 5 shows the stock levels of ammonia compared to its international price. Sufficient ammonia stocks existed until 2006, whereafter they decreased to reach their lowest level for the time period depicted. As mentioned, fertiliser, but also ammonia, consumption increased, which caused international stock levels to decrease. It is assumed that these lower stock levels also prompted additional sales because buyers wanted to make sure they had sufficient stock available for the next year. This caused a squeeze in the market as indicated during 2007. Indications are that these low stocks contributed to the rise of ammonia prices. Further indications are that the tight stock levels continued to exist during the first part of 2008, contributing to supply not catching up with the increased demand as explained above.

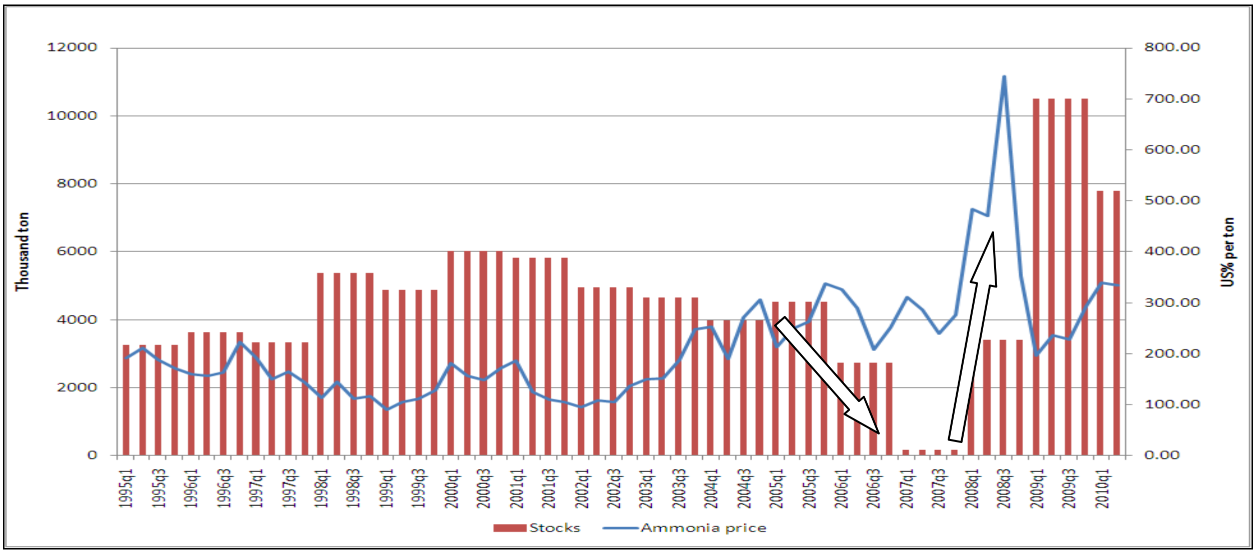

Figure 5: World ammonia stocks vs ammonia price
Source: IFA data bank, 2010; FMB, 2010; Grain SA 2010

Figure 6 shows the balance of urea stocks compared to their international price. According to the International Fertiliser Industry Association (IFA, 2008), urea's global physical production was estimated at close to 146.8 million tons in 2008, representing a 23 % increase from 2007. It is important to remember that ammonia is the main feedstock for urea production. As in the case for ammonia, global urea stocks evolved from tight supplies during 2007 and the beginning of 2008 to a large surplus in the major part of 2008. If the same comparison is made between the international urea price and its stocks, it can be seen that the same trend is evident with urea as with ammonia. The growth in worldwide biofuel production, high agricultural commodity prices etc., are among a number of factors that contributed to an increase in demand and causing low stock levels in 2007 and in the early parts of 2008.

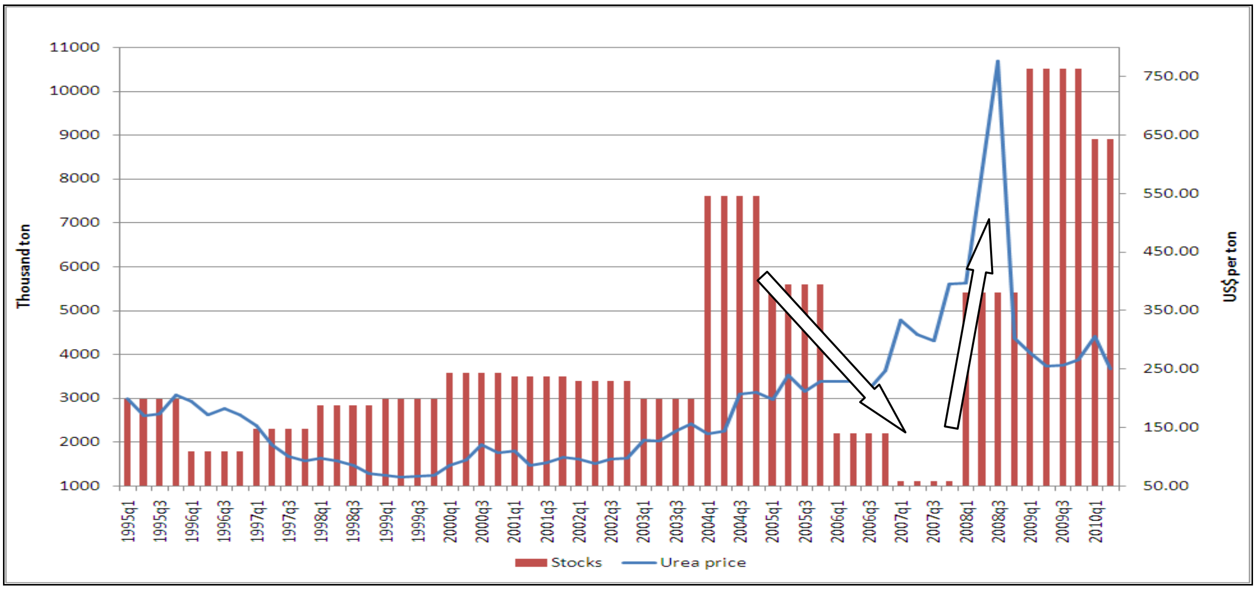

Figure 6: World urea stocks vs urea price
Source: IFA data bank, 2010; FMB, 2010; Grain SA, 2010

b) Brent crude oil

Few inputs impact the world economy like the price of Brent crude oil; it powers all transport and competes with natural gas in terms of a heating resource. As oil prices rise, costs go up for transportation companies, squeezing their profit margins and forcing them to raise prices, similarly affecting all the other companies that rely on them to transport products and people. Increased transport cost contributes to more expensive fertiliser prices, as it must be taken from centralised locations to different markets.

Brent crude oil and natural gas are both sources of energy. These two products are substitute products; thus the one that is cheapest will be used, for example as a heating resource. Due to this, the price of Brent crude oil has a direct influence on the price of natural gas which is again the main feedstock for nitrogen production.

Figure 7 shows the movement of the Brent crude oil price in comparison with the ammonia and urea price. The price trends of the fertilisers and the Brent crude oil were in the same direction, confirming the influence the oil price has, both directly and indirectly, on fertiliser prices.

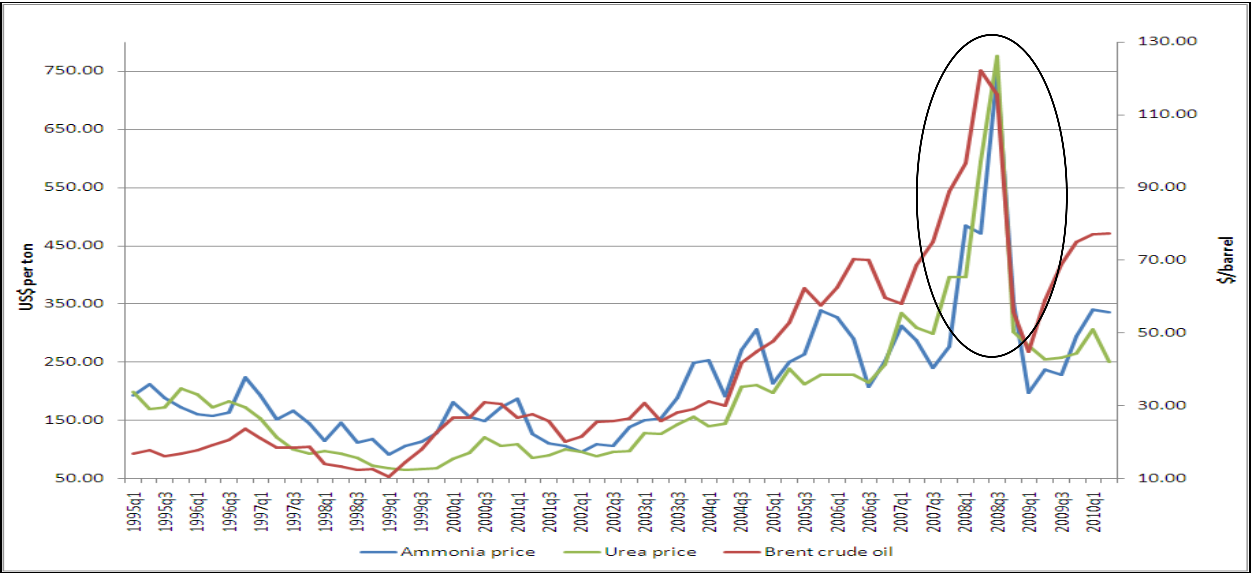

Figure 7: Brent crude oil price vs ammonia and urea prices
Source: FMB, 2010; Energy Information Administration, 2010

According to Statistics from Sentralbyra (2008), the sharp Brent crude oil price increase in the first half of 2008 was mainly due to a strong increase in crude oil demand in Asia, the Middle East and Latin America. They stated that this price increase was due to very low spare capacity in crude production and unusual low build-up of crude oil stocks in the second quarter of 2007. Brent crude oil prices began to decline during July 2008, due to resistance against the high Brent crude oil price as well as the recession in the United States of America (USA), which dampened crude oil demand in the OECD countries (Organisation for Economic Co-operation and Development).

Engdahl (2008) stated that the price of crude oil is not made up according to any traditional relation of supply to demand. According to him, it is controlled by an elaborate financial market system and by the four major Anglo-American oil companies. As much as 60 % of the Brent crude oil price is pure speculation and driven by large trader banks and hedge funds and has nothing to do with the convenient myths of peak oil, but rather with the control of oil and its price.

c) Natural gas

As mentioned, the natural gas price is highly influenced by the crude oil price because they substitute each other in terms of energy sources, depending on the price relation. The increase in Brent crude oil prices during 2008 was therefore a precursor for higher natural gas prices. From 1999 to 2009, the price correlation between natural gas and Brent crude oil was strong at 0.73. Natural gas, on the other hand, is the main input used to produce nitrogen fertilisers. The price of nitrogen fertilisers is thus directly related to the price of natural gas.

According to a study by Abram and Forster (2005), natural gas has a major impact on the pricing of all nitrogen fertilisers because it is the largest source of production material. A rise in natural gas prices causes producer margins (natural gas-producing companies) to shrink and eventually, margins turn negative as gas prices continued to increase. Natural gas-producing companies have been in due course forced to reduce production, to be temporarily idle, or even to permanently close plants depending on the specific economic situation they were in (USDA, 2005). The impact that high natural gas prices has on ammonia and urea prices can be seen in Figure 8, which compares the prices of natural gas, ammonia and urea, and shows that a relationship exists between these prices.

The volatile and upward trend in natural gas prices led to a significant change in the prices of ammonia and urea. Increases in natural gas prices from 2000 to 2008 led to increased ammonia and urea prices. From 2000 to 2008, on average, natural gas prices increased from US$4.44 per 1000 cubic feet to US$9.13 per 1000 cubic feet, which is an increase of 105 %. During the same time period, ammonia prices increased with 211 % while the price of urea increased with a significant 409 %; the price correlation between natural gas and ammonia was strong at 0.71 while the correlation between natural gas and urea was 0.63. From the above, it is clear that ammonia and urea prices are highly influenced by natural gas prices.

When Figure 8 is studied, it can be seen that natural gas prices made three exceptional spikes; one during the end of 2000 and the beginning of 2001, the other during the last quarter of 2005 and the last in the second quarter of 2008. During the first spike, international nitrogen prices reacted to the increased natural gas prices but did not reach the record level as during 2008, although natural gas prices were higher during 2005 than 2008. This indicates that natural gas prices contributed to the exceptional nitrogen prices in 2008, although they were not the only contributing factor.

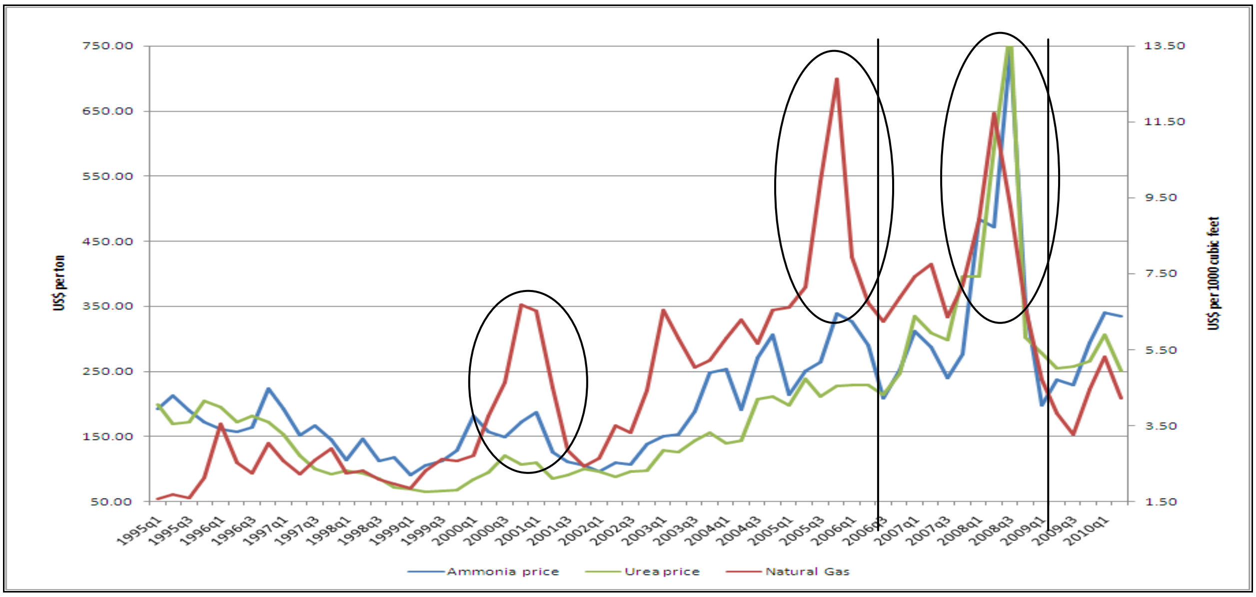

Figure 8: Natural gas price vs ammonia and urea prices
Source: FMB, 2010; Energy Information Administration, 2010

Figure 9 shows the natural gas reserves in the world according to the Oil & Gas Journal. World natural gas reserves generally trended upward and were estimated at 6,254 trillion cubic feet on 1 January 2009. Reserves have remained relatively constant since 2004, despite growing demand for natural gas, implying that, this far, producers have been able to continue replenishing reserves successfully with new resources over time. As mentioned, natural gas has a huge impact on the pricing of all nitrogen fertilisers because of its importance in the production process. According to Figure 9, there is enough natural gas stock available and this could not have had a significant influence on nitrogen fertiliser prices.

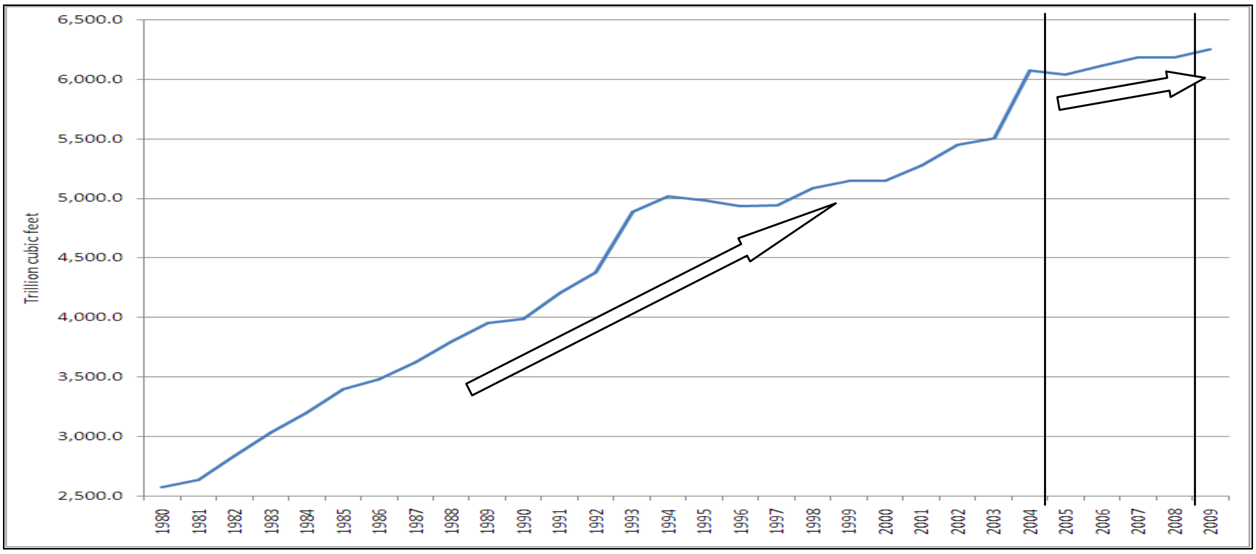

Figure 9: World natural gas reserves
Source: Worldwide oil and gas at a glance (1980-1993) & Oil & Gas Journal (1994-2009)

d) Baltic Dry Index (BDI)

The Baltic Dry Index (BDI) is a number issued daily by the London-based Baltic Exchange which tracks worldwide international shipping prices of various dry bulk cargoes. This index provides an assessment of the price of moving major raw materials by sea. It measures the demand for shipping capacity versus the supply of dry bulk carriers (supply vs demand). Marginal increases in demand have the ability to push the index rapidly higher, and marginal demand decreases can cause the index to fall rapidly again. The BDI is expressed in US dollars, so it is also influenced by changes in the value of the US dollar.

For the shipping industry, iron ore, coal, grains, fertilisers, cement and oil are its major cargoes. Demand for these commodities was also the most important driver of the freight boom (Risk Management, 2009). As the BDI increases, so, effectively, does the cost of raw materials. This cost, associated with procuring the materials, must be passed along the value chain by producers and refiners. In the end, consumers will see higher dry bulk rates in the higher prices they pay for goods derived from these raw materials.

Figure 10 shows the Baltic Dry Index from 2005 to 2010. The index can be quite volatile. According to Wikinvest (2009), the run-up from 2005 to the end of 2007 was primarily due to Chinese demand for industrial precursors to production and its shift from being a coal exporter to importer. During this time, shortages of supply for dry bulk cargo ships occurred which caused large accumulations at shipyards. The combination of these two factors caused a nearly 200 % gain in the index.

From June 2008 to October 2008, the index lost 85 % of its value as demand for shipping plummeted. This was due to a simultaneous convergence of several factors; of which the most important one was the rapid slowdown in the "global growth" phenomenon. In addition to this, credit had been nearly impossible to obtain for the purchase of goods and the payment of time charters on the vessels (Wikinvest, 2009).

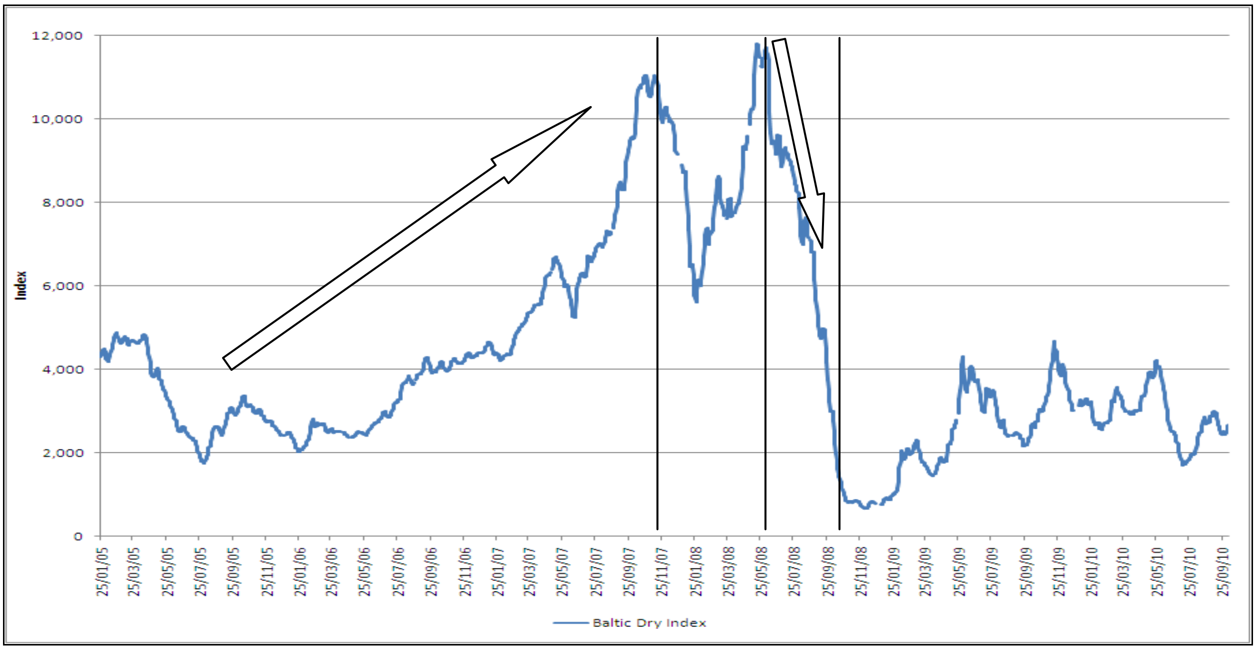

Figure 10: Baltic Dry Index trend from 2005 to 2010
Source: IGC, 2010

By the end of 2008, shipping times had already been increased by reduced speeds to save fuel consumption, but lack of credit meant the reduction of letters of credit, historically required to load cargoes for departure at ports. Debt load of future ship construction was also a problem for shipping companies, with several major bankruptcies and implications for shipyards. This, combined with the collapsing price of raw commodities, created a perfect storm for the world's marine commerce.

The influence the BDI has on fertiliser prices is not just for nitrogen prices but also for phosphate and potash prices.

2.2.1.2 Factors influencing the demand for nitrogen

a) USA maize price

The average price of a specific commodity usually influences producers' enthusiasm to plant that specific commodity. For example, a relative high maize price stimulates producers to plant maize rather than another commodity with a lower price. Larger maize plantings, due to good prices, are anticipated to result in increased demand for fertiliser, particularly for nitrogen.

According to Figure 11, the USA maize, ammonia and urea prices mostly move in the same direction, although deviations do occur during some specific years. During 1995 and 1996, the USA maize price increased significantly while there was no remarkable change in the price of ammonia and urea. The reason for this specific maize price increase can be ascribed to low maize plantings in the USA as well as in the world during 1995. These low plantings can be seen in Figures 12 and 13. Again, on the other hand, during the third quarter of 2000 and during 2005, the maize price decreased while the price of ammonia increased. As mentioned, ammonia prices are influenced by natural gas prices and when Figure 8 is considered, one can see that natural gas prices increased during 2000/01, 2005 and the beginning of 2006. During each of these years, one can see that ammonia and urea prices increased while the maize price decreased. One reason for the low maize price during 2005 was higher yields and thus a big carry-over surplus. During 2008, the ammonia, urea and maize prices increased at the same rate.

Grain prices were relatively high during 2008 and an assumption is made that producers' enthusiasm to plant maize was stimulated, resulting in increased fertiliser demand which again resulted in short-term fertiliser shortages (Figures 5 and 6).

Figure 11 shows the trend lines of the USA maize, ammonia and urea prices. In this period, the price correlation between the USA maize price and ammonia was fairly strong at 0.69, while the correlation between the USA maize price and urea was even stronger at 0.83. From the above, it is clear that ammonia and urea prices are influenced by the USA maize price.

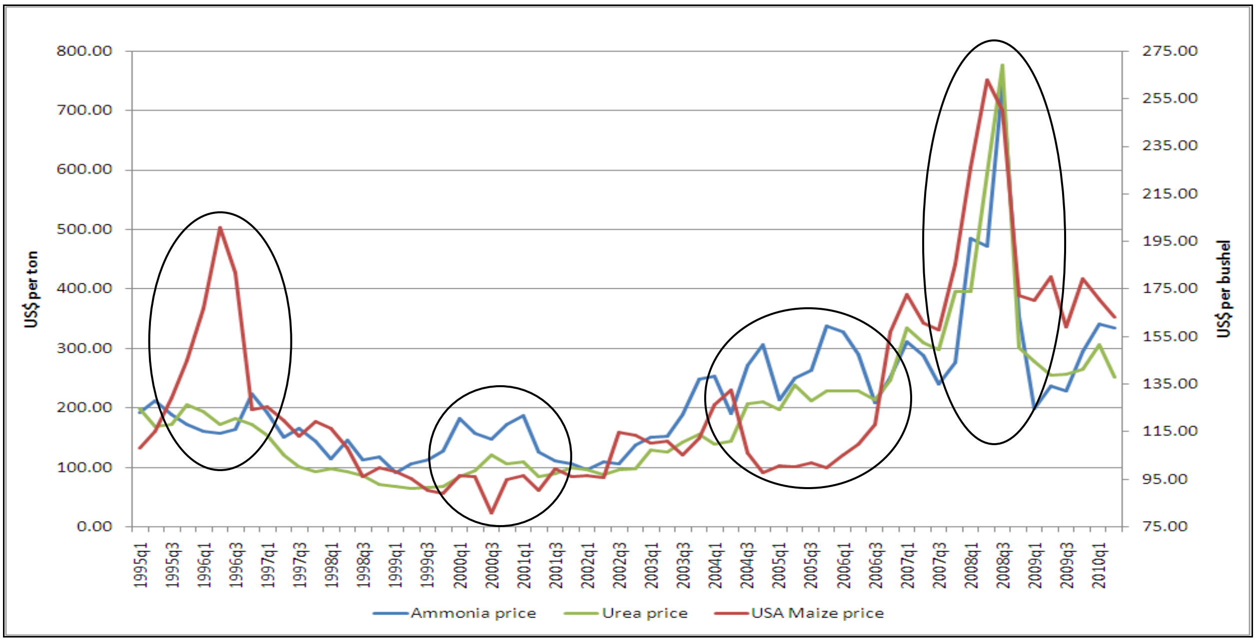

Figure 11: USA maize price vs ammonia and urea prices
Source: FMB, 2010

Both Figures 12 and 13 indicate an increase in the maize area planted for the USA as well as for the world for the 2007/08 production season. Such an increase has mainly been driven by the increased cropping for the production of ethanol fuel. Fertiliser prices increased significantly the following year. This suggests that fertiliser demand increased faster than supply, due to the large area planted, and therefore a greater reliance on fertiliser placed upward pressure on prices. It is interesting to note from the figures that fertiliser prices reacted with a slight lag on higher maize plantings. According to Figures 12 and 13, the high areas planted as mentioned in this section can again be seen.

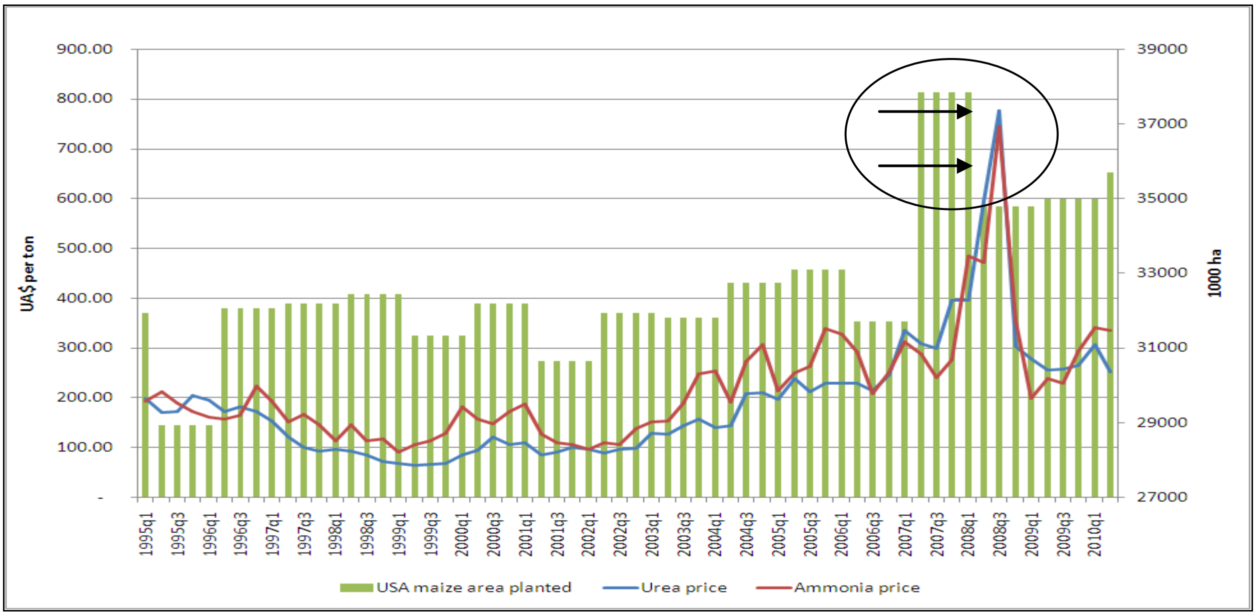

Figure 12: USA maize area planted vs ammonia and urea prices
Source: FMB, 2010; USDA, 2010

The world maize area planted increased with an enormous 10.9 million hectares (7.7 %), from 149.6 million hectares planted during 2006/07 to a record of 160.5 million hectares planted in 2007/08. After ammonia and urea prices were plotted against the maize price as well as the USA and world maize plantings, it can be seen that the area planted had a larger influence on fertiliser prices than the maize prices itself did. Figure 13 illustrates the world maize area planted compared to ammonia and urea prices.

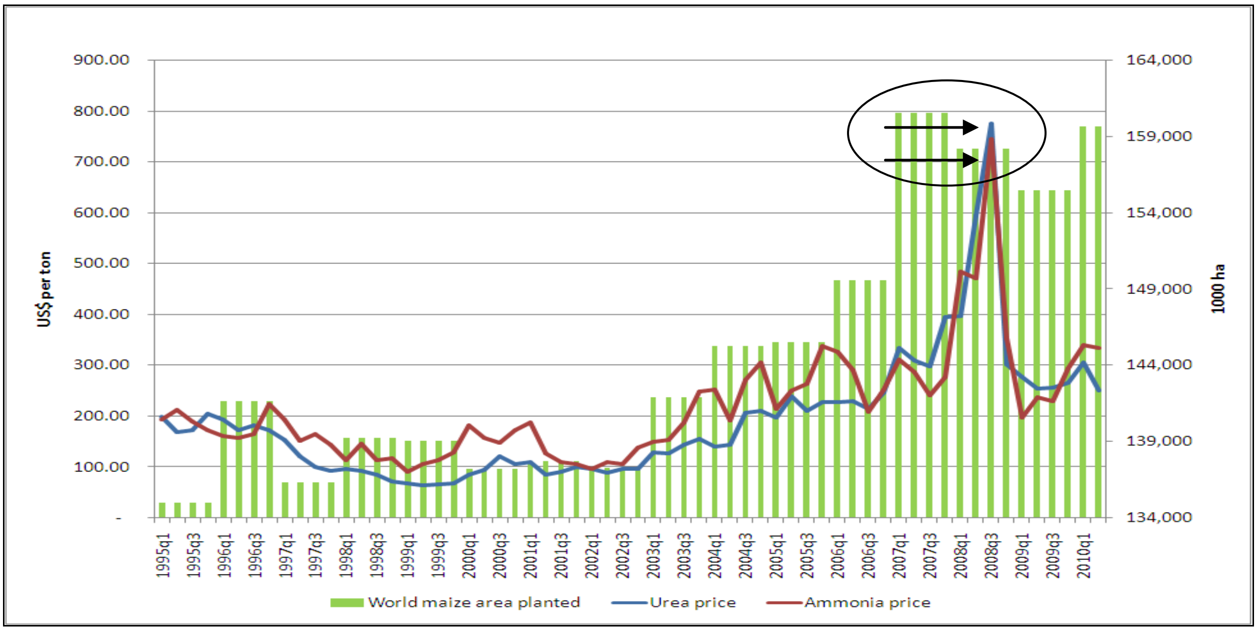

Figure 13: World maize area planted vs ammonia and urea prices
Source: FMB, 2010; USDA, 2010

2.2.3 World trade

China plays a very important role in the world ammonia and urea industry and influences the quantity of these products that are traded globally. China imposed export taxes on these nitrogen products in order to restrict their export volumes to ensure price stability of these fertilisers in their own domestic market and to protect their farmers from product shortages and high cost. According to Velten (2008), because China is the world's largest grain producer, increased export duties were implemented to ensure domestic supply for their producers during their main growing season.

Table 1 shows China's export taxes implemented during 2008; this includes the normal as well as the special export taxes. A special export tax of 150 % was imposed by China for ammonia and nitrogen fertilisers which was effective from 1 September 2008 to 31 December 2008, mainly to satisfy its own domestic demand. The total export tariffs are calculated by the following formula:

Total export tax = normal export tax + special export tax

For example, the total export tax of urea was 185 % from 1 September to 30 September and 175 % from 1 October to 31 December 2008.

Table 1: China's fertiliser export taxes for ammonia and nitrogen fertiliser

Product		Normal export tax	Special export tax
Ammonia		0	150 % (effective from 1 September 2008 to 31 December 2008)
Nitrogen fertilisers	Urea	from 1 April 2008 to 30 September 2008: 35 % from 1 October 2008 to 31 December 2008: 25 %	150 % (effective from 1 September 2008 to 31 December 2008)
	AS (Ammonium Sulphate)	0	
	AN (Ammonium Nitrate)	0	

Source: China Fertiliser Market Week, 2008

As stated, the world's physical ammonia production for 2008 was estimated at 156.2 million tons while global ammonia trade for 2008 was 19.2 million tons. Relatively small volumes of ammonia are thus traded compared to the amounts produced.

According to Figure 14, ammonia exports increased at a considerable rate from 2002 to 2006, whereafter they decreased on a year-to-year basis. As mentioned, China implemented a special export tax on ammonia during September 2008 until the end of that year. This tax increase did not play a radical role in decreasing ammonia exports during 2008 (Figure 14), although it is expected that it had an effect on nitrogen fertiliser prices as was anticipated, because China, one of the largest ammonia consumers, consumes approximately one third of the ammonia it produces. It was expected that this tax would contribute to decreasing exports.

It is well known that the world experienced an economic recession during 2009. The decrease in exports can be attributed to the lower demand for ammonia during 2009.

The USA is the largest ammonia importer and accounts in the region of 40 % of world trade. Europe, which is a higher cost-producing region, accounts for roughly 25 % of trade (Potashcorp, 2009). Figure 14 shows world ammonia trade from 1999 to 2009.

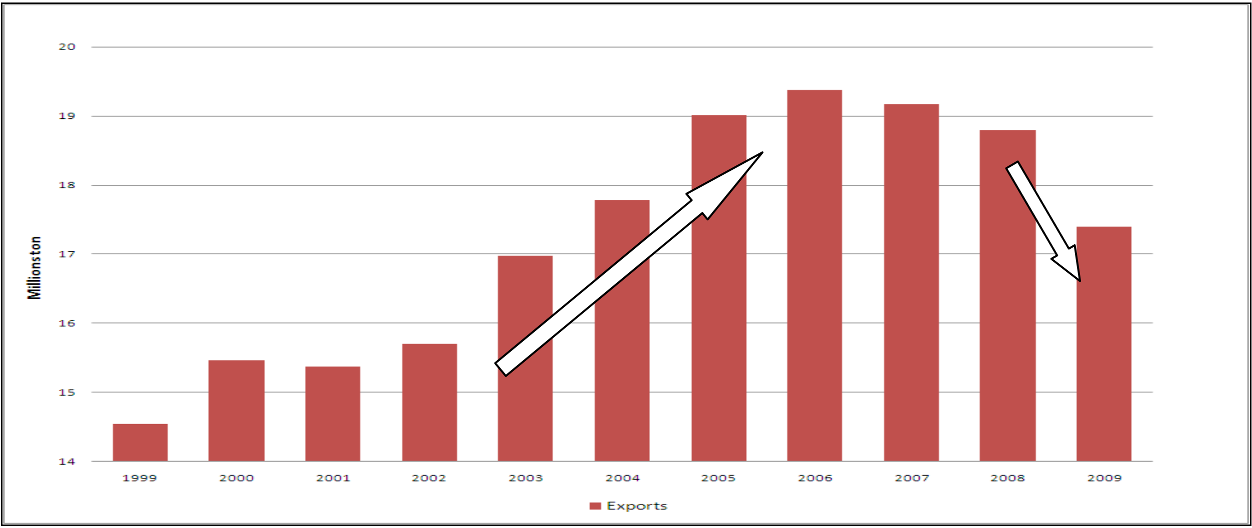

Figure 14: World ammonia trade
Source: IFA, 2009

Urea is widely traded on international fertiliser markets. According to ICIS (2008), there are mainly two hubs, the Black Sea and the Arabian Gulf, trading urea and which mainly determine the global urea price. The Black Sea generally supplies Europe and Latin America while the Arabian Gulf supplies the USA and Asia/Oceania. All other trade flows tend to be more regional but can be important when they affect the need for Black Sea or Arabian Gulf material.

China, the world's largest urea exporter, exported an estimated 5 million tons in 2008. India and the USA are the major urea importers. These two countries account for approximately 35 % of the global urea imports. China, being such an important urea exporter, implemented a urea export tax during 2008 in an attempt to protect its domestic demand. The effect of this tariff can be seen in Figure 15. Exports decreased from the previous year due to China's contribution to limit urea exports, which resulted in higher prices.

During 2008, India imported 6.1 million tons of urea, which is 0.5 million tons down from 2007; while USA imports declined by 1 million tons to 5.5 million tons for 2008 (Potashcorp, 2009). The above mentioned decreases in imports can clearly be seen in the urea trade figure. Figure 15 shows world urea trade from 1999 to 2009.

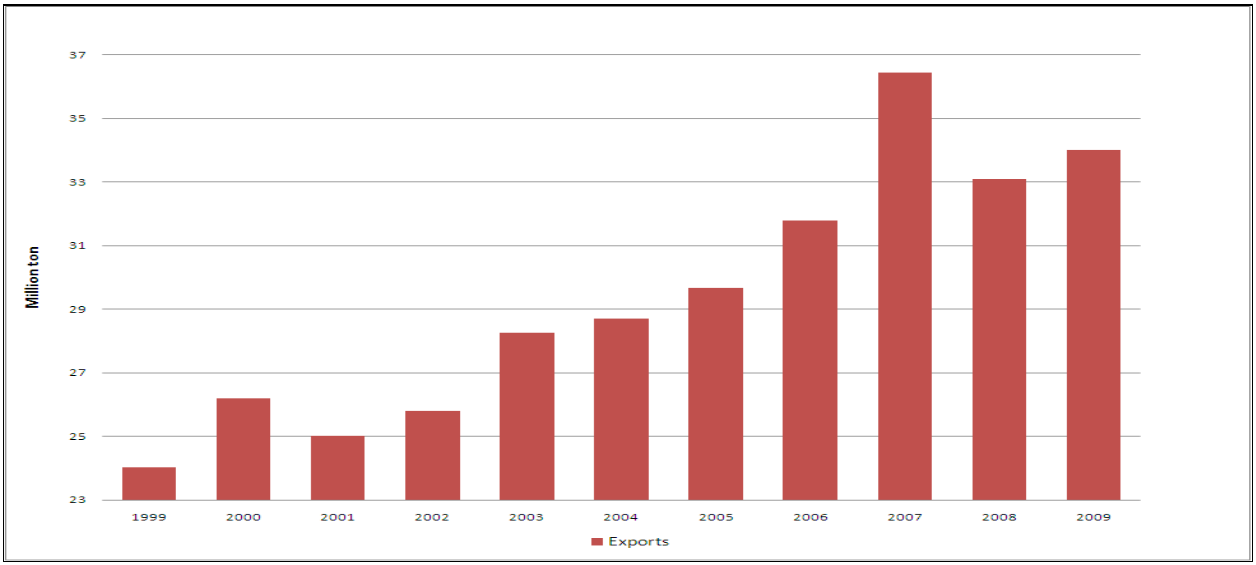

Figure 15: World urea trade
Source: IFA, 2009

2.2.4 Important role players in nitrogen

a) Ammonia

There are numerous large-scale ammonia production plants worldwide. China is the largest market and produces 33 % of the worldwide production, followed by India and Russia with 8 % each, and the USA with 6 %. The largest private sector companies (in order of size: Yara, Terra, PotashCorp, Koch, Agrium and Togliatti) total approximately 13 % of world ammonia capacity. China, the USA and India are the largest consumers and although China is one of the largest consumers, it does not play a major role in global trade because it consumes almost one third of the ammonia it produces (Thomas, 2008). Figure 16 shows the largest ammonia-producing countries in the world during 2009.

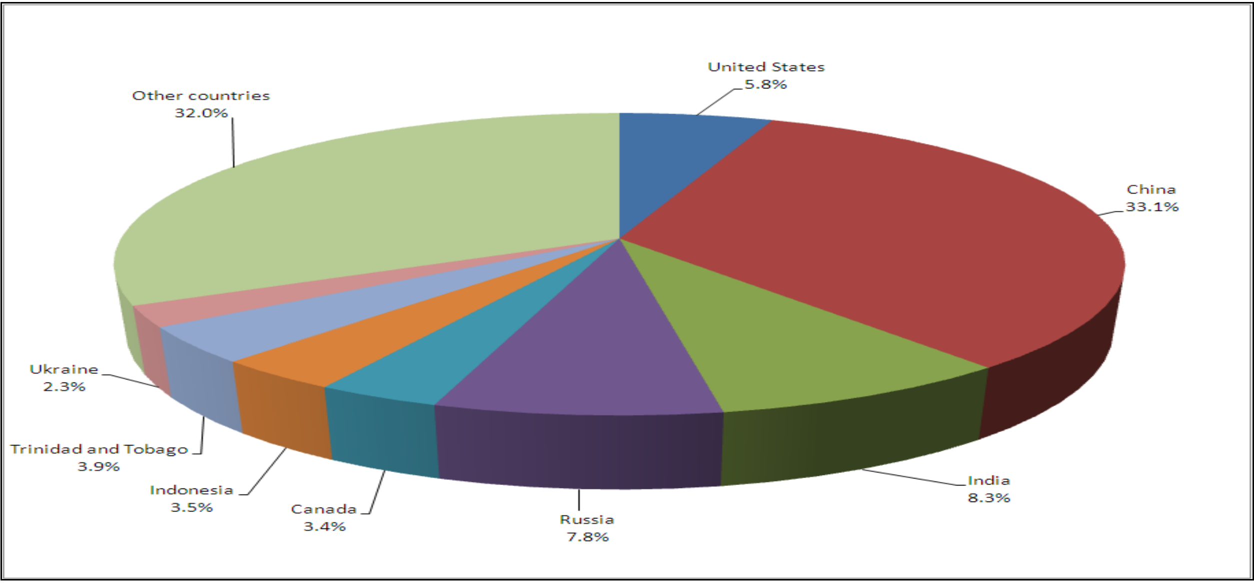

Figure 16: Leading ammonia-producing countries in the world for 2009
Source: USGS, 2010

b) Urea

China and India are the world's largest urea producers; together they produce more than half of the world's total. During 2007, China produced 37.5 % of the total world production (of which they consumed 83.5 % and exported the rest), while India produced 14 %. Other countries with significant production include the USA, Indonesia and Russia. Figure 17 shows the largest urea-producing countries in the world during 2007.

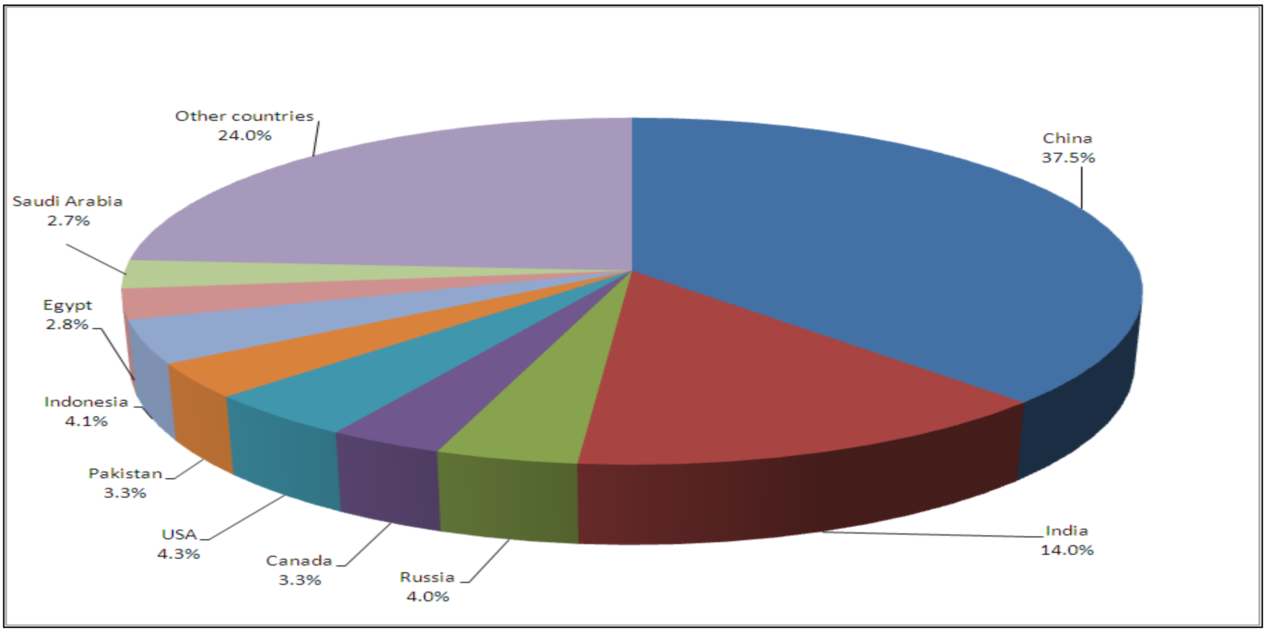

Figure 17: Leading urea-producing countries in the world for 2007
Source: IFA, 2008

2.3 Phosphate Background

Phosphate is the second most widely-used fertiliser nutrient after nitrogen. Phosphates for the use in fertilisers are the most important factor in the demand for phosphate rock. Almost 90 % of annual phosphate rock production is used in chemical fertiliser products; industrial end-use sectors consume around 6 % of the phosphate rock produced, while animal feed additives make use of about 4 %. China, the USA and Morocco are the world's largest miners of phosphate rock. China produces about 35 % of the total world production while the USA and Morocco produce 17 % and 15 % respectively.

When used in the fertiliser industry, phosphate rock or its concentrate needs to contain at least 30 % phosphorous pentoxide (Pb2O5) and reasonable amounts of calcium carbonate (CaCO3), while having less than 4 % combined content of iron and aluminium oxides (SA DME, 2009).

2.3.1 Factors influencing the phosphate price

Steady increases in fertiliser prices and the price spike in 2008 reflect the combined effects of a number of global long and short-run forces. Phosphate is examined in the next section with the intention to identify the aspects that might have contributed to the increase of the prices for phosphate and phosphate-based products. This will also help in identifying and understanding price changes in the future.

2.3.1.1 Factors influencing the production cost, price and supply of phosphates

a) World phosphate production and consumption (stocks)

Figure 18 shows the stocks of phosphates compared to its international price. Di-Ammonium Phosphate (DAP) prices moved sideways from 1995 to 2006 although fluctuations occurred in the stock levels during the same time period. According to the figure, the DAP price started to increase at a steep trend during 2007, which is one year after phosphate stock levels were at their lowest in a long time. The low stock levels of 2006 also came to pass during previous years, but such steep increases in the DAP price did not incur. Phosphate shortages thus primarily occurred in 2006 while DAP prices reached record levels in mid-2008 when stocks were moderately high. A lag can be seen from 2006 (low stock levels) to 2008 (peak in the international DAP price), which can be due to the fact that it takes some time for phosphate production to increase. Phosphate rock is mined; thus making it a prolonged process.

As stated by various articles, demand exceeded supply, contributing to increased phosphate prices. However, from Figure 18, the above statement could not be supported due to the extended delay between when the tight balances occurred in 2006 and when prices attained their record levels. It could be understandable that prices increased during 2007 due to continued shortage of 2006 carried over to 2007. The hypothesis is that tight balances contributed to the price increase in 2008; however, from the graph, this does not seem to be the primary reason, except if low stocks were still present at the beginning of 2008.

According to an article by Hargrove (2008), the prices of phosphate and potash fertilisers rose more steeply during 2008 than nitrogen-based prices because production sources were more limited. Most of the world's phosphate for fertiliser is mined and is thus a non-renewable resource. While capital investment in production facilities is substantial and takes time to put in place, it is expected that demand for the nitrogen component of fertiliser can be more readily met than that for phosphates and potash (Walker, 2008).

IFA's estimates for 2008 indicated a reduced output of all phosphate-based products from 2007. The physical phosphate rock production decreased by 1 % to about 174 million tons, while the physical processed production of phosphates decreased by 5 % to 23.8 million tons phosphorus oxide (P2O5).

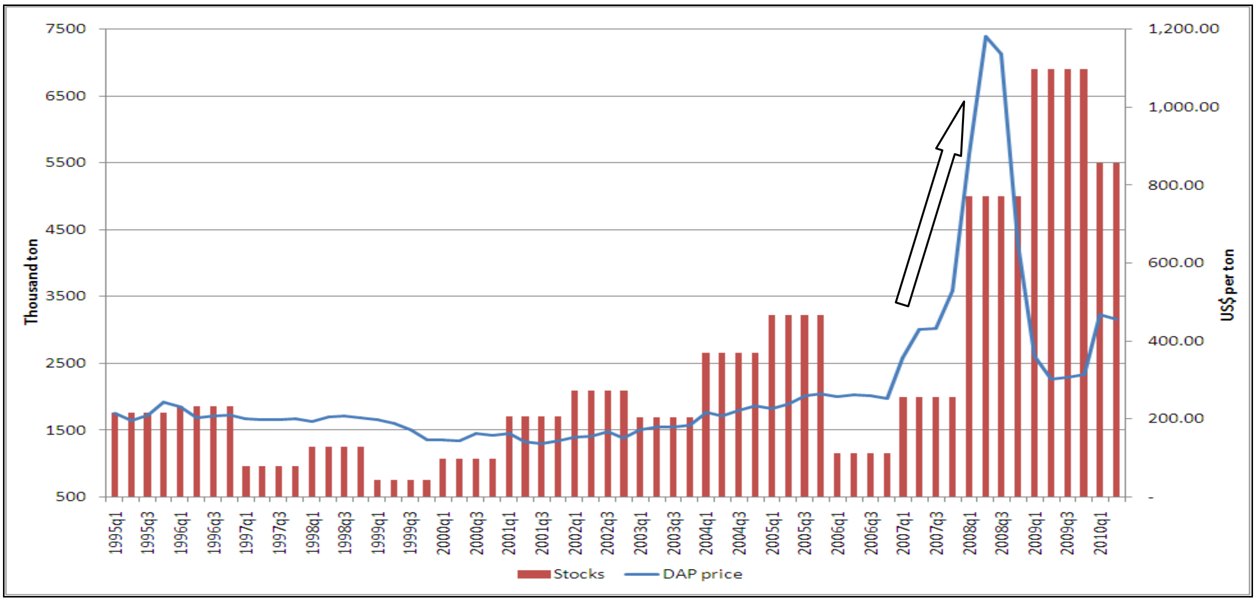

Figure 18: World phosphate stocks vs DAP price
Source: IFA data bank, 2010; FMB, 2010

b) Brent crude oil

The impact of high oil prices affected agriculture in a fundamental way. According to V. Go (2009), fertiliser prices increased due to the non-stop jump in oil rates in the world market and big demand by certain countries during the first three quarters of 2008. The decline in the crude oil price during the last quarter of 2008 again resulted in a stable drop in the prices of popularly-used farm inputs such as fertiliser. The above mentioned can be confirmed in Figure 19. The price trends moved in the same direction and validate the influence of the oil price on fertiliser prices. The same comparison can be made between phosphate/Brent crude oil prices and nitrogen/Brent crude oil prices.

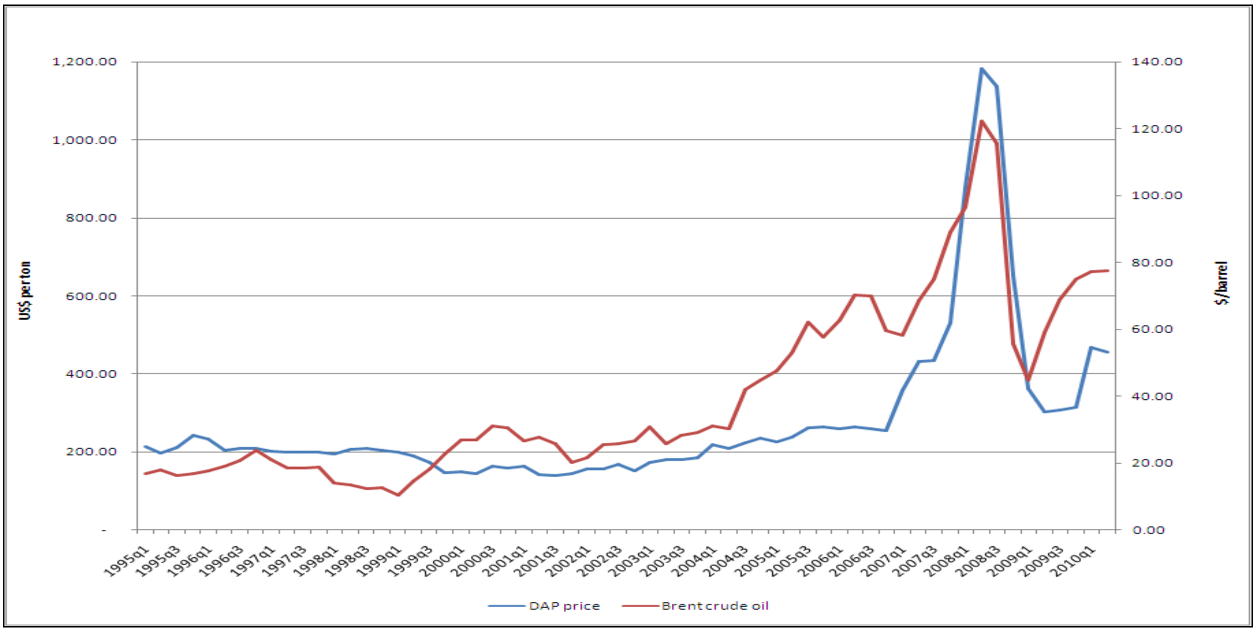

Figure 19: Brent crude oil price vs DAP price
Source: FMB, 2010; Energy Information Administration, 2010

c) DAP, ammonia, sulphur and phosphate rock prices

There are mainly three raw materials used to produce DAP, which is one of the main forms in which phosphate fertilisers is present; these are phosphate rock, sulphur and ammonia. When Figure 20 is studied, it can be seen that all the prices moved sideways from 1995 to 2006, and then sudden increases occurred during 2007 and 2008. The three raw materials as well as the DAP price indicated radical increases during the same time period.

Average prices for ammonia, sulphur and phosphate rock increased by 210 %, 349 % and 412 % respectively from the third quarter of 2007 to the third quarter of 2008. From this, the assumption can be made that the price increases of the raw materials used to produce phosphates contributed to increase in the DAP price.

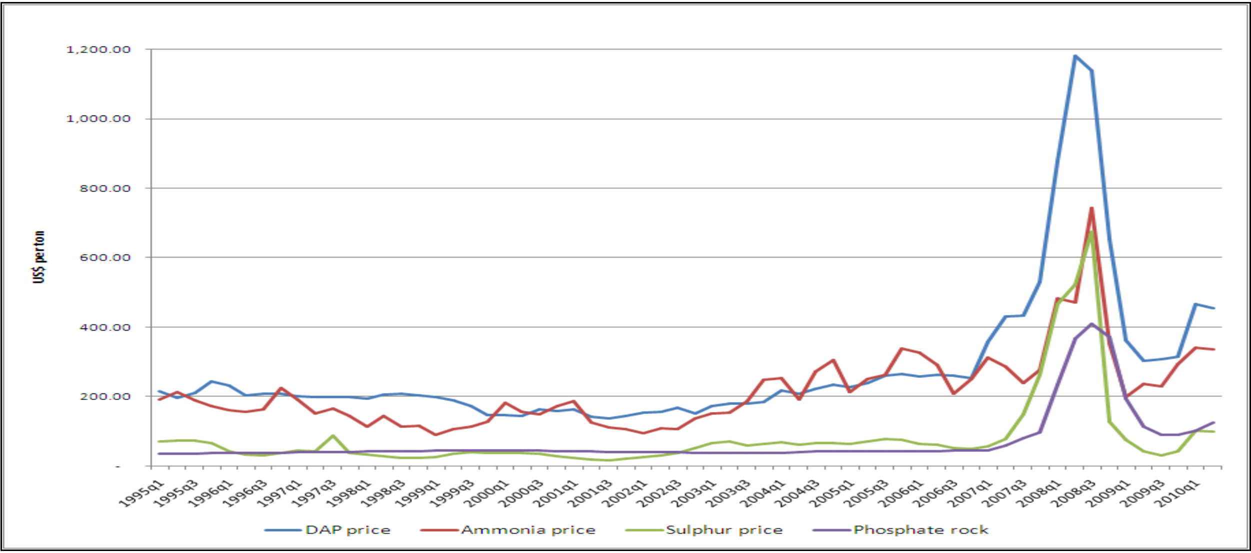

Figure 20: Comparison of DAP, ammonia, sulphur and phosphate rock prices
Source: IFA data bank, 2010

2.3.1.2 Factors influencing the demand for phosphates

a) USA maize prices

Similarly to nitrogen, during the second quarter of 1996, the USA maize price increased exceedingly in relation to phosphate prices. The reason for this specific maize price increase is ascribed to low maize plantings in the USA as well as in the world during 1995. The low USA maize plantings during 1995 can be seen in Figure 22. Grain prices were relatively high during 2008 and undoubtedly stimulated producers' eagerness to plant, resulting in an increase demand for phosphates. From the third quarter of 2007 to the third quarter of 2008, the DAP price rose by 163 % and at the same time, the USA maize price rose by 59 %.

In this period (1995-2010), the price correlation between the USA maize price and the DAP price was strong at 0.83. Figure 21 shows the trend lines of the USA maize price in comparison with the DAP price.

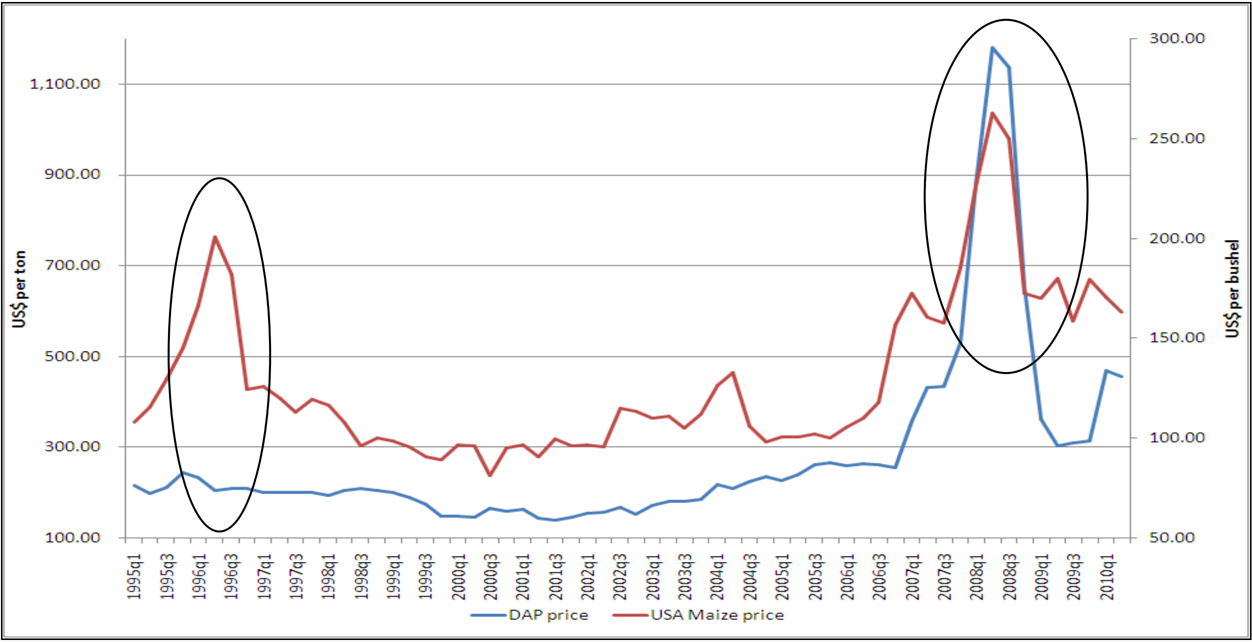

Figure 21: USA maize price vs DAP price
Source: IFA data bank, 2010

Figure 22 indicates the movement in the DAP price compared to the USA maize area planted. During the 2007 production season, a remarkable increase in the USA maize area planted occurred, which was mainly caused by the increased cropping for the production of ethanol fuel. The figure shows that the DAP price began to systematically increase during the 2007 planting season. This suggests that fertiliser demand increased during the 2007 planting season because of expansions in maize production. As with nitrogen, it seems as though plantings caused higher demand and higher prices of DAP.

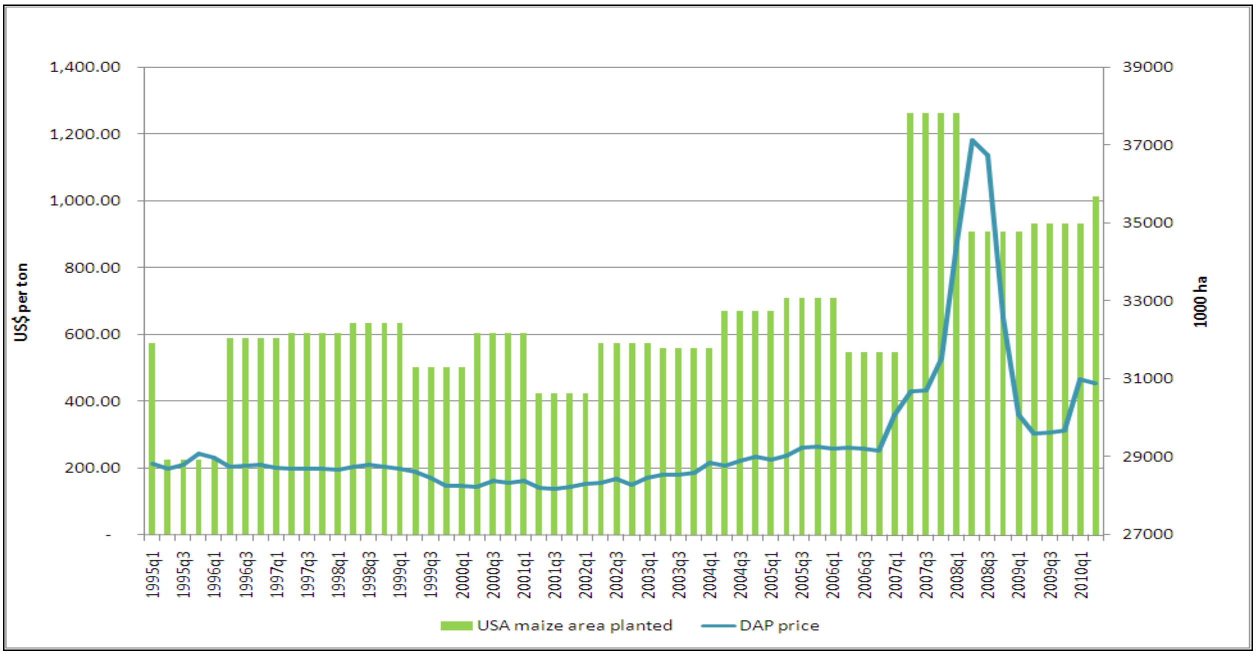

Figure 22: USA maize area planted vs DAP price
Source: FMB, 2010; USDA, 2010

2.3.2 World phosphate trade

China plays a very important role in the world phosphate industry. To emphasise the important role China plays in global trade, it can be mentioned that it is the world's largest miner of phosphate rock, at 55 million tons during 2009. In China, phosphate rock is consumed mainly by the phosphate fertiliser industry, yellow phosphorus industry and feed calcium hydrogen phosphate industry. A certain amount of phosphate rock is exported directly. The consumption structure is: phosphate fertiliser industry approximately 80 %; yellow phosphorus industry 10 %; other phosphorus products 8 %-9 %; and export volume 1 %-2 % (China Fertiliser Market Week, 2009).

Increasing concern over food security led China to tax phosphate fertiliser exports to ensure sufficient domestic supply. This was done in an attempt to reduce China's domestic food prices but resulted in repercussions on international phosphate prices. Table 2 shows the export tax implemented by China during 2008 for phosphoric acid, phosphate fertilisers and other fertilisers. China increased its export tax of phosphoric acid between 20 April 2008 and 30 September 2008 from 0 % to 100 % and that of phosphate fertiliser from 30 % to 100 %. Di-Ammonium Phosphate (DAP) and Mono-Ammonium Phosphate (MAP) export tax rates were also increased to 35 %, effective from 15 February 2008 to 30 September 2008; and restored the previous export tax rate (20 %) in the remaining months of the year.

Table 2: China's fertiliser export taxes for phosphoric acid, phosphate fertilisers and other fertilisers

Product		Normal export tax	Special export tax
Phosphoric acid		0 %	100 %
Phosphate fertilisers	TSP	30 %	100 %
	SSP	30 %	
NPK and other fertilisers	NPK	from 15 February 2008 to 30 September 2008 - 35 %	100 %
		from 1 October 2008 to 31 December 2008 - 20 %	
	DAP	from 15 February 2008 to 30 September 2008 - 35 % from 1 October 2008 to 31 December 2008 - 20 %	
	MAP	from 15 February 2008 to 30 September 2008 - 35 % from 1 October 2008 to 31 December 2008 - 20 %	

Source: China Fertiliser Market Week, 2008

Global phosphate rock trade increased slightly from 31.3 million tons to 31.9 million tons from 2007 to 2008. Morocco alone accounts for almost half of the phosphate rock exports (PotashCorp, 2009). According to IFA (2008), phosphate rock imports increased mostly in Asia and Oceania.

Physical phosphate rock production decreased by 1 %, while exports increased by 1.9 %. As stated, Morocco plays a large role in phosphate rock exports and the USA is their largest market. Exports of phosphate rock from Morocco to the USA were 2.75 million tons in 2008, compared with 2.67 million tons in 2007 (USGS, 2008).

According to Xinhua (2009), Moroccan phosphates and derivatives exports dropped 62.6 % from the first five months of 2009 compared to the same period in 2008. Increasing concern over food security led China to tax phosphate fertiliser exports to ensure sufficient domestic supply. This reduced China's exports of DAP/MAP from 4 million tonnes in 2007 to 2 million tonnes in 2008 (PotashCorp, 2009).

At the beginning of the 2009 crop year, international phosphate prices were approximately US$355 per ton. According to Gurr (2010), phosphate rock and fertiliser production facilities were nearly at full capacity. However, only a few months into the 2009 crop year, the world recession began to have a major impact on the phosphate market. As a result, sales of phosphate rock and fertilisers plummeted and by June 2009, the international phosphate price had fallen to approximately US$280 per ton and producers' stocks began to increase. Gurr stated that in reaction to these conditions, producers closed plants and reduced their mine output. The impact of the economic recession on world phosphate rock exports during 2009 can be seen in Figure 23.

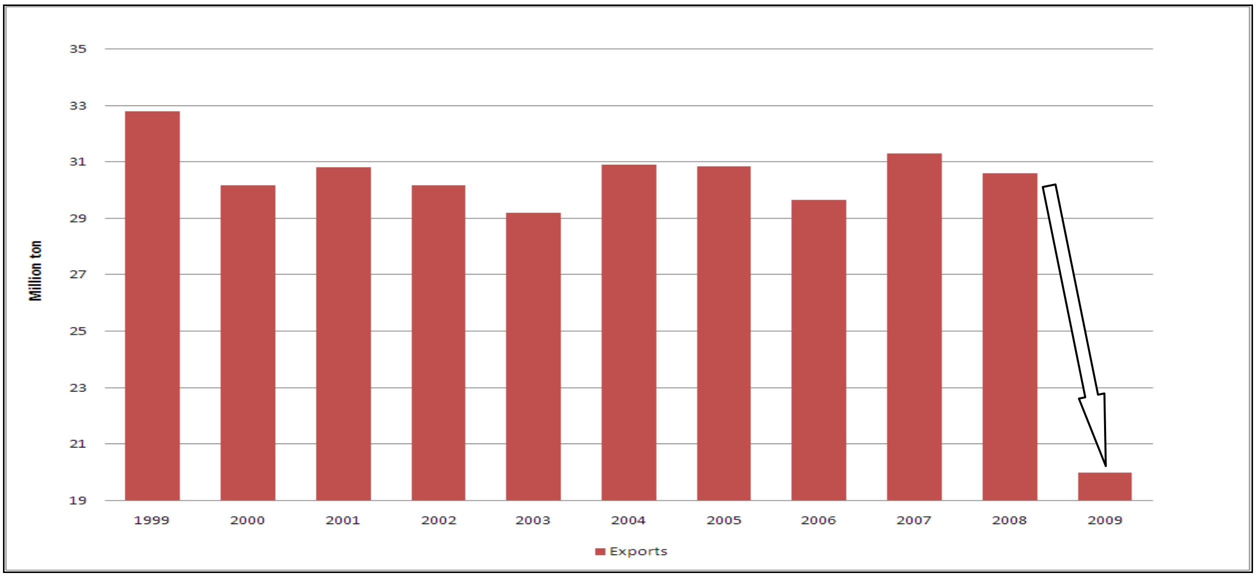

Figure 23: World phosphate rock trade
Source: IFA, 2009

Phosphoric acid is a major raw material used in making DAP. As mentioned, China is a big role player with regards to phosphate. Due to the implementation of China's export tax, China's phosphate fertiliser is on the market for a price 100 % higher than what it would have been. It is thus assumed that only if phosphate prices increased by 100% - only then would China's phosphates be available in the market.

China's exports of industrial phosphoric acid slumped after April 2008. Their exports totalled 35,000 tons from May to August, plunging from 92,000 tons from January to April (AsiaInfo Services, 2008).

Figure 24 shows the exports of world phosphoric acid from 2005 to 2009. It can be seen that global phosphoric acid exports decreased steadily from year to year. Global exports for 2008 were 4.4 million tons, which represents a 6.4 % decrease in trade from 2007. According to IFA (2008), the sales of phosphoric acid decreased due to lower domestic consumption in China and reduced imports in India and Brazil.

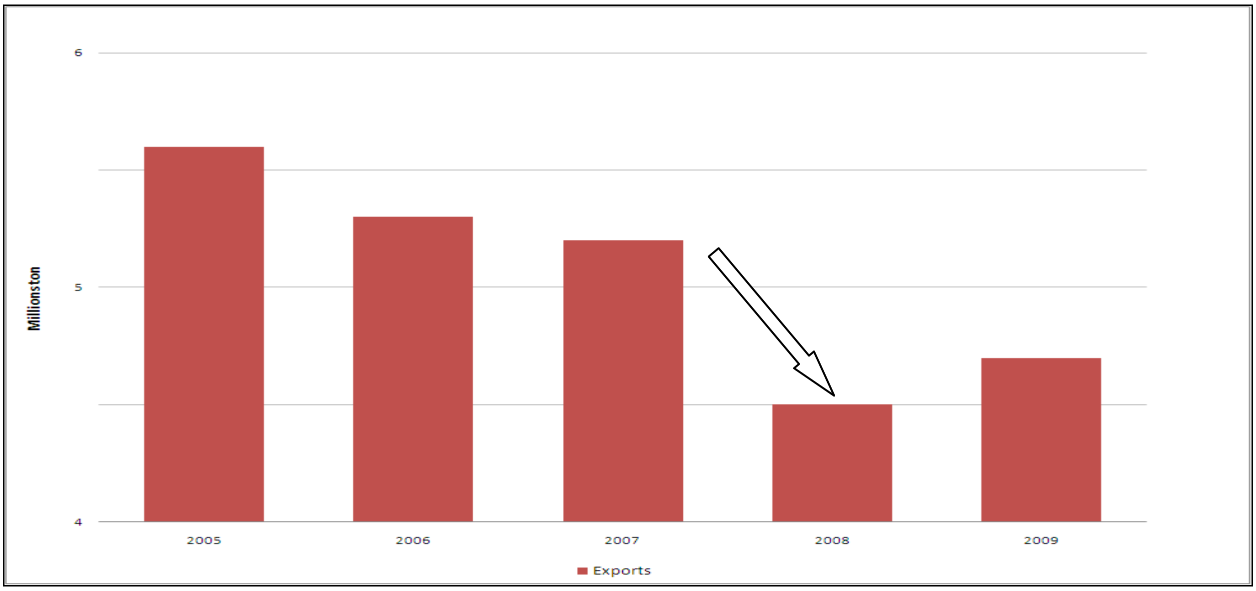

Figure 24: World phosphoric acid trade
Source: IFA, 2009

2.3.3 Important role players in the phosphate industry

China, the USA and Morocco are the world's largest miners of phosphate rock. China produces approximately 35 % of the total world production while the USA and Morocco produce 17 % and 15 % respectively. Other countries with significant production include Russia, Tunisia and Brazil. South Africa contributes approximately 1.5 % to the world's total phosphate rock production (Figure 25).

Integrated producers have their own rock supply and, according to PotashCorp (2009), 70 % of global phosphate rock is consumed by integrated producers. Producers that are non-integrated must buy and process more expensive rock to produce downstream phosphate products. Non-integrated producers consume the remaining 30 %, with 12 % obtaining their rock supply domestically and 18 % importing it from other countries.

Although China is the world's largest producer, it allocates most of its rock to domestic markets. An estimated 25 % of Chinese producers are non-integrated; they make use of rock bought from domestic suppliers. Morocco, on the other hand, is the major player in the global phosphate rock export market and provides 45 % of all the exported rock. All phosphate producers in India are non-integrated, and must import all their rock consumed.

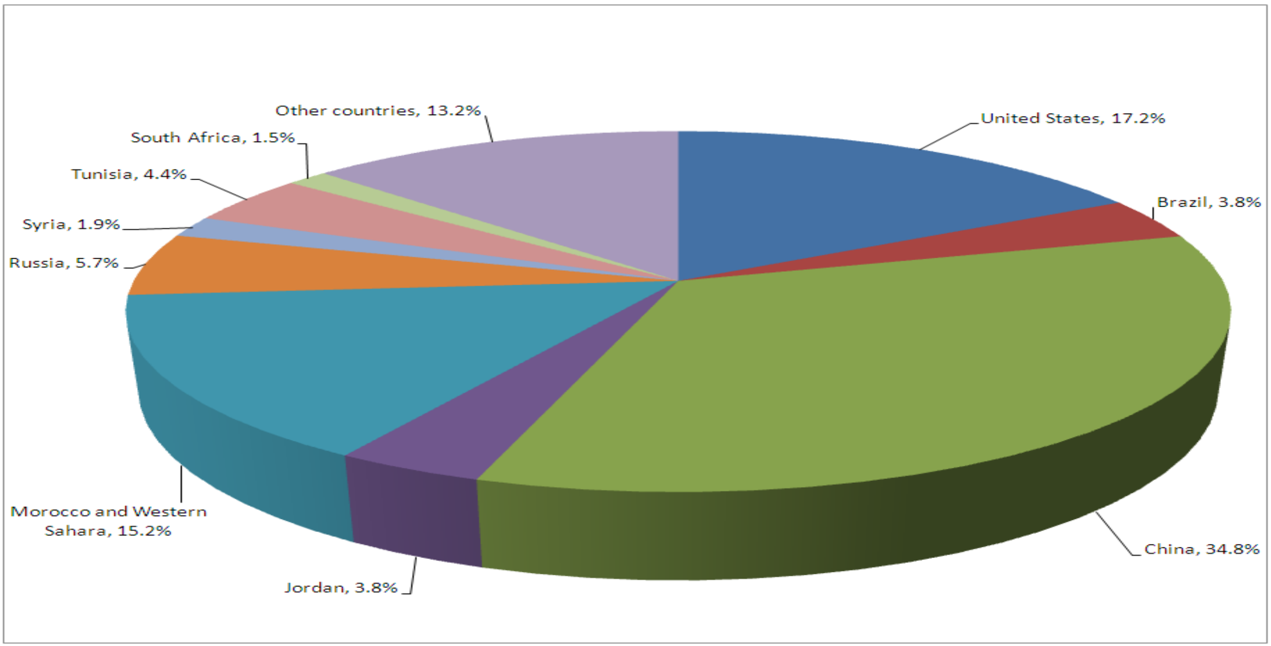

Figure 25: Leading phosphate rock-producing countries in the world for 2009
Source: U.S Geological Survey, 2010

2.4 Potassium (Potash) Background

Potassium (K) is the third most widely-used fertiliser nutrient after nitrogen and phosphorous. Potassium chloride, also known as Muriate of Potash (MOP), is the most common source of potassium for fertilisers and has a potassium oxide (K2O) content of 60 %. Other forms of potassium include potassium sulphate, with 50-54 % K2O content, and potassium magnesium sulphate, with 22-30 % K2O content (DME, 2009).

Potassium is one of the three primary plant nutrients for plants; it is necessary for normal and important functions like water use, protein synthesis and photosynthesis. Plants cannot complete normal life cycles without potassium and receive their potassium needs from the soil. Food and forage crops use large amounts of potassium and that is why potassium-rich fertilisers are required to replace the potassium removed in harvested crops, as well as to enrich soils that are infertile (Cambell, 2009).

2.4.1 Factors influencing the potassium price

In the next section, potassium will be examined with the aim to identify potential aspects that might have had an influence on the price of potassium and potash-based products.

2.4.1.1 Factors influencing the production cost, price and supply of potassium

a) World production and consumption (stocks)

Supply and demand have generally been in balance in the potassium industry, except for 1996. According to USGS (2005), the growth of potassium consumption began in 2004 and continued throughout 2005, which led to rising potash prices. After years of relative stability, potassium prices increased significantly from the beginning of 2007, whereafter they began to decrease in the first quarter of 2009.

According to Laboski and Bundy (2005), international demand and logistical problems with transporting potassium fertiliser from the Canadian source to USA fertiliser suppliers have resulted in significant potassium price increases and potential supply shortages for the 2005 growing season. In Figure 27, one can see the price increase of MOP during 2005.

According to PotashCorp (2008), the growth in global potassium demand exceeded the increase in supply during the first half of 2008 and all available stocks were consumed, which left large shortages in the market. Strikes at three PotashCorp mines and capacity decreases in certain countries were also identified as factors that tightened the supply of potassium and pushed spot prices up.

Figure 26 shows the trend lines of the available surplus potassium stocks and the international potassium price on a quarterly basis. The data were gathered from FMB and the International Fertiliser Industry Association (IFA). The figure shows that potassium shortages primarily occurred in 2007, while prices were at their highest between the third quarter of 2008 and the first quarter of 2009. From Figure 26, the above statement of Potash Corp could not be supported unless the same happened with potassium as with nitrogen and phosphate. International potassium prices could have increased during 2008 and the beginning of 2009, possibly because a shortage still existed during 2008 or because of a lag – meaning that it takes a while for mining and production to catch up with fast-rising demand. This could be why prices spiked only a year later. The conclusion that can be made is that the shortages that occurred only contributed to these price increases, but were not the main and only reason. The figure shows that potassium prices began to show the largest quarter-to-quarter increase in the last quarter of 2008, somewhat behind the price spikes of nitrogen and phosphate products.

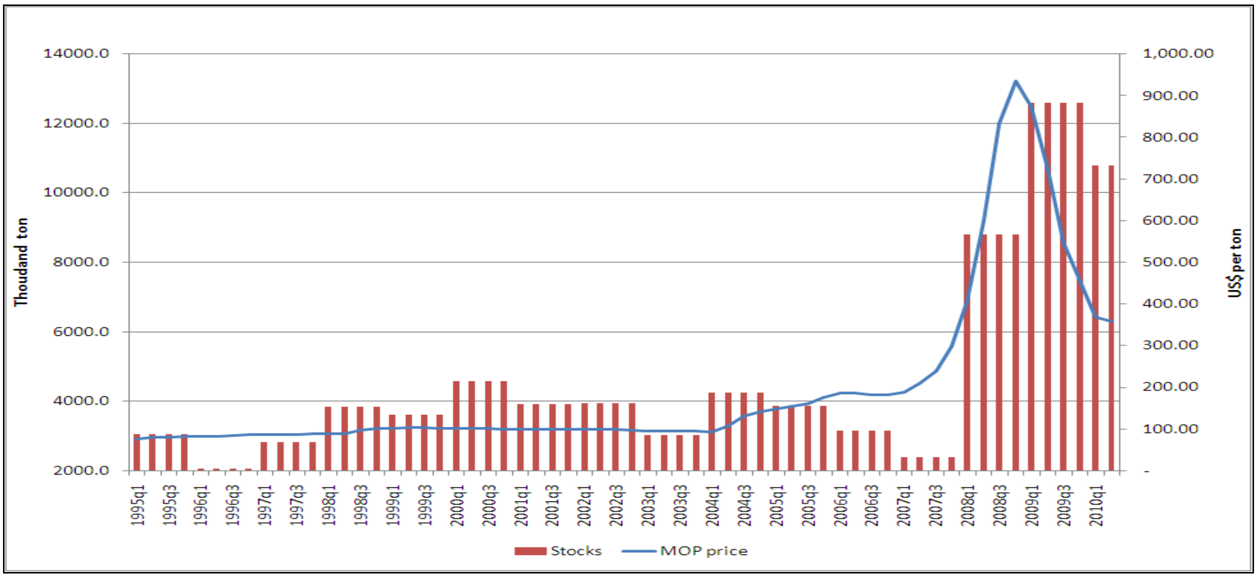

Figure 26: World potassium stocks vs MOP price
Source: IFA data bank, 2010; FMB, 2010

2.4.1.2 Factors influencing the demand for potassium

a) USA maize price

Figure 27 shows the trend lines of the USA maize price in comparison with the MOP price. This figure's trend lines are mostly the same as those for nitrogen and phosphate prices drawn with the USA maize price. In this period (1995-2010), the price correlation between the USA maize price and the MOP price was reasonably strong at 0.68. During the second quarter of 1996, the USA maize price was very high with absolutely no effect or volatile movement in the price of MOP. The reason for this specific maize price increase can be ascribed to low maize plantings in the USA as well as in the world during 1995.

During 2008, which is the specific year under investigation for this study, both the MOP price and the maize price increased at a very fast rate. It could be that higher commodity prices have increased maize production and correspondingly added to greater fertiliser demand; which again has led to tight markets and higher fertiliser prices.

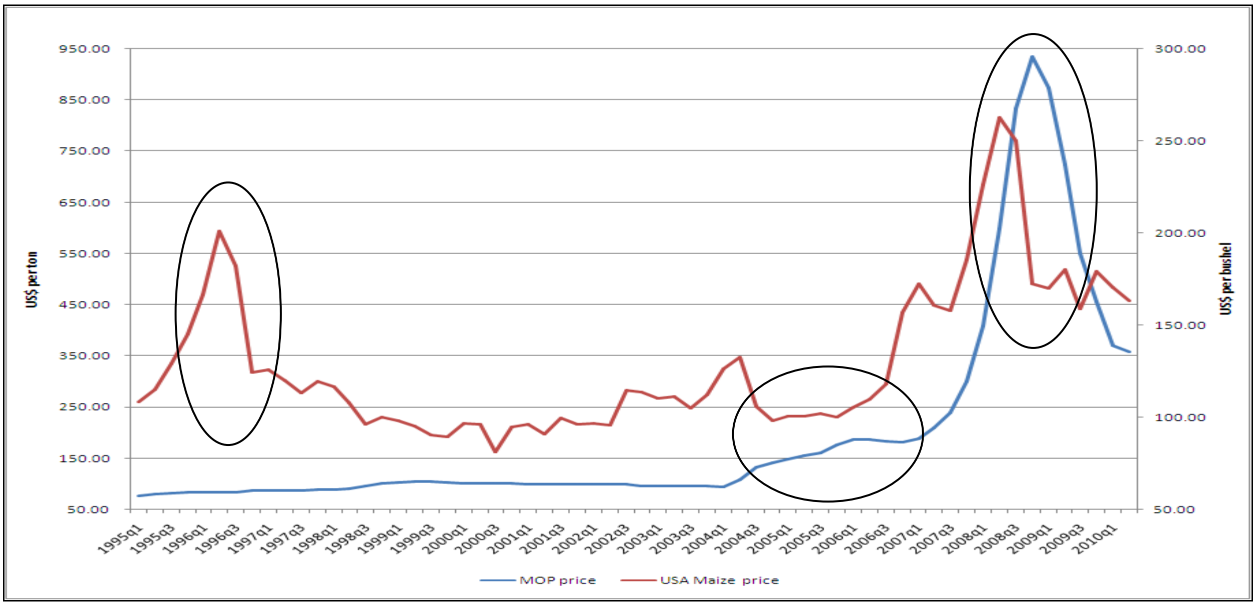

Figure 27: USA maize price vs MOP price
Source: IFA data bank, 2010; USDA, 2010

Figure 28 shows the MOP price measured against the USA maize area planted. The figure shows that the same trend occurred for MOP prices compared to the USA maize plantings as for nitrogen and phosphate prices. Higher fertiliser demand due to higher maize plantings might have placed upward pressure on MOP prices.

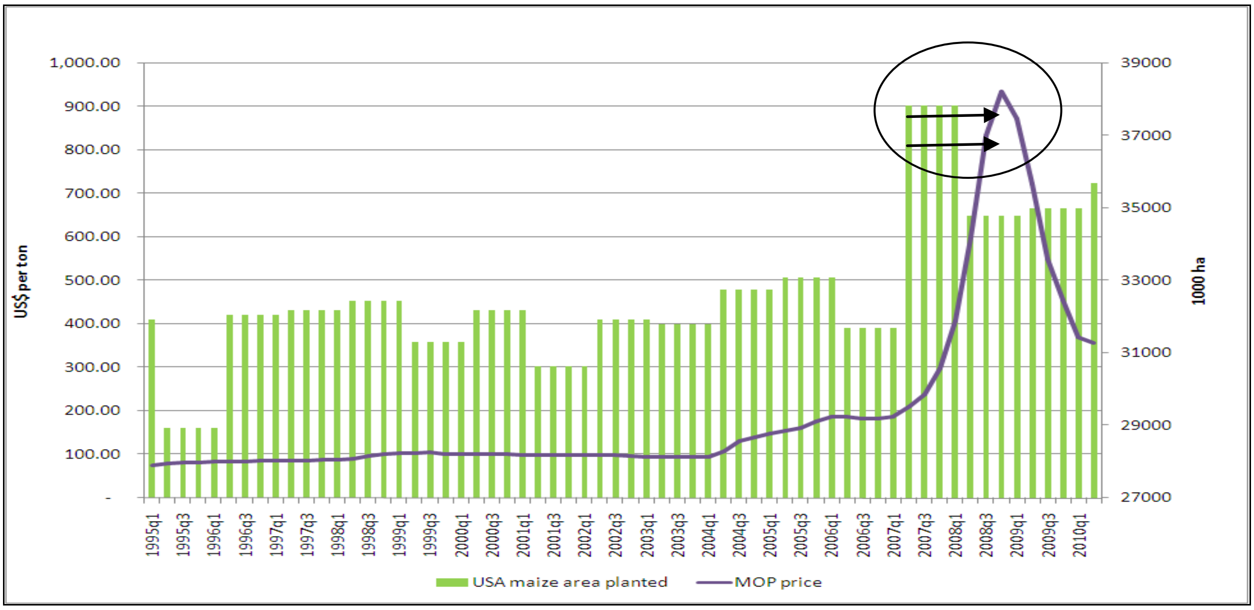

Figure 28: USA maize area planted vs MOP prices
Source: FMB, 2010; USDA, 2010

2.4.2 World potassium trade

Enormous inventories existed within the retail distribution system at the end of 2008 in some major consuming countries (Brazil, China and the USA). This occurrence was expected to dampen potassium import prospects for 2009, although IFA expected global import demand to grow at high rates after 2009. Figure 29 shows the potassium exports from 1999 to 2008.

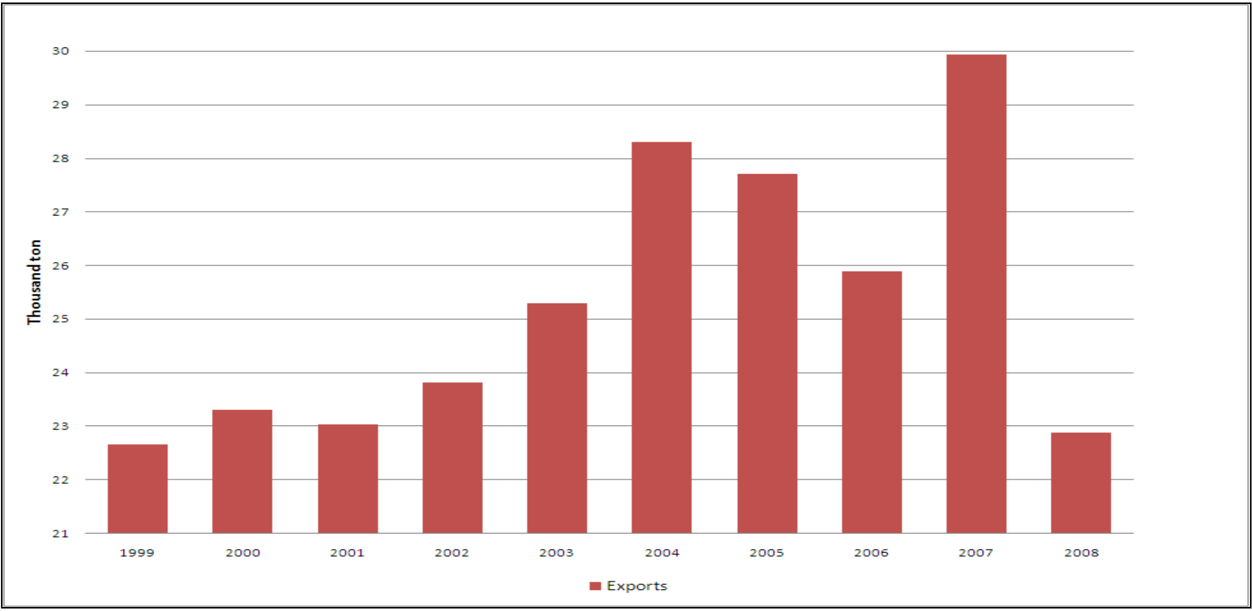

Figure 29: World MOP exports
Source: IFA, 2010

2.4.3 Important role-players in the potassium industry

The main potash-producing countries in the world are Canada, Belarus, Russia and Germany. Canada is by far the worlds' leading potash-producing country; it produces 26 % of the total production. Canada, Russia and Belarus together account for approximately 55 % of the world's production. According to PotashCorp (2009), significant potassium production occurs in only twelve countries. The total global potassium mine production in 2008 reached 36 million tons.

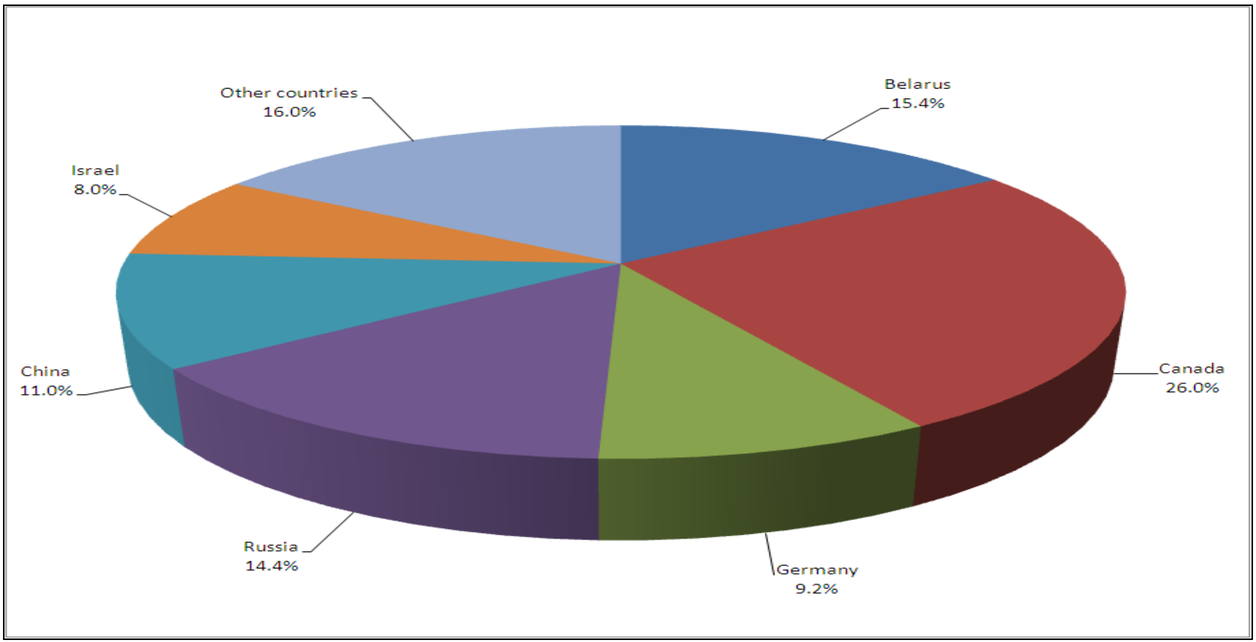

Figure 30: Leading potassium-producing countries in the world for 2009
Source: U.S. Geological Survey, 2010

2.4.4 Monopolistic behaviour of potassium-producing companies

PotashCorp is the world's largest fertiliser company by capacity, producing all three of the primary crop nutrients (N, P and K), and is well equipped to expand internationally because of its enormous size and market share. Together with Mosaic Company, PotashCorp controls approximately 75 % of the world potassium market. Regardless of decreased world demand due to declining crop prices in 2009, these two companies have maintained their high contract pricing. This monopolistic pricing power is a function of a competitive landscape with extremely high barriers to entry and economies of scale. PotashCorp estimated in 2007 that a new entrant would have to spend at least US$2.5 billion to get a new mine operational (Wikinvest, 2009).

2.5 Conclusion

In general, it was found that not only one factor but a multitude of factors caused prices to increase. This, together with a few other factors in 2007 and 2008, caused a "perfect storm" in international markets – and the fertiliser industry did not escape the storm. All the possible aspects contributing to the increase of each of the three main nutrients are summarised below:

Nitrogen (N)

- Low ammonia stock levels during 2007
- High Brent crude-oil price
- High natural gas price
- High Baltic Dry Index (BDI)
- High USA maize price and area planted
- The introduction of China's export tax on nitrogen fertilisers

Phosphate (P)

- Relatively lower than usual phosphate stock levels during 2006
- High Brent crude oil price
- High ammonia, sulphur and phosphate rock prices
- High Baltic Dry Index (BDI)
- High USA maize price and area planted
- The introduction of China's export tax on phosphate fertilisers

Potassium (K)

- Relative low potassium stock levels during 2007
- High Brent crude oil price

- High Baltic Dry Index (BDI)
- High USA maize price and area planted
- Monopolistic behaviour of potash-producing companies

CHAPTER 3

OVERVIEW OF LOCAL FERTILISER INDUSTRY

3.1 Introduction

The objective of this chapter is to better understand the local fertiliser industry – the structure or composition, concentration and the factors that have an influence on the market, price structures and the price formation in the local fertiliser market.

The first part of the chapter focuses on the history and the early development of the South African fertiliser industry, followed by the current situation and structure.

Although phosphates and certain nitrogen fertilisers are locally produced, a large amount of South Africa's fertiliser needs are imported. Theoretically, when a country is a net importer of a product, local prices will follow import parity prices. The second part of the chapter looks at how dependent South Africa is on imports and whether there are fundamental reasons for local fertiliser prices to be closely linked to international fertiliser prices.

Price structures and price forming will also be looked at by using import parity price calculations and comparing these with the average fertiliser prices as reported on fertiliser companies' price lists. This will help to provide an understanding of how prices are determined and to draw conclusions on whether prices are market related, i.e. related to the import parity price. When examining price formation, it is relatively easy to calculate and interpret the prices of products that are actually imported, but it becomes difficult with products that are locally produced and seldom imported.

3.2 Structure of the South African fertiliser industry

3.2.1 Historical overview of the local fertiliser industry: Structural development

Fertiliser manufacturing in South Africa dates back to 1903, when the South African Fertiliser Company (SAFCO) commissioned the first phosphate plant, using animal bones, in Durban. The development of the mining industry made the production of explosives crucial in South Africa; this enabled the production of large quantities of sulphuric acid, as a by-product. The sulphuric acid was used in fertiliser production with imported rock phosphates, which became a feasible proposition. This led to the commissioning of the Kynoch superphosphate plants in Umbogintwini in 1919, and two years later Cape Explosives (Capex) at Somerset West, which was originally known as De Beers Explosives. The original Kynoch and Capex joined forces in 1924 as AE&EI, which later became African Explosives and Chemical Industries and then AECI Limited.

South Africa was dependent on imported fertiliser products, which were mixed and blended with the local products. Import supplies dried up during the Second World War. Price control was introduced as a war measure during the early 1940s and was again abolished in January 1984. During the post Second World War years, until the early eighties, the industry flourished in a protected trade environment and government support measures for agriculture in general. This led to the development of SASOL, ISCOR and Foskor in the early 1950s. One consequence of the support measures was the encroachment of cultivation agriculture on marginal areas that were better suited for extensive and semi-extensive cattle farming. While these policies stimulated the horizontal expansion of fertiliser use in the 1970s and 1980s, they were not sustainable.

South Africa used to import phosphates from Morocco until a government official, DJR van Wijk, recognised the need for the domestic production of phosphates in 1951. Both the Second World War and the Korean War left the phosphate-dependent agricultural sector in South Africa severely constrained. The most viable source of phosphate rock was found in Phalaborwa. Foskor, which began as a wholly-owned subsidiary of the Industrial Development Corporation (IDC), developed the igneous deposit (phosphate rock) at Phalaborwa in 1951, which stimulated further development and major facilities (nitrogen and phosphates) were commissioned through the 1960s, 1970s and 1980s. The Sasolburg oil from coal plants was brought on stream between 1950 and 1960. Raw materials for fertiliser production became available and the Fisons and Windmill fertiliser factories were established at Sasolburg and at the Bosveld factory in Phalaborwa. By 1969, these three factories, together with a Fisons factory at Milnerton, became part of Fedmis. During this time, other companies such as Omnia and Triomf also started up.

Omnia started with the distribution of agricultural lime in 1953 and opened its first fertiliser factory at Sasolburg in 1967/68. Three liquid fertiliser plants were located at Dryden, Danielsrus and Hectorspruit; a second factory at Sasolburg and a phosphoric acid plant at Phokeng near Rustenburg followed this. Triomf established its factory in Potchefstroom in 1967. Thereafter, a factory at Richards Bay was established in the 1970s.

Triomf and AECI separated their interests. Triomf kept the factories at Potchefstroom and Richards Bay, while AECI revived the name Kynoch Fertilisers with their factories at Somerset West, Umbogintwini and Modderfontein, which they repossessed from Triomf. In 1986, Kynoch took over the local interests of Triomf. At about the same time, an overseas consortium, Indian Ocean Fertiliser (IOF) took over the Richards Bay plant. IOF produced phosphoric acid and soluble phosphates mainly for the export market.

In 1988, the operational interests of Fedmis, a division of Sentrachem, were taken over by Sasol Fertilisers, Kynoch Fertilisers and Omnia Fertilisers. During 1990, Foskor became a shareholder in IOF. In 1992, Sasol fertilisers decided to cease its direct marketing to farmers. In 1993, Kynoch Fertilisers took over the nitrogen interests of AECI. Chemfos (a subsidiary of Samancor), which mined phosphates at Langebaan and which was also a fertiliser blender, ceased its activities towards the end of 1993. In the period 1999 to 2004, Foskor obtained the entire shareholding of IOF. Norsk Hydro obtained the controlling interest in Kynoch. Sasol obtained a 100 % interest in Fedmis of Phalaborwa, which had been operated as a 50-50 joint venture by AECI-Kynoch and Sasol Fertilisers. Sasol Agri was renamed Sasol Nitro and Kynoch became known as Yara SA.
The lifting of price control on fertilisers in 1984 coincided with several other events, including the most severe drought in two centuries, and, with the coincidence of the worst recession since the 1930s, it had a serious effect on both farmers and the fertiliser industry. Sasol Limited, which had previously been a supplier only, established its own fertiliser company and began marketing directly to farmers in 1984. The marketing directly to farmers stopped briefly in 1992, but started again within four months. The years of 1999 to 2002 were characterised by large-scale rationalisation and acquisitions in the industry (DME, 2003).

3.2.2 Production, consumption and trade in the local fertiliser industry

The South African fertiliser industry is currently in a mature stage. The consumption of fertiliser on an annual basis has been hovering at ±2 million tons since the early 1980s and it is not expected to change drastically in the short term (Van der Linde, 2009). Although the nutritional concentration of fertiliser has increased over the years, there has not been much growth in the fertiliser industry in the past few decades. The highest annual consumption was recorded in 1981, when 3.3 million tons of fertiliser products were consumed (Figure 31). The main market for fertiliser is the agricultural industry. Crop farming constitutes around 85 % of the fertiliser demand and animal feed 5 % (Frost & Sullivan, 2008).

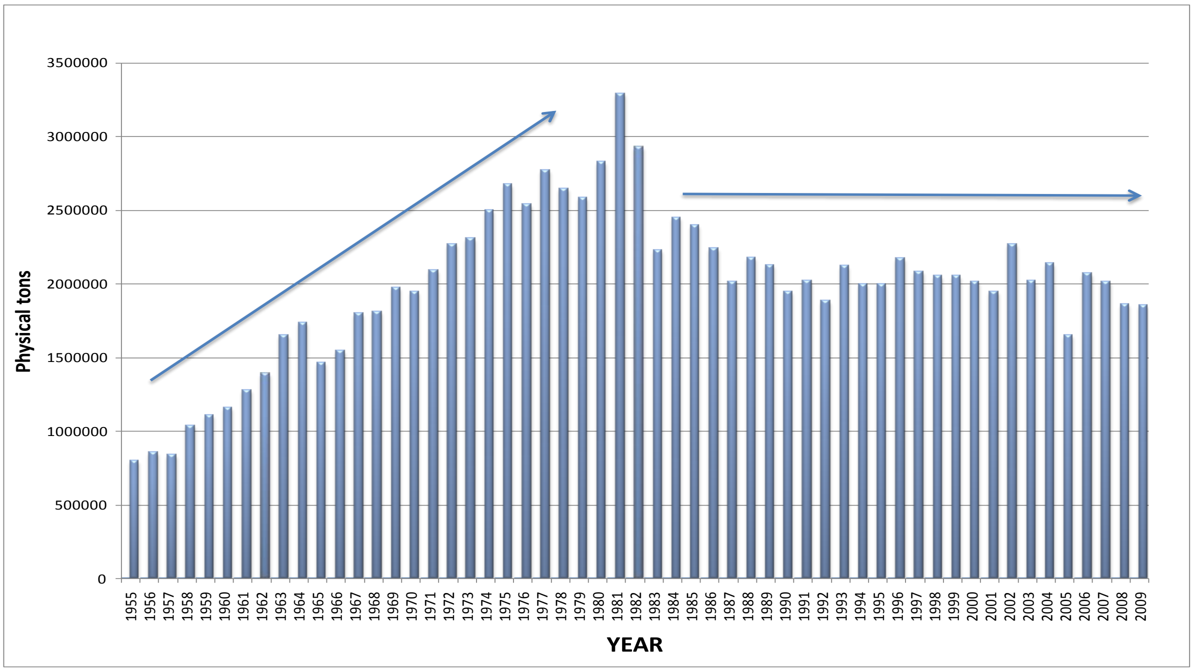

Figure 31: South African fertiliser consumption – physical
Source: Fertiliser Society of South Africa, 2010

The major reason for the stagnation in the fertiliser industry, in terms of demand, is that the recent past and the current economic market conditions in the grain and oilseeds industry (47% of total fertiliser consumption) do not allow for any profitable expansions in terms of area. Another factor that puts a damper on fertiliser demand is the fact that most marginal lands are converted to grassland for livestock farming.

The liberalisation of trade policies and the opening up of the economy that began in 1984, and gained momentum during the 1990s, led to large-scale rationalisation and restructuring in the industry throughout the 1980s and 1990s. Today, the fertiliser industry operates in a totally deregulated environment with no import tariffs or government support measures. Having been a net exporter of downstream fertilisers until the late 1990s, South Africa became a net importer after fertiliser plant closures in late 1999 and early 2000.

South Africa currently imports more than 50 % of its plant nutrient requirements (Figure 32). Although South Africa produces nitrogen-based fertiliser products in the form of LAN and nitrate-based N: P: K blends and can produce all its phosphate requirements, all the country's potassium and urea requirements needs to be imported.

South Africa stopped producing urea in 2000, which can be clearly seen in the increase in the percentage of N: P: K imports.

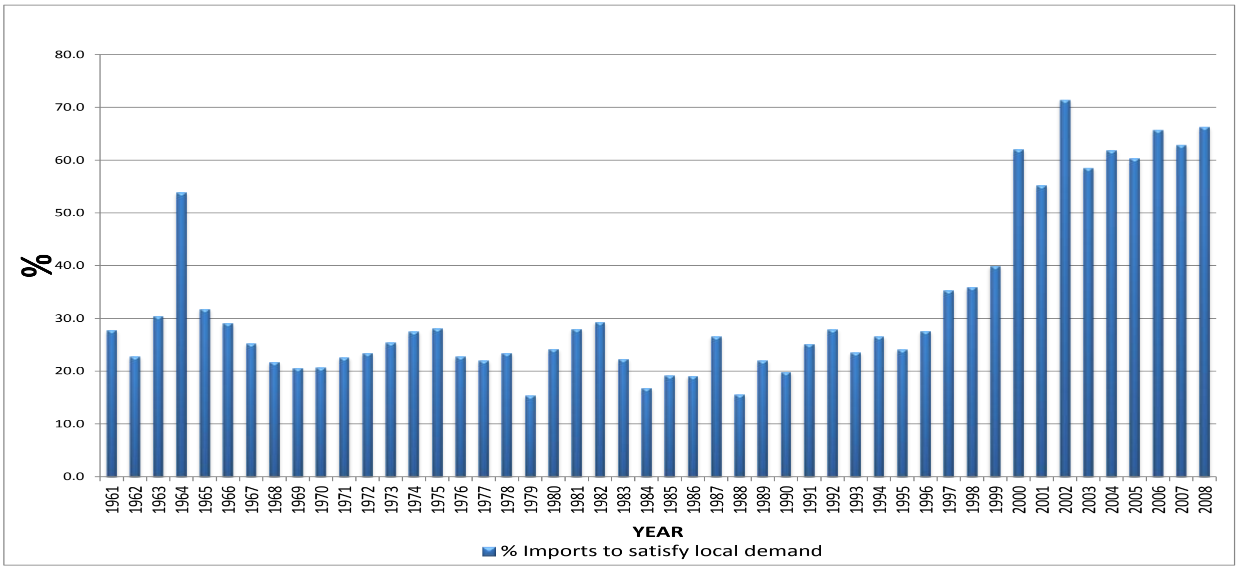

Figure 32: Percentage of N: P: K imports to satisfy local demand
Source: International Fertilizer Association, 2010

3.2.2.1 Local fertiliser consumption

Fertiliser consumption in South Africa has increased with a tempo of 310.8 % from 1955 to 1981 (Figure 31). After 1981, fertiliser consumption rapidly decreased until 1983, after which consumption moved relatively sideways. Fertiliser consumption in the space of two years, from 1981, decreased by 32 % and from thereon, consumption reached a new equilibrium (long-term average consumption).

The physical consumption of fertiliser increased from 800,000 tons in 1955 to 3.2 million tons in 1981. Price control was in place and the industry operated in a protected trade environment. Government initiative was greatly responsible for the strong growth as they promoted maximum production during this era. In 1982, the country suffered the most severe drought in two centuries. This, together with interest rates that increased dramatically in the worst economic times since 1930, caused agriculture to scale down and fertiliser consumption to consequently decrease. From then on, producers' focus shifted from maximum production to maximum profitability. In 1984, the liberalisation of the South African trade policies began with the abolishment of price control and the opening up of the economy (Van der Linde, 2009).

Gauteng, Mpumalanga, Limpopo and the North West account for approximately 40 % of total domestic consumption; and the Free State, KwaZulu-Natal and the Western Cape for approximately 20 % each (Van der Linde, 2009).

It is interesting if one looks at the consumption of N, P and K individually. From Figure 33, it is clear that the plant nutrition consumption of K has moved sideways, while the consumption of N has increased since 1983 and the consumption of P has actually decreased since 1981.

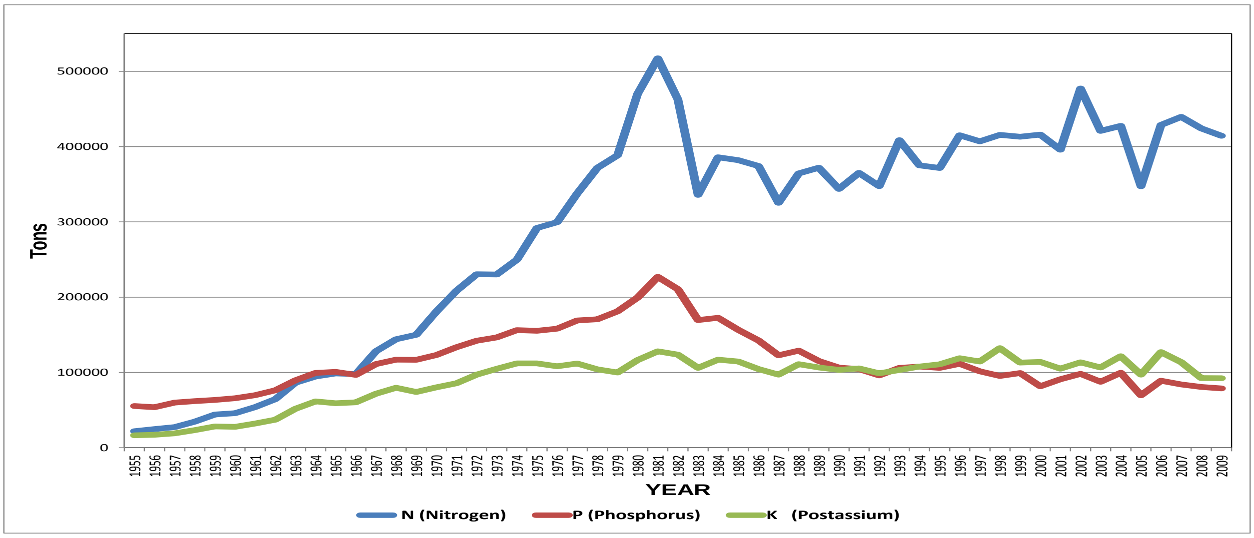

Figure 33: South African consumption of N, P and K plant nutrition
Source: Fertiliser Society of South Africa, 2010

3.2.2.1.1 South African fertiliser consumption by crop

Fertiliser consumption is determined by mainly two factors. The first is the total area planted to fertiliser using crops and the second is the amount of fertiliser these crops use per hectare. Maize and sugar cane are the two biggest users of fertiliser in South Africa, while soft and stone fruit, wheat and vegetables are the other important users. Currently (2008/09 production season), maize consumes 36 % while sugar cane, wheat, soft and stone fruit, and vegetables consume 17.9 %, 6.9 %, 2.5 % and 0.8 % respectively (Figure 34). Figure 35 shows that grain and oilseeds' use make up half of South Africa's total fertiliser consumption.

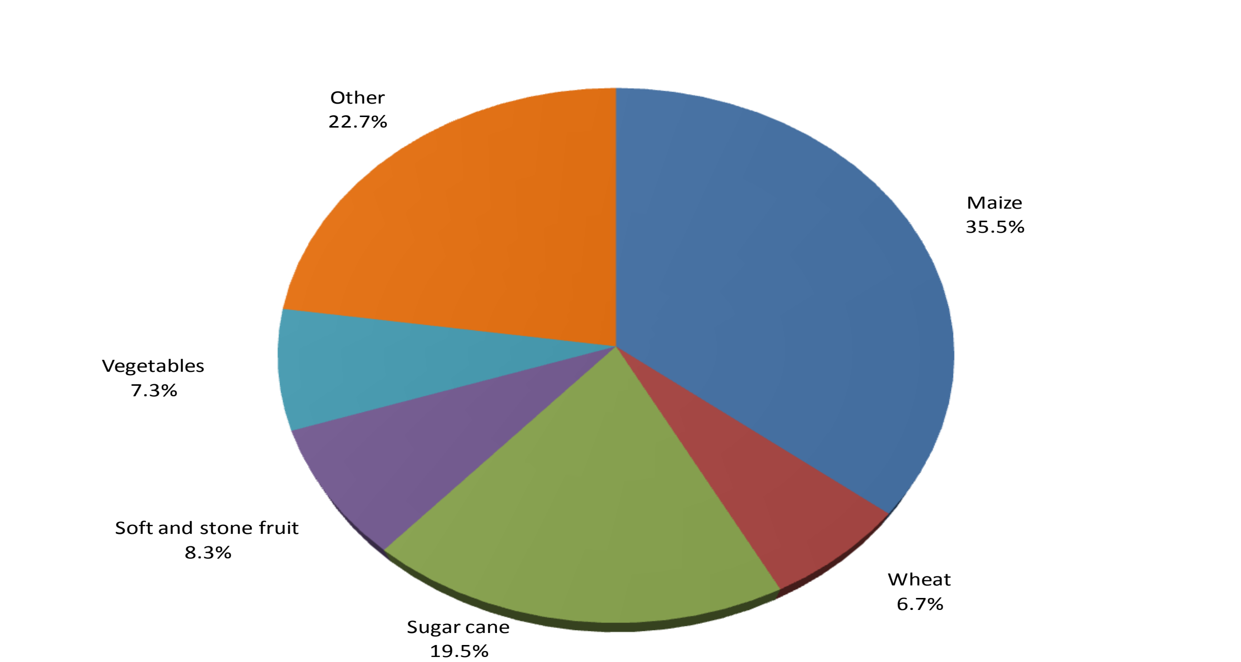

Figure 34: South African fertiliser demand per crop in 2009
Source: Fertiliser Society of South Africa, 2009

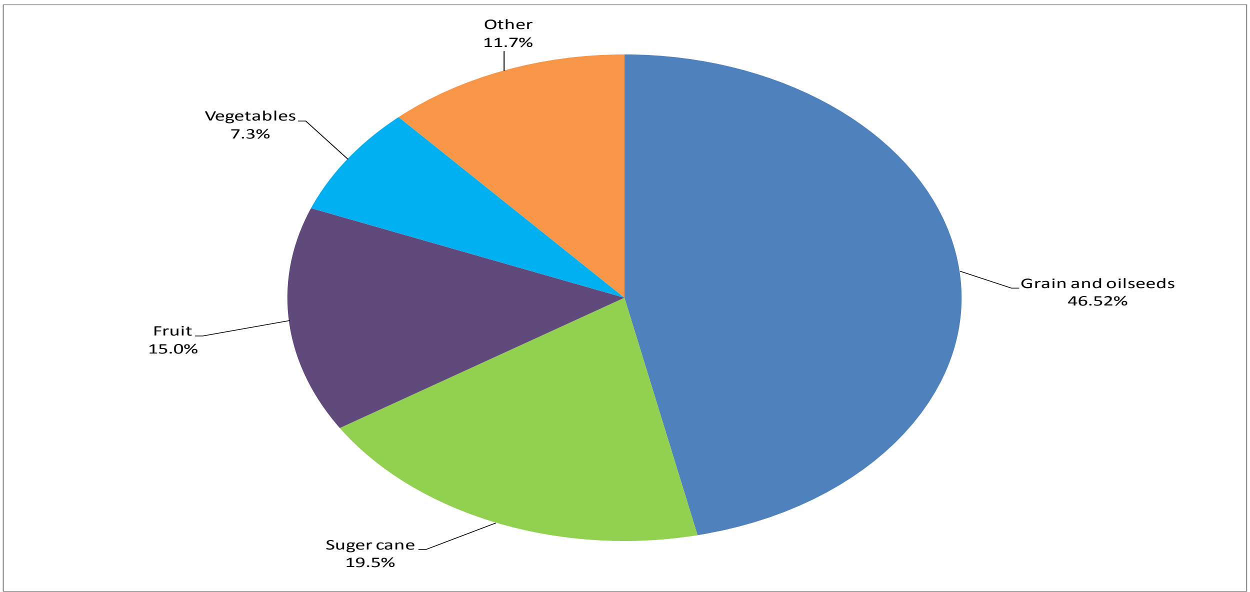

Figure 35: South African fertiliser consumption per crop in 2009
Source: Fertiliser Society of South Africa, 2009

3.2.2.2 Value chain approach

A value chain approach will be used to map the current market structure in the South African fertiliser industry. Diagram 1 shows the current organogram of the local fertiliser industry and is divided into a raw material and intermediate segment; a straight and chemical compound segment; and a downstream N: P: K compound and blend segment. From the diagram, it is clear which companies produce what and to what extent they take part in the whole fertiliser chain.

Raw materials and intermediates

Ammonia	**Phosphate rock**	**Sulphur (element)**
(Sasol)	(Foskor)	(Sasol)
(Import)	(Fer-Min-Ore)	(Import)
Nitric acid	**Phosphoric acid**	**Sulphuric acid**
(Sasol)	(Sasol Agri Phalaborwa)*	(Sasol Agri Phalaborwa)*
(Omnia)	(Omnia)#	(Sasol SFF Secunda)
(AECI)	(Foskor Richards Bay)	(Foskor Richards Bay)
		(Chemical Initiatives, Impala, Anglo, Zincor)
		(Imports)

Straight and chemical compounds

Urea	**Single Super Phosphate**	**KCl**
(Imports)	(Omnia)	(Imports)
LAN	(Fer-Min-Ore)	**K2SO4**
(Sasol)	**MAP**	(Imports)
(Omnia)	(Omnia)	
(Imports)	(Foskor Richards Bay)	**KNO3**
Ammonium Sulphate	(Imports)	(Imports)
(Sasol)	**DAP**	
(Exarro)	(Foskor Richards Bay)	
(Impala)	(Imports)	
(Imports)		

Downstream NPK compounds and blends

Granular solids	**Liquids**	**Blended solids**
(Omnia)	(Sasol)	(Sasol)
(Sasol) – Only LAN(28)	(Omnia)	(Omnia)
(Imports)	(Kynoch)	(Kynoch)
	(Sidi Parani)	(Profert)
	(Other smaller companies)	(Sidi Parani)
		(Other smaller companies)

***Taken over by Meridian/Farmers World.**

 # Plant mothballed

Diagram 1: The organogram of the South African fertiliser industry
Source: DME, 2003 (modified to current structure)

3.2.2.2.1 Fertiliser product chain

- **Nitrogen Chain**

  ✓ **Ammonia**

Ammonia is the main source of nitrogenous fertiliser. Ammonia (NH_3) in South Africa is manufactured with the well-known Haber-Bosch process. Sasol supplies most of the country's ammonia, with some produced by Mittal Steel (Exarro), while the rest of the ammonia demand is imported. Most of South Africa's ammonia imports come from Middle East countries like Saudi Arabia, Kuwait, Bahrain and Oman and when exporting ammonia, it is mainly to African countries.

Sasol produces ammonia in its coal-to-liquids process where it converts coal at Secunda, with the aid of heat, pressure, steam and oxygen, into crude synthesis feed gas (syngas, a mixture of hydrogen and carbon monoxide). Once cooled and recovered from the gas stream, the gasification condensates yield the first generation of co-products: tars, oils and pitches, as well as ammonia, sulphur and phenols.

Sasol also uses natural gas, which it obtains through a cross-border pipeline with Mozambique, as its sole hydrocarbon feedstock at Sasolburg and as a supplementary feedstock to coal at Secunda. This process identifies the different feedstocks used in the ammonia process, the prices of which ultimately form the price of ammonia. Diagram 2 shows the schematic representation of the ammonia synthesis process.

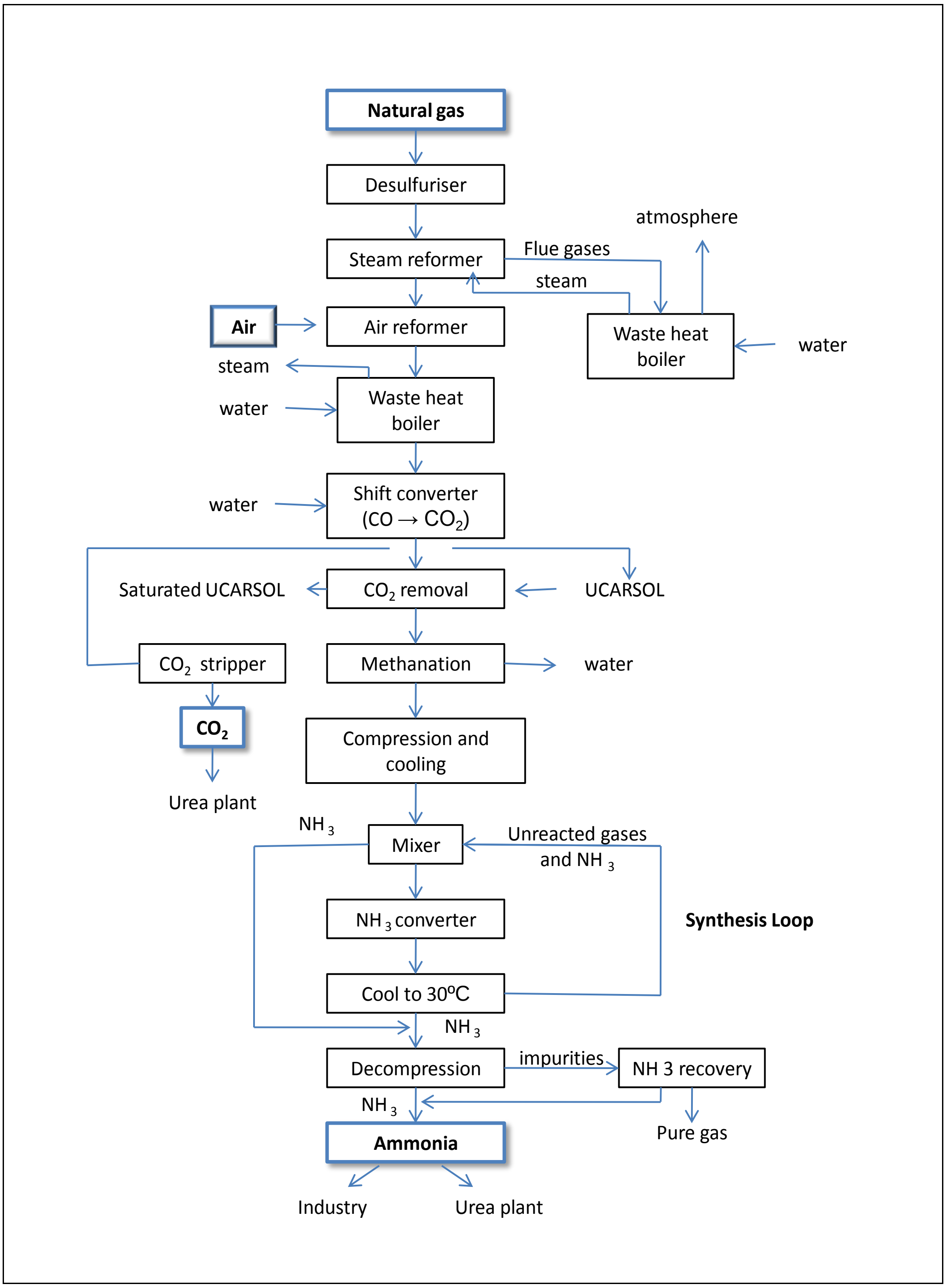

Diagram 2: Schematic representation of the ammonia synthesis process
Source: Petrochem, 2009

- ✓ **Urea**

As mentioned earlier, all South Africa's urea needs are imported. From the schematic presentation (Diagram 3), it is seen that ammonia is the main feedstock in urea production and would thus play a pivotal role in its price formation.

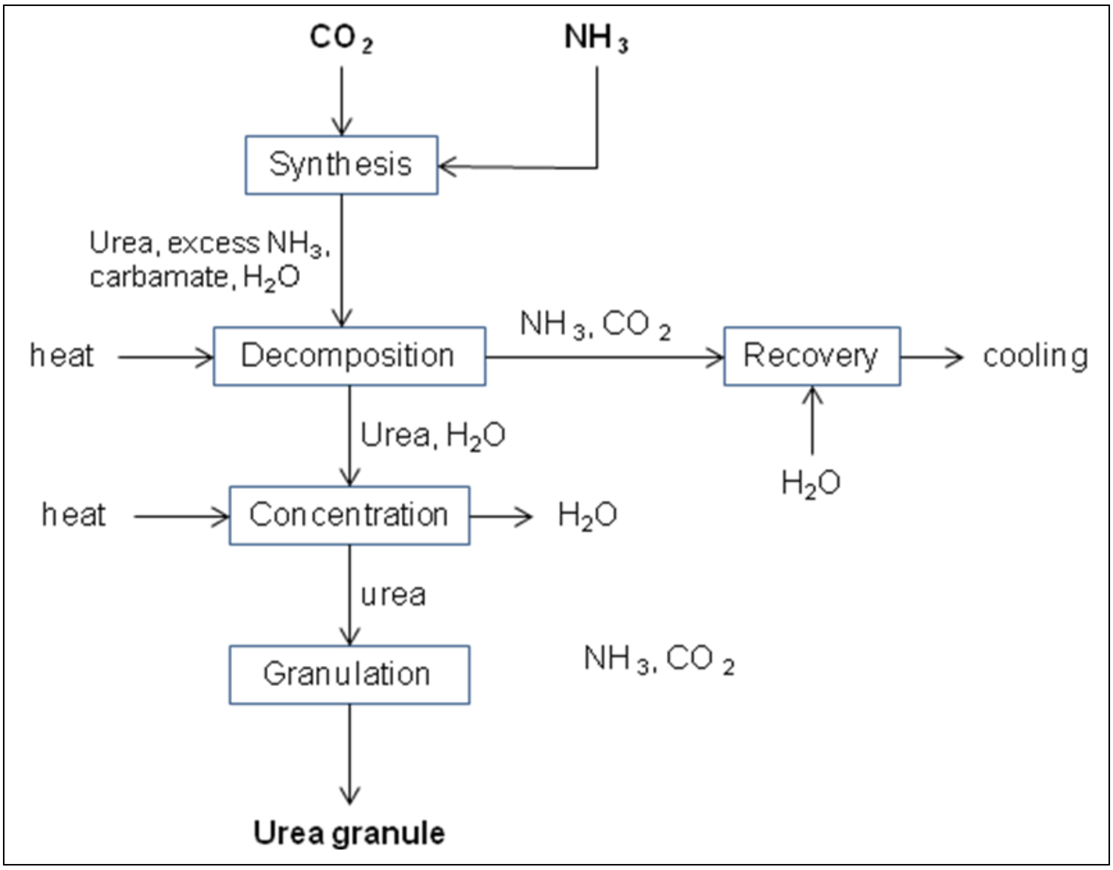

Diagram 3: Schematic presentation of urea synthesis
Source: Petrochem, 2009

- **Phosphate chain**

In South Africa, Foskor supplies phosphate concentrates to local and foreign fertiliser producers. Foskor can provide phosphates to satisfy the whole demand for P in South Africa.

Through Foskor's local production of phosphate rock concentrates and through treatment with sulphuric acid; phosphoric acid or nitric acid, the concentrate can be converted into a whole range of intermediate (e.g. phosphoric acid and DAP) and downstream products (e.g. superphosphate). Foskor has got the capacity to produce intermediate products like phosphoric acid, DAP and MAP. SASOL and Omnia stopped producing phosphoric acid from rock they received from Foskor in 2008 and 2009 respectively and Sasol recently also stopped producing MAP. This means that Foskor is currently the only producer of phosphoric acid and DAP in South Africa, until Farmers World (Meridian), who took over the Sasol Phalaborwa phosphoric acid plant, is again up and running. Omnia still produces MAP powder for own use.

In the schematic representation (Diagram 4) of the phosphoric acid, DAP and MAP production process, it is clear that phosphate rock and sulphuric acid are the main feedstock in the production process, and their prices would for this reason be an important factor in determining the prices of processed phosphates.

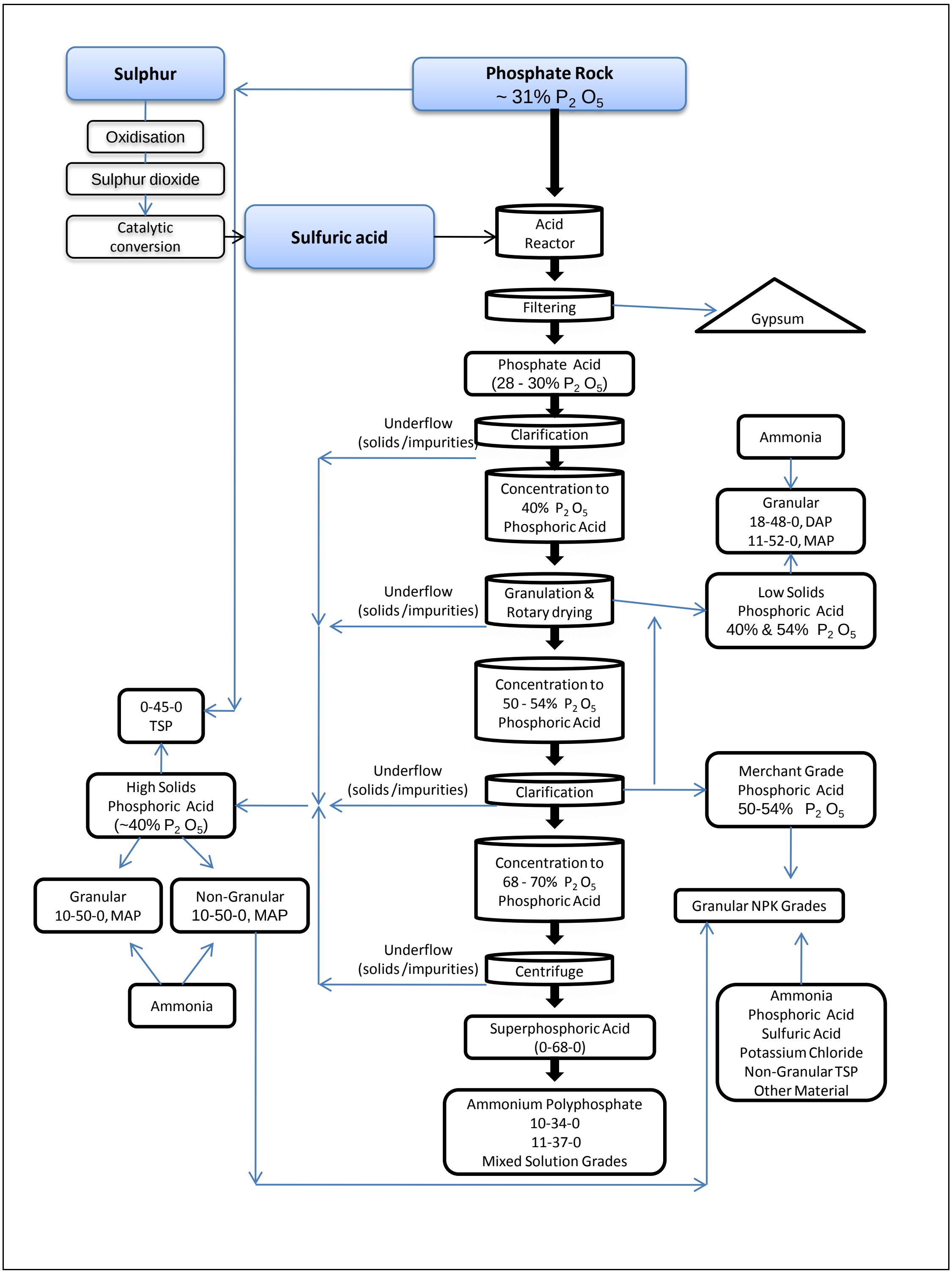

Diagram 4: Schematic representation of the phosphate production process
Source: DME, 2008; Foskor, 2009

3.2.2.2.2 South African fertiliser industry's organogram

The fertiliser industry in South Africa is dominated by a few large raw material suppliers that supply raw materials to other fertiliser manufacturers. In addition, they also have downstream processing facilities for blending and granulation and are therefore able to supply directly to end users, distributors and fertiliser manufacturers.

The dominant four companies are Sasol, Omnia, Yara (now Kynoch – taken over by Farmsecure) and Foskor, all with an annual revenue from their fertiliser business of above R100 million (Frost & Sullivan, 2009). Of these companies, it is now only Sasol, Omnia and Foskor that is into manufacturing (excluding blending). Companies like Profert, Nutri-Flo, Nitrophoska and Greenlands are typically bulk blenders that either import raw materials or source them from the local manufacturing companies.

Figure 36 shows the market share of the different fertiliser companies in terms of their revenue in 2008. Foskor's market share is not included in this analysis done by Frost and Sullivan, as Foskor supplies the bulk of its products to other manufacturing and blending companies. According to Frost and Sullivan (2009), Omnia is the leading company in terms of revenue with 36 % of the market share, followed by Sasol and Yara with 31% and 19 % respectively. Profert, Nutri-Flo, Nitrophoska and Greenlands have a market share of 8%, 3%, 1% and 1% respectively. According to anecdotal evidence, market share in terms of volumes fertiliser sold is Omnia – 35%; Sasol – 20%; Yara – 20%; and Profert – 20%. It has to be said that since 2008 there has been major changes in the fertiliser industry (which will be mentioned below), which could have changed the marked shares mentioned above.

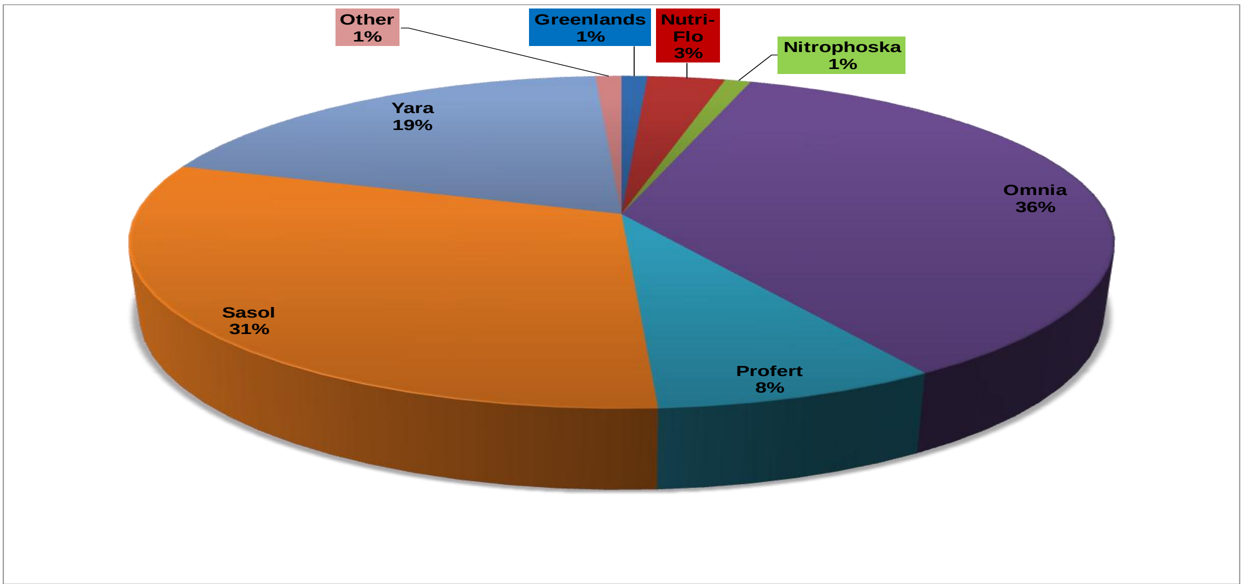

Figure 36: South African fertiliser market share by revenues
Source: Frost & Sullivan, 2008

Omnia

The Omnia Group (Pty) Ltd is divided in three divisions, namely a chemical division, a mining division and an agricultural division. In 2009, the agricultural division contributed 46 % (in 2008 this was 54 %) to Omnia's operating profit. The agricultural division produces and supplies granular, liquid and speciality fertilisers to individual farmers, co-operatives and wholesalers throughout South Africa and, increasingly, to sub-Saharan Africa, as well as to Madagascar, Australia and New Zealand.

Omnia produces raw materials and it also has downstream processing facilities for blending and granulation, and is therefore able to supply directly to end users and other fertiliser distributors. Omnia produces raw materials, such as nitric acid, straights, and chemical compounds, such as single super phosphates, MAP and LAN. It also produces granular solids, liquids and blended solids which it sells directly to farmers.

Sasol Nitro

Sasol Nitro is a division of Sasol Chemical Industries, which is a major company in Sasol's family of businesses. Sasol locally produces and markets ammonia, ammonium nitrate-based fertilisers, commercial explosives, nitric acid and a range of specialised blasting accessories.

In the chain of fertiliser raw materials and end products, Sasol produces ammonia (mainly the only producer in South Africa), nitric acid, sulphur, sulphuric acid, LAN, ammonium sulphate, and downstream NPK compounds such as granular solids, liquids and blended solids.

In August 2009, Sasol announced an initiation of consultations with various stakeholders ahead of the closure of Sasol Nitro's phosphoric acid operations in Phalaborwa due to unprofitability over a long period. A company called Farmers World (Meridian) purchased.

In July 2010, Sasol Nitro undertook, as part of an agreement with the Competition Commission, to divest from five of its regional fertiliser blending plants. Sasol intends to sell the Bellville, Durban, Kimberley, Potchefstroom and Endicott fertiliser blending plants as going concerns before August 2011. Sasol also announced that it intends to increase its focus on upstream activities of its fertiliser value chain, which was supported by investments in several new fertiliser production facilities at its Secunda operations. Sasol will continue with the production of LAN, ammonium sulphate and a range of ammonium nitrate and ammonium sulphate-based liquid and granular fertiliser blends. The divestment of the blending plants and the agreement with the Competition Commission that they will only market fertiliser from Secunda and three distribution centres within a 100 km radius of Secunda and Sasolburg means that Sasol will become only a wholesaler.

Yara / Kynoch

Yara is one of the world's largest suppliers of crop nutrients; it does sales to more than 120 countries, and operates and has offices in more than 50 countries. Yara is one of the only fertiliser companies that has a significant global presence and it also has a big share in the South African fertiliser industry.

As mentioned, Yara has closed down most of its local fertiliser manufacturing plants in South Africa and is now mainly focusing on importing to satisfy its demand.

Yara International ASA and Farmsecure Technologies (Pty) Ltd announced on the 15th of May 2010 its agreement in principle for Farmsecure to acquire Yara's South African fertiliser retail marketing businesses. The Competition Commission approved this transaction on the 31st of August 2010. All assets, employees and the historic Kynoch brand are included in the transaction, and Farmsecure Technologies intends to rename the acquired businesses as Kynoch Fertiliser. Kynoch will be the exclusive distributor of a selected range of premium Yara fertilisers in South Africa.

Profert

Profert is a typical bulk blender that either imports raw materials or sources them from the local manufacturing companies. After it was founded in 1999, Profert contributed to radically changing the price competition of fertiliser in South Africa. It has also recently started a unique product range of coated fertiliser. The bio-organic fortified coating is aimed to actively and directly affect the soil environment by supplementing essential soil micro-organisms, inhibiting the acidifying process of fertilisation and supplying the soil with essential nutrients the plant and soil micro-organisms need.

Although a study by Frost and Sullivan in 2008 showed that Profert only has an 8 % market share in terms of revenue, most local commentators feel that it is higher.

Foskor

Foskor is one of the world's few vertically-integrated producers of phosphoric acid, with its own phosphate rock mining, chemical processing and granular fertiliser operations. It was founded by the South African Industrial Development Corporation (IDC) in 1951 to provide a domestic source of phosphates to support local agriculture with phosphate-based fertiliser.

Foskor's rock and copper division is located in Phalaborwa (Limpopo Province) and the Acid Division is in Richards Bay (KwaZulu-Natal). Granular fertilisers, namely DAP and MAP, are also produced in Richards Bay.

Foskor is one of the largest suppliers of phosphoric acid to India, which is known to be the world's largest phosphoric acid market. Locally, Foskor has the capacity to produce 2.2 million tons of sulphuric acid (H_2SO_4), 720,000 tons of phosphoric acid (P_2O_5) and 300,000 tons of phosphate-based fertiliser (MAP and DAP). The phosphate rock concentrate, a key input in phosphoric acid production, is transported by rail primarily from Phalaborwa to Richards Bay, with the phosphoric acid exported to India, Japan, the Netherlands, Bangladesh and Dubai, and a small quantity sold locally.

According to Foskor, approximately 89 % of the phosphate rock concentrate is transported by rail to Richards Bay for processing into phosphoric acid, which is then used as a raw material in the production of granular fertiliser. Approximately 74 % of the phosphoric acid produced is exported to Europe and Asia, and the balance is converted into granular which is mainly sold to the local market.

Foskor had an agreement in place with Sasol Nitro – referred to as the Sasol Nitro tolling agreement – which began on the 1st September 2005 and ended on the 31st March 2008. During this period, in terms of the tolling agreement, Foskor outsourced the production of phosphoric acid to Sasol Nitro. On termination of the tolling agreement, Foskor entered into a supply agreement with Sasol Nitro for the sale of phosphate rock concentrate. Sasol sold its plant to Farmers World (Meridian). Foskor also used to sell phosphate rock to Omnia, which produced its own phosphoric acid; however, the plant is currently mothballed.

Currently (at the time of writing this report), Foskor's' shareholding is as follows:

- 59 % held by the Industrial Development Corporation of South Africa Ltd (IDC);
- 26% BEE Partners;
- 14 % held by Coromandel International Ltd (CIL – based in India); and
- 1 % held by Sun International FZE (a company based in India).

Competition issues

On 20 May 2009, the Competition Tribunal confirmed a fine of R251 million that was negotiated between the Competition Commission and Sasol, for uncompetitive behaviour of its fertiliser division during the period 1996 to 2004 (Competition Commission, 2009 – Annexure A of the consent and settlement agreement between the Competition Commission and SASOL Chemical Industries (CTD). This came after Nutri-Flo, a fertiliser company predominantly operating in KwaZulu-Natal, lodged a complaint with the Commission against Sasol on 3 November 2003. At the time, Nutri-Flo alleged that Sasol, Kynoch and Omnia had engaged in uncompetitive behaviour. The claims included the following conduct:

- Collusion in dividing the market for LAN;
- Collusion in respect of prices of LAN and of certain other fertilisers;
- Excessive pricing in respect of LAN and ANS; and
- Exclusionary conduct through an effective margin squeeze, which became increasingly severe after Nutri-Flo lodged the second complaint with the Commission, and which resulted in Nutri-Flo closing its granulation facility.

The Commission then conducted an investigation into the matter; as a result of which it found that Sasol, Kynoch and Omnia had contravened Section 4 of the Competition Act, as alleged. Pursuant to its investigation, the Commission found that the following anti-competitive conduct occurred in contravention of Section 4 of the Act:

- Collusion in constructing and dividing the market such that Sasol became the exclusive supplier of LAN to the wholesale market;
- Agreements, arrangements and understandings concluded within the Import Planning Committee (IPC), Nitrogen Balancing Committee (NBC), and the Export Club that amounted to collusion in respect of ammonia, potash, urea, MAP, DAP and LAN; and
- Excessive pricing and exclusionary conduct – the details of which were not relevant for the purposes of the first agreement between Sasol and the Commission.

In the agreement between Sasol and the Competition Commission, Sasol admitted the following facts:

- Sasol entered into a series of agreements, arrangements and understandings with Omnia, Kynoch and AECI, including but not limited to, the tolling and supply agreements relating to the products referred to in the settlement agreement;
- These agreements, arrangements and understandings contributed to Sasol becoming the principal supplier of LAN to wholesale customers;
- Sasol participated in the IPC, the Export Club and the NBC, which were established by Sasol. These committees were composed of producers and suppliers. The members of these committees included Sasol, Kynoch and Omnia;
- These committees were used, amongst other things, to co-ordinate business practices; to exchange information about production, supply and demand; to allocate, redistribute and swap

product by reference to sales targets, prevailing market shares and product availability monthly, by product and market and to discuss export volumes;

- From the exchange of such information the members of the committees were able to derive forecasted market shares;
- The NBC was also used to ensure balance of supply and demand;
- The members of the committees engaged in swaps of various products and in particular, in relation to LAN, potash and urea;
- The products variously covered in the committees included ammonia, potash, urea, MAP, DAP, LAN, ammonium sulphate, sulphate of potash, triple super phosphate and ANS. Members of the committees further communicated estimated landed cost of imported products based upon published international prices and estimated freight costs;
- In 2001, a meeting was held between managers and/or employees of Sasol Nitro, Omnia and Kynoch at a hotel in Johannesburg. At the meeting, agreement was reached between the parties as to pricing formulae from which base prices would be derived for the fertiliser products sold by the parties to the agreement. Agreement was also reached as to the range of discounts that the parties would offer on the base prices. In the period of approximately 2001 to 2005, meetings were held between these parties in order to address any instance of deviations by any of the other parties from the agreement. To the best of Sasol's knowledge, no meetings were held after 2005; but Sasol is not able to say whether the other parties continued to apply the formulae in respect of fertiliser products. Sasol Nitro continues to price its fertiliser products according to the concepts embodied in the original formulae; however, Sasol Nitro has independently amended the formulae in a number of material respects, specifically the margins.

Excessive pricing and exclusionary conduct by Sasol has not been included in this agreement that was confirmed by the Competition Tribunal. The case against Omnia and Yara with their involvement in uncompetitive behaviour in the Nutri-Flo case is still ongoing.

In July 2010, Sasol Nitro undertook, as part of an agreement with the Competition Commission, to divest from five of its regional fertiliser blending plants. This settlement was reached as a remedy for the alleged abuse of dominance in its fertiliser business. Sasol intends to sell the Bellville, Durban, Kimberley, Potchefstroom and Endicott fertiliser blending plants as going concerns before August 2011. Sasol also announced that it intends to increase its focus on upstream activities of its fertiliser value chain, which was supported by investments in several new fertiliser production facilities at its Secunda operations. Sasol will continue with the production of LAN, ammonium sulphate and a range of ammonium nitrate and ammonium sulphate based liquid and granular fertiliser blends. The divestment of the blending plants and the agreement with the Competition

Commission that they will only market fertiliser from Secunda and three distribution centres within a 100 km radius of Secunda and Sasolburg means that Sasol will become only a wholesaler. The agreement with the Competition Commission suggests the following structural changes within Sasol’s fertiliser business:

- Divesting its regional blending capacity in Bellville, Durban, Kimberley, Potchefstroom and Endicott while retaining its full production activities in Secunda.
- Altering Sasol Nitro's fertiliser sales approach to a Secunda ex-works model. All fertiliser retail agent contracts will be phased out and a new fertiliser sales operating model formulated.
- Supplying the market, in future, from Sasol Nitro Secunda and three distribution centres within a 100 km radius of Secunda and Sasolburg.
- Pricing all ammonium nitrate-based fertilisers on an ex-Secunda basis.
- Phasing out ammonia imports on behalf of customers in South Africa.

3.3 Supply and demand (production, consumption, imports and exports)

As mentioned earlier, South Africa was a net exporter of downstream fertiliser until the late 1990s, but became a net importer after major plant closures in late 1999 and early 2000. The reasons for the plant closures were unprofitability because of old technology and seen as a strategic decision for the company. Yara is one of the largest role players in terms of fertiliser manufacturing on international markets and therefore can obtain relatively inexpensive products. Currently, all South Africa’s urea and potassium needs are imported, while all South Africa’s needs in terms of phosphates and nitrate-based fertilisers can be met. Figure 37 shows the supply (production + imports) and demand (consumption + exports) of plant nutrients (N + P_2O_5 + K_2O) in South Africa. With the exception of 1993, there has always been sufficient fertiliser available, which was acquired through local production and imports.

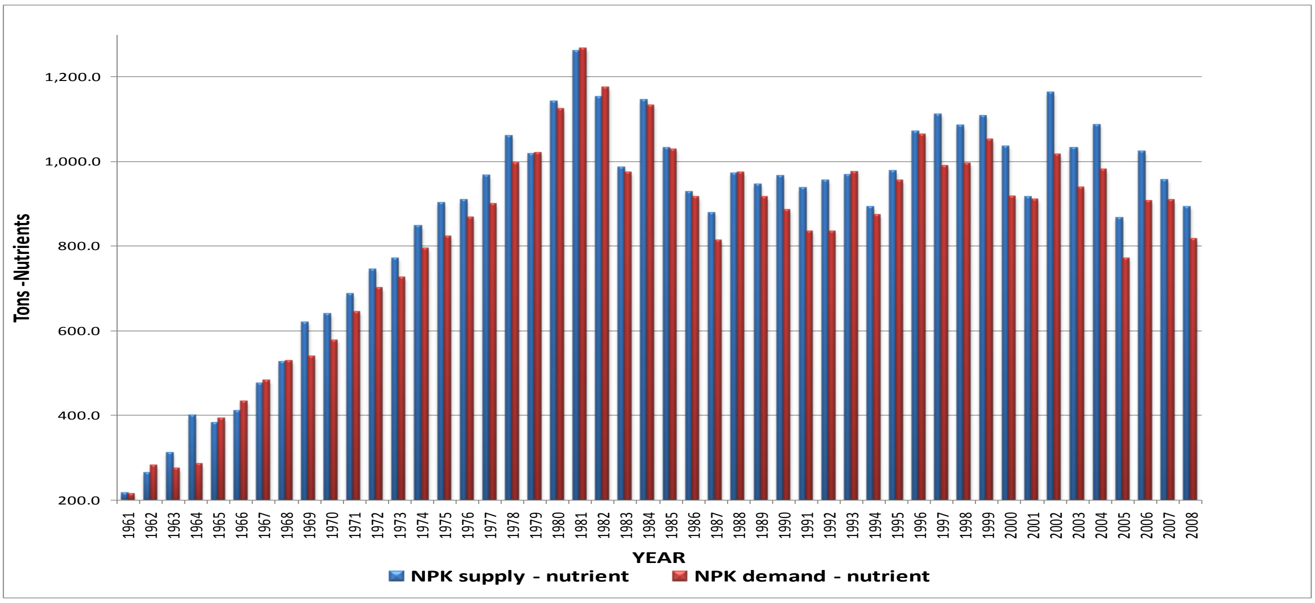

Figure 37: Supply and demand of NPK nutrients in South Africa
Source: International Fertilizer Association, 2010

3.3.1. Nitrogen

Figure 38 shows the supply and demand of nitrogen nutrients in South Africa. According to the figure, the fertiliser industry has been mostly able to provide the country's nitrogen needs through local production and imports.

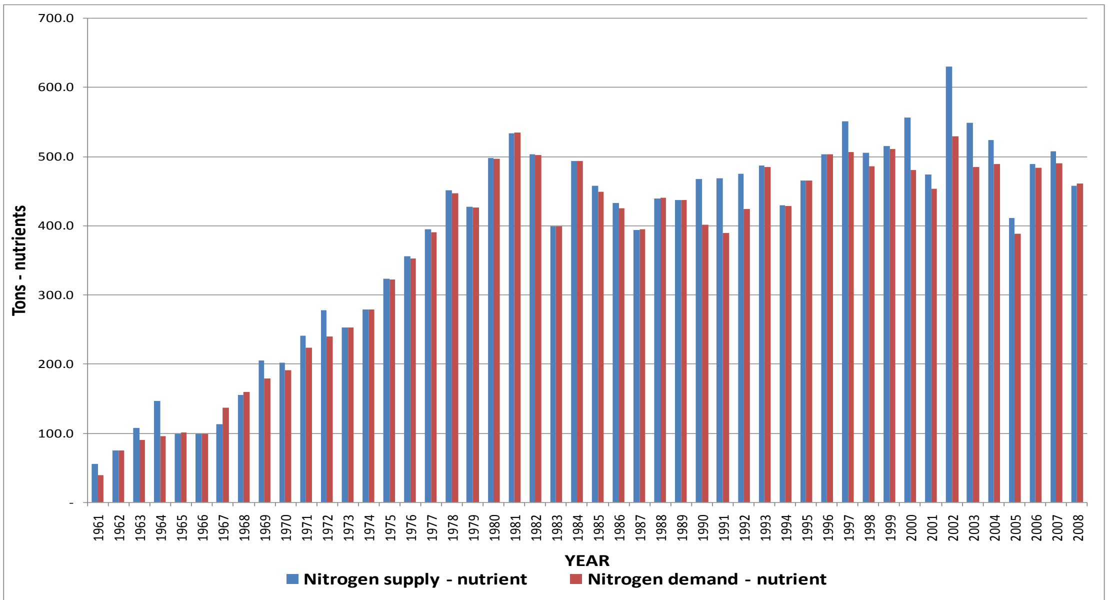

Figure 38: Supply and demand of nitrogen in South Africa – nutrient
Source: International Fertilizer Association, 2010

Figure 39 shows South Africa's dependency on imports to satisfy the country's nitrogen needs. South Africa's dependency on imports of nitrogen increased significantly in 2000, following the closure of Kynoch's urea plants at Modderfontein and Milnerton. This, together with Profert coming into the market, resulted in a significant increase in the importation of urea.

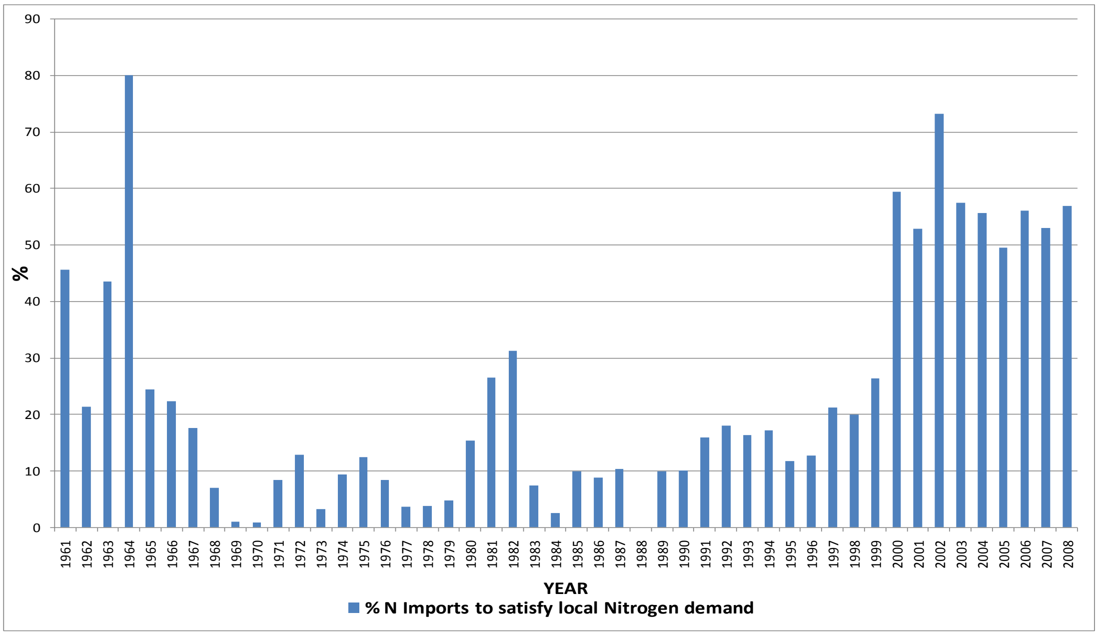

Figure 39: Percentage N imports to satisfy local nitrogen demand
Source: International Fertilizer Association, 2010

Ammonia is the main source of nitrogenous fertiliser. Sasol Ltd supplies most of the country's ammonia, with some produced by Mittal Steel (Exarro), while the rest of the ammonia demand is imported. Most of South Africa's ammonia imports come from Middle East countries such as Saudi Arabia, Kuwait, Bahrain and Oman and when exporting ammonia, it is mainly to African countries (Figure 40). According to anecdotal evidence, only Sasol and Foskor have the capacity to import ammonia – they have the facilities to handle and store ammonia, which requires very expensive infrastructure and is highly dangerous and hazardous. Omnia has 23 % shares in the Richards Bay ammonia terminal.

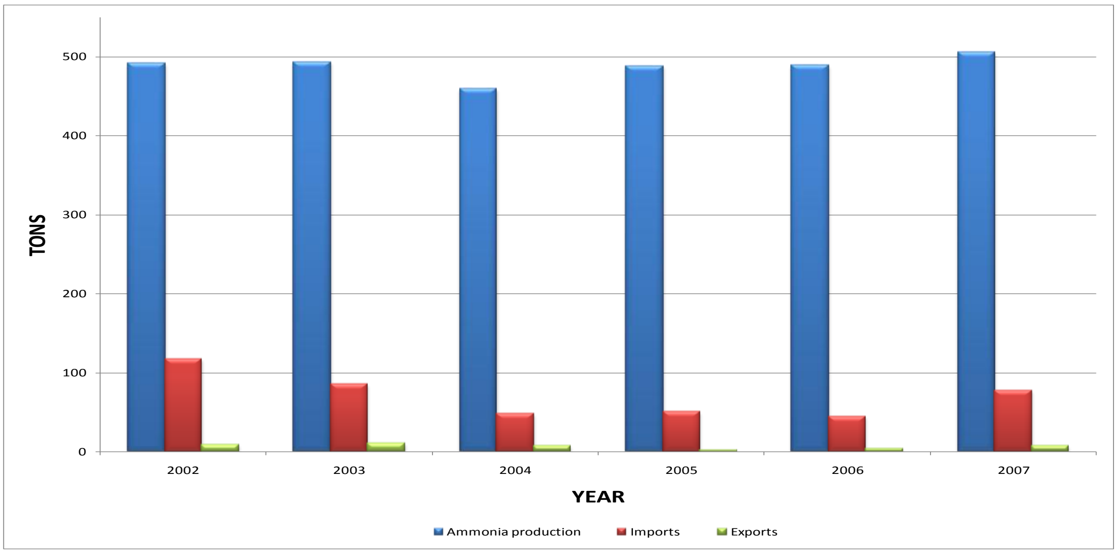

Figure 40: South African production and trade of ammonia
Source: Van der Linde, 2009

Currently, South Africa has to import all its urea needs but can completely satisfy the demand for LAN and nitrate-based fertiliser blends, which is approximately 250,000 tonnes annually (Van der Linde, 2009). The restructuring of Kynoch in 2000 resulted in the AECI-Kynoch urea plants at Modderfontein and Milnerton being closed down. This meant that South Africa had to import all its urea needs. In 1999, Senwes decided to enter the fertiliser industry and a new company, Profert, was founded. Profert focused on bulk blending which also increased the demand for urea imports. The rise in import quantities since 2000 can be seen in Figure 41. The supply and demand of urea can also be seen in Figure 42. According to Van der Linde (2008), South Africa has also became a net importer of ammonium sulphate since 2005, when Sasol closed down its 160,000 tons per annum plant.

Almost all of South Africa's urea imports come from Saudi Arabia and Qatar. In 2007, South Africa imported 57 % of its urea imports from Saudi Arabia and 41 % from Qatar.

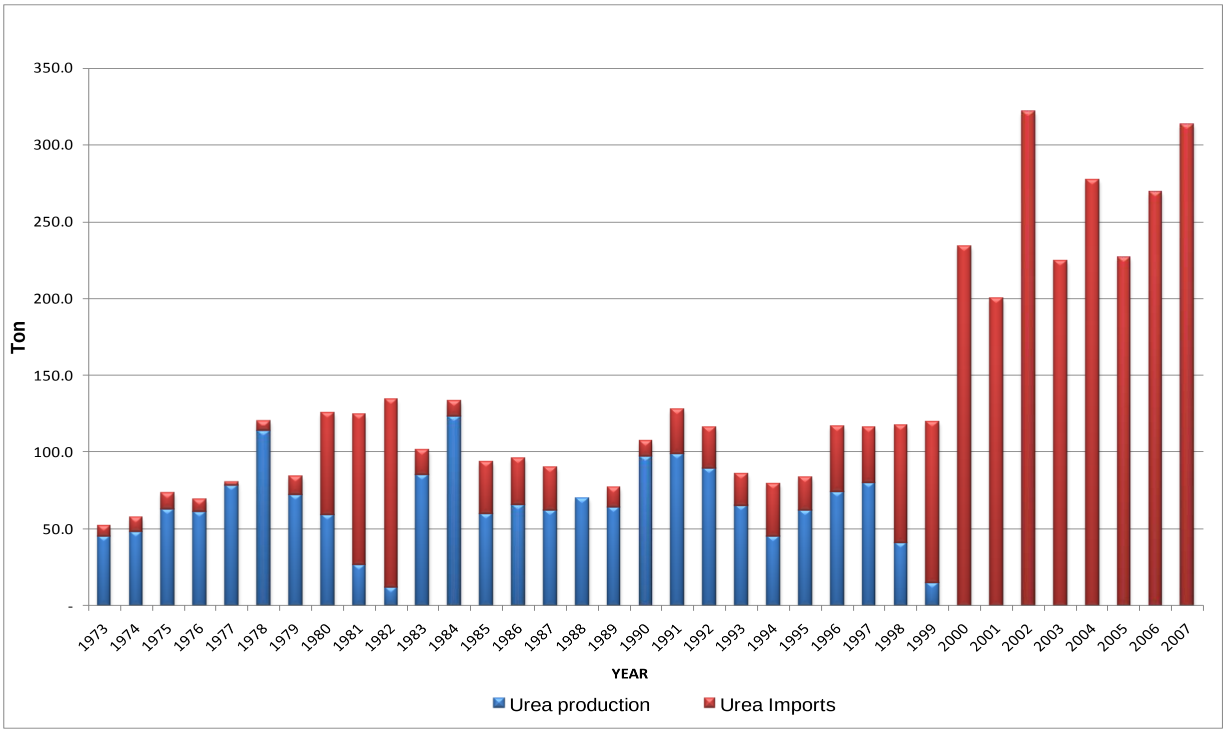

Figure 41: South African production and imports of urea
Source: International Fertilizer Association, 2009

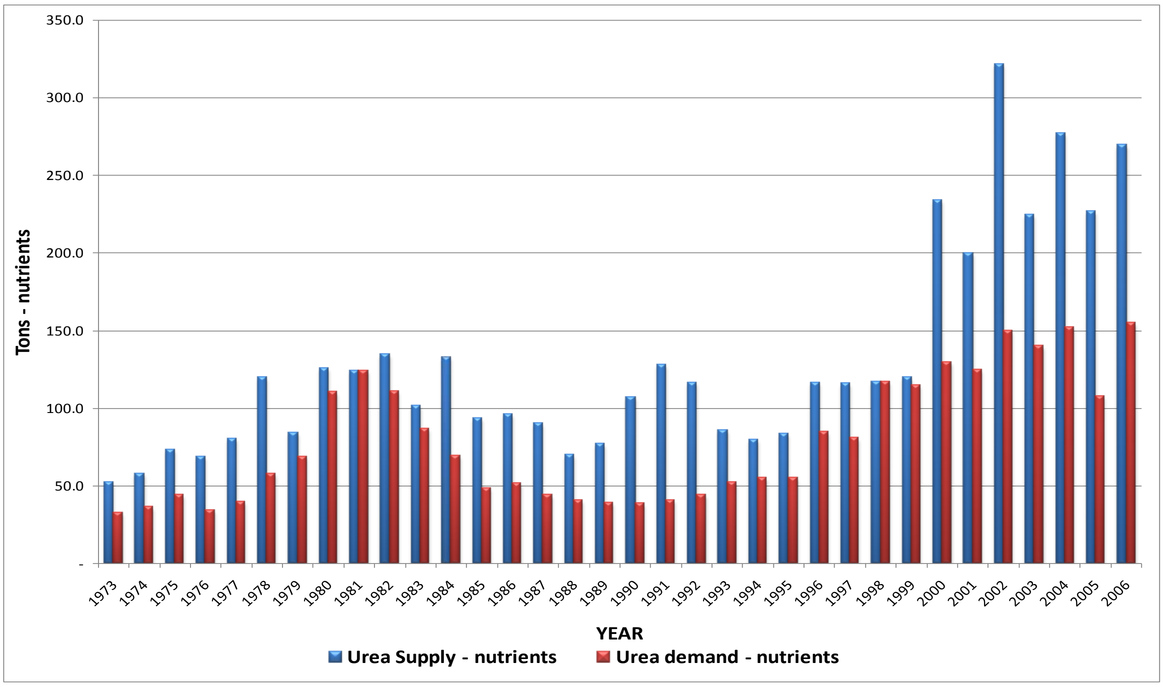

Figure 42: Supply and demand of urea in South Africa – nutrient
Source: International Fertilizer Association, 2009

3.3.2. Phosphates

Phosphates are extracted from three main types of deposits; marine phosporites, apatite-rich igneous rocks, and modern and ancient guano accumulations. Although all three types occur in South Africa, the igneous deposit at Phalaborwa is the major one currently being exploited (South African Department of Minerals and Energy, 2008). Approximately 30 countries produce phosphate rock and most commercial producers exploit sedimentary sources. However, igneous rocks containing phosphate in the form of apatite are exploited in South Africa, Brazil, Russia, Finland and Zimbabwe. Sedimentary sources are characteristically soft and cheap to mine and process, as well as being of high grade, although they often contain impurities, especially cadmium and arsenic, which are carried over into downstream products and waste products. Igneous ores are hard and low grade, but relatively free of impurities and ideally suited to froth flotation.

As discussed earlier, in South Africa, Foskor supplies phosphate concentrates to local and foreign fertiliser producers. Foskor is one of the world’s few vertically-integrated producers of phosphoric acid, with its own phosphate mining and chemical processing operations.

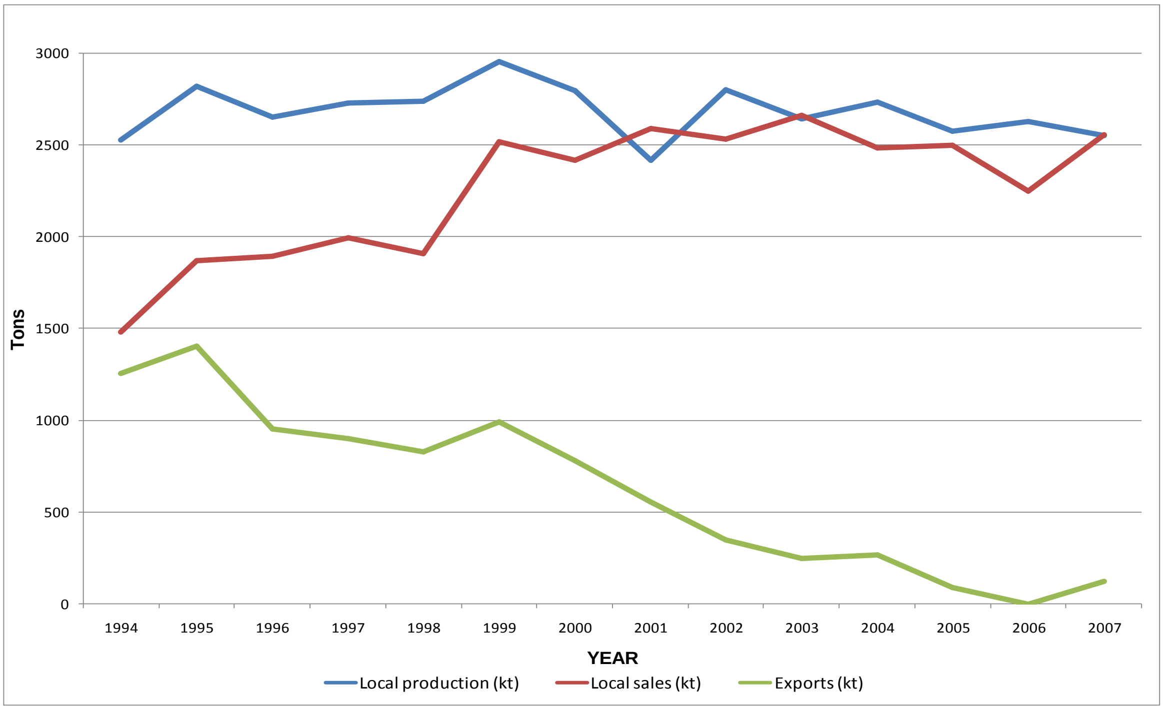

Figure 43: South Africa's production, local sales and exports of phosphate rock
Source: Directorate Mineral Economics, 2009

Figure 43 shows the South African production, local sales and exports of phosphate rock from 1994 to 2007. South Africa produces a high quality grade phosphoric rock, falling into the class of 25.7 % P_2O5 and over. When looking only at this superior (best) quality of rock, South Africa produces 11.1 % (Van der Linde, 2007) of the total rock production in this class in the world.

Figure 44 shows the production and exports of phosphoric acid in South Africa. In South Africa, Foskor is now the only producer of phosphoric acid (after Sasol and Omnia recently ceased their production). Great quantities of South Africa's production are exported, with 90 % of the phosphoric acid going to India.

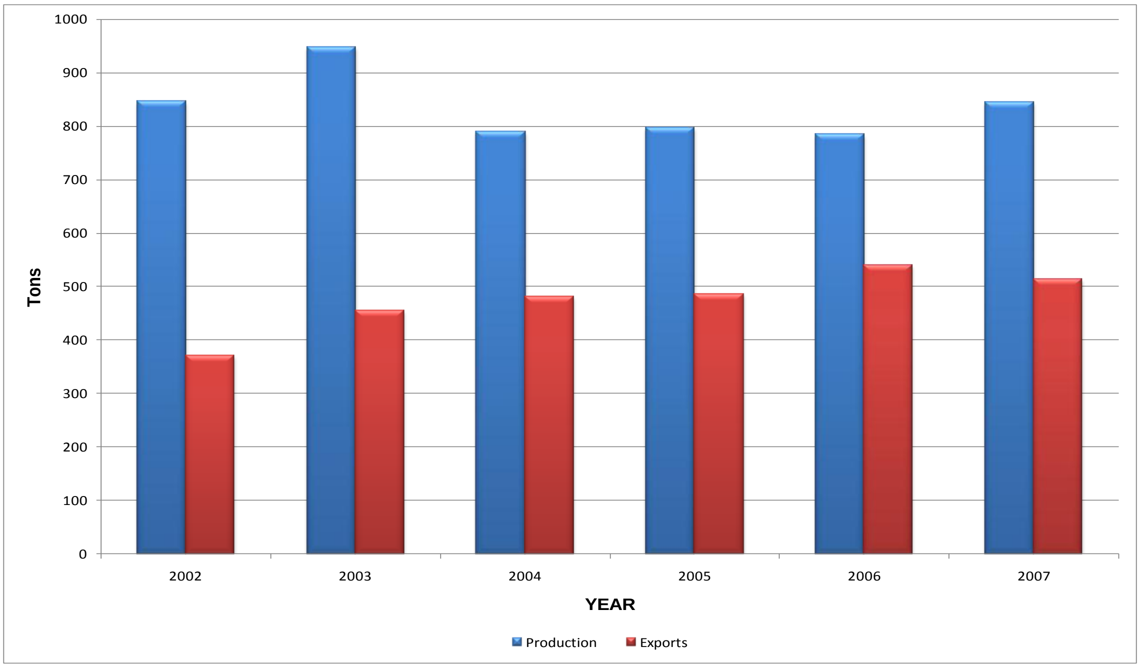

Figure 44: South African phosphoric acid production and exports – P_205
Source: Van der Linde, 2009

Figure 45 shows the supply and demand of phosphates (nutrients) in South Africa since 1961. In recent years, demand has outweighed supply two times, in 2001 and in 1996.

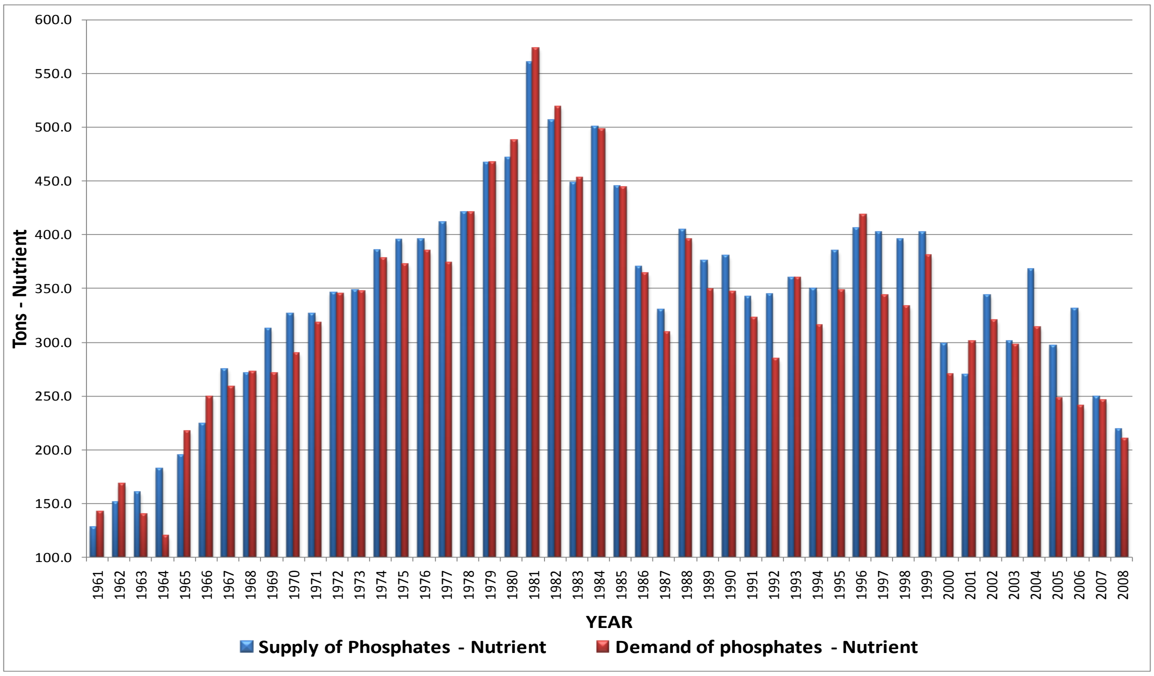

Figure 45: Supply and demand of phosphates in South Africa – nutrient
Source: International Fertilizer Association, 2010

As mentioned earlier, South Africa also has the capacity to produce intermediate phosphate fertiliser products such as MAP and DAP. Locally, Omnia and Foskor produces MAP while only Foskor produces DAP from phosphate rock concentrate. Figures 46 and 47 respectively show the South African production and trade of MAP and DAP. From the graphs, it is clear that South Africa is exporting a large amount of MAP and DAP and at the same time also importing great quantities, especially DAP. This can be ascribed to the fact that certain fertiliser companies are importing 100 % of their fertiliser demand whether it is locally available or not, and due to the fact that Foskor has decreased its production of DAP.

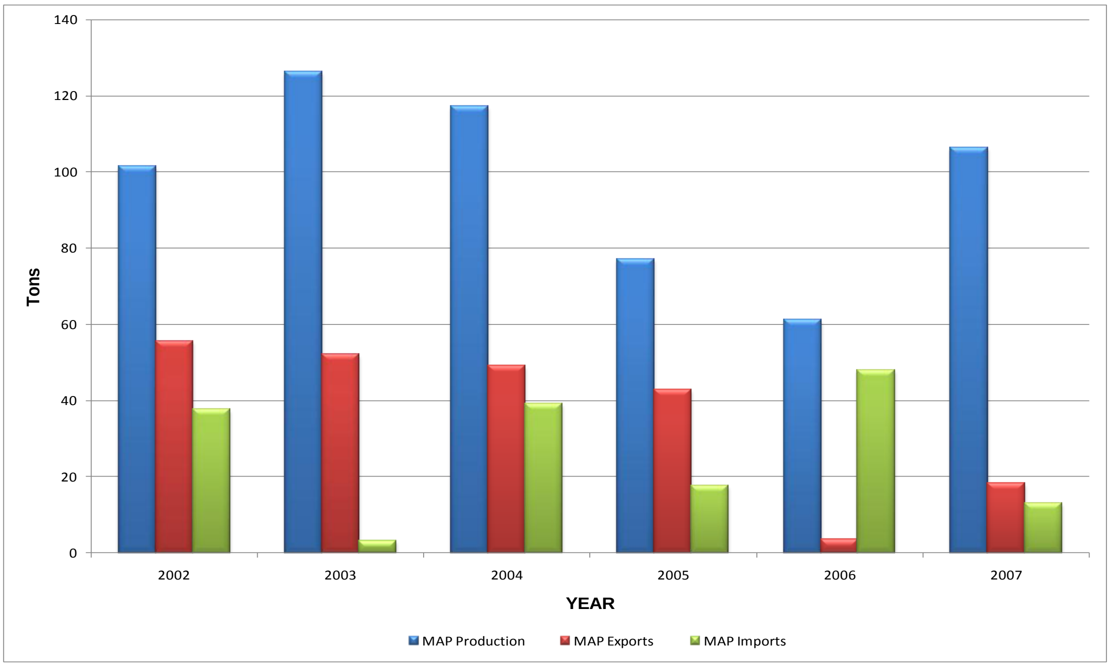

Figure 46: South African production and trade of MAP
Source: Van der Linde, 2009

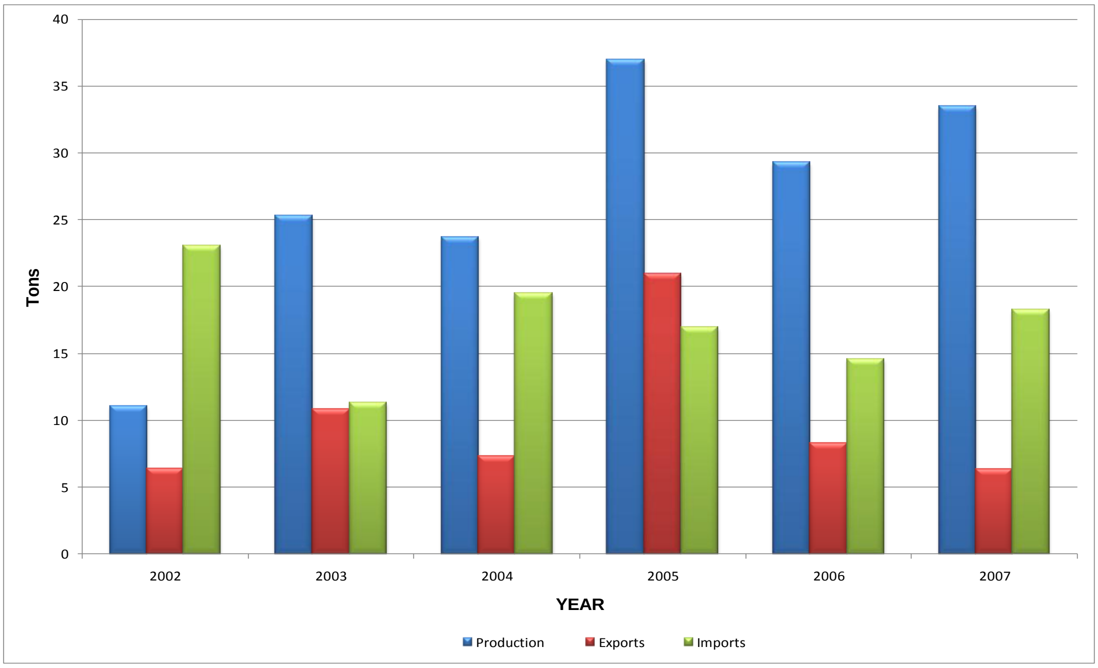

Figure 47: South African production and trade of DAP
Source: Van der Linde, 2009

3.3.3. Potassium

According to the Directorate of Mineral Economics (2008), potential sources of potash in South Africa generally contain less potassium than the ores exploited in other countries. Sources from seawater would have to be subjected to chemical treatment to render them water soluble. Phlogopite, occurring in association with vermiculite ore in the Phalaborwa complex, is the most promising potential source in South Africa, because of its relatively high (11 %) K_2O content. The material decomposes more easily than other silicate materials. To date, no source has been able to produce potassium on an economically-viable basis and therefore all South Africa's potassium requirements are imported (Figure 48). According to the FSSA (2009), South Africa has used 125,000 tons of K_2O on average, per year, over the past ten years. According to figures from the International Fertilizer Association (2009), South Africa imported 180,000 tons of K_2O on average over the past ten years, with the highest imports being 204,000 tons in 2004. Imports are mainly from Germany, Belarus, Chile, Israel and Jordan, with around 80 % of imports coming from Germany and Israel. South Africa has also exported around 25,000 tons on average, per year, over the past ten years; presumably, mainly to African countries.

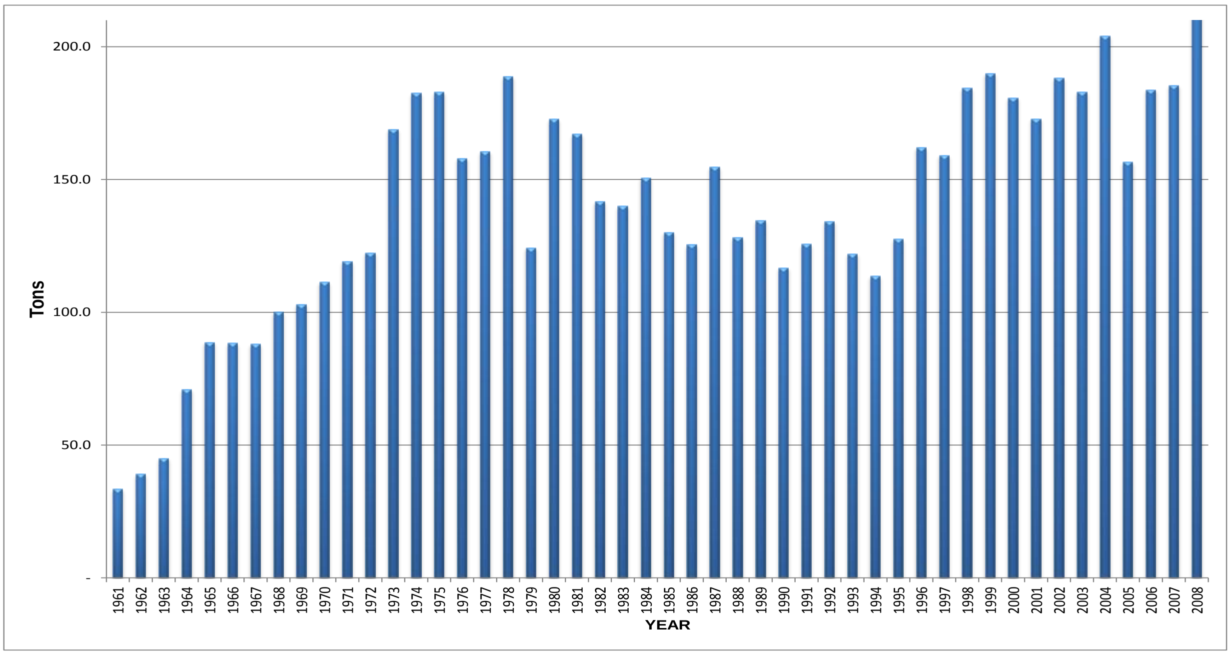

Figure 48: South African imports of potassium – K_2O
Source: International Fertilizer Association, 2010

3.4 Drivers in South African fertiliser price

All South Africa's potassium and urea needs are imported because South Africa currently has no economically feasible potassium sources, and local urea plants have been closed due to un-competitiveness against imports. Because so much of South Africa's product (raw materials and end products) needs are imported, prices in the South African fertiliser market are driven by the same drivers as in the international fertiliser market (as discussed in Chapter 2). It is expected that the most important driver in South African fertiliser prices should be international fertiliser prices. Because of the high import need of fertiliser for South Africa, the exchange rate will also have an important role in determining local fertiliser prices.

For materials that are locally produced, both local and international drivers will have an influence on prices. Imported materials are also subjected to local factors after they have landed at a local harbour. Drivers that affect the prices of materials that are locally manufactured are the international price of ammonia, the international prices of phosphate rock, phosphoric acid, MAP/DAP prices and international sulphur prices.

In both imported and locally produced materials, the South African transport system plays a pivotal role in the forming of local fertiliser prices. Especially for imported materials, the capacity problems and the logistics in the harbour ports play a role in the local fertiliser price structure. In certain products, such as phosphate rock and phosphoric acid, supply and demand in the local industry also plays a role because South Africa is currently a net exporter of these products.

3.4.1 Correlation between international and local fertiliser prices

Because South Africa is so dependent on fertiliser imports, it is expected that local fertiliser prices and international fertiliser prices should be closely related due to the fact that the raw imported material should contribute a large share to the final “farm gate” fertiliser price. With correlation calculations, the strength and direction of the relationship between local and international fertiliser prices can be determined. Correlation coefficients generally take values between -1 and +1. A positive value implies a positive association while a negative value implies a negative association. A coefficient of -1 means the variables are perfectly negatively related; while +1 means a perfectly positive relation. If there is, for example, a correlation between “a” and “b”, four possible conclusions can be made: 1) “a” is caused by “b”; 2) “b” is caused by “a”; 3) both “a” and “b” are caused by a third factor; or 4) the correlation is a coincidence.

In this case where international (b) and local (a) fertiliser prices are compared, numbers 1) and 3) are likely to apply due to the fact that South Africa is so dependent on fertiliser imports. It will thus be either international prices that affect local prices or an external factor that affects both.

Table 3 shows the international and local price comparisons that were used for the correlation calculations.

Table 3: Price comparisons used for correlations

Prices compared in correlations	
International ammonia price (fob Middle East)	Local LAN price (average pricelist price)
International urea price (fob Eastern Europe)	Local urea price (average pricelist price)
International DAP price (fob US Gulf)	Local urea price (average pricelist price)
International potassium chloride price (fob CIS)	Local potassium chloride (average pricelist price)

From the graphs below, it is evident that the gaps between international and local fertiliser prices increased after 2008. This occurrence is further investigated in Chapter 4.

International ammonia and local LAN

The local limestone ammonium nitrate (LAN) price is compared with the international ammonia price, because local ammonia prices are not frequently available. From Figure 49, the movement of the international ammonia price (free on board (fob) in the Middle East) in Rand terms together with the local LAN price can be seen. When comparing month-on-month prices (for example January international with January local), the correlation between the international ammonia price and the local LAN price is +0.87. This correlation is relatively good, given the fact that ammonia is compared to LAN. The correlation (+0.90) between the international ammonia price and the local LAN price is even better when the international price is compared with the local price of a month later (for example January international with February local), because it is generally excepted that it takes four to six weeks for a fertiliser consignment to reach South Africa.

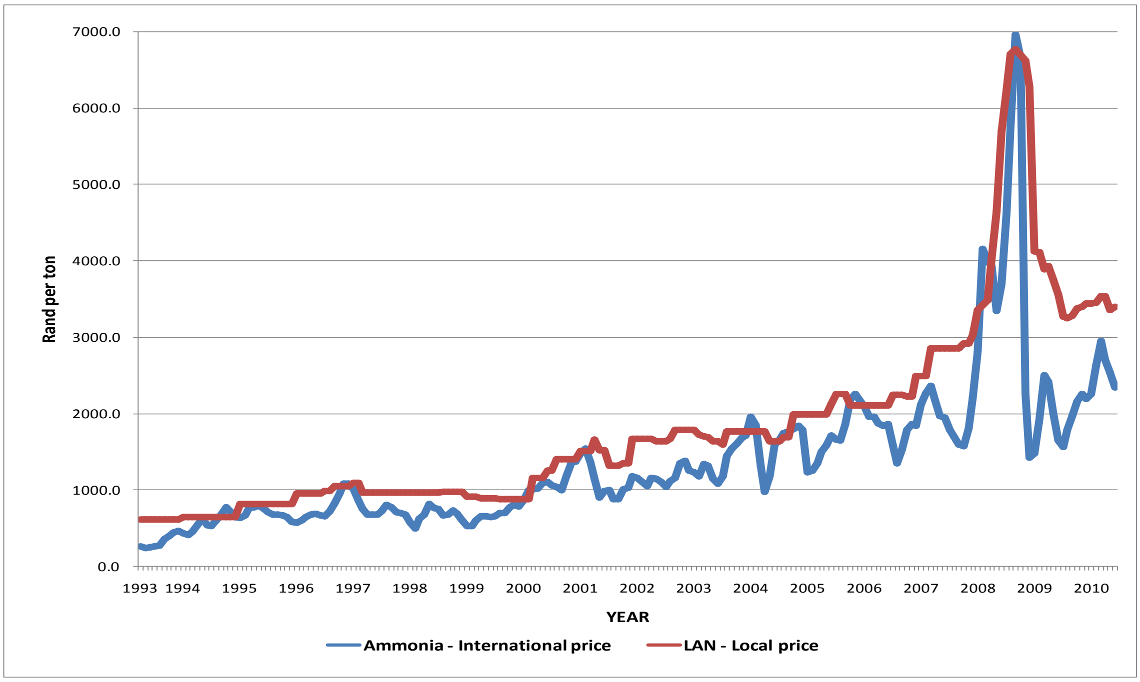

Figure 49: International ammonia price and local LAN price in Rand terms
Source: Grain SA, 2010

International and local urea price

The international urea price in Eastern Europe (fob) in Rand terms was compared to the local urea price (average pricelist price) to determine the correlation between local and international urea prices. When month-on-month prices are compared, there is a +0.93 correlation between the international and local urea price, while the correlation compared to the local price a month later is +0.97. This is an indication that there is a very good correlation between the international and local urea price. From Figure 50, the movement of the international and local fertiliser prices in Rand terms can be seen.

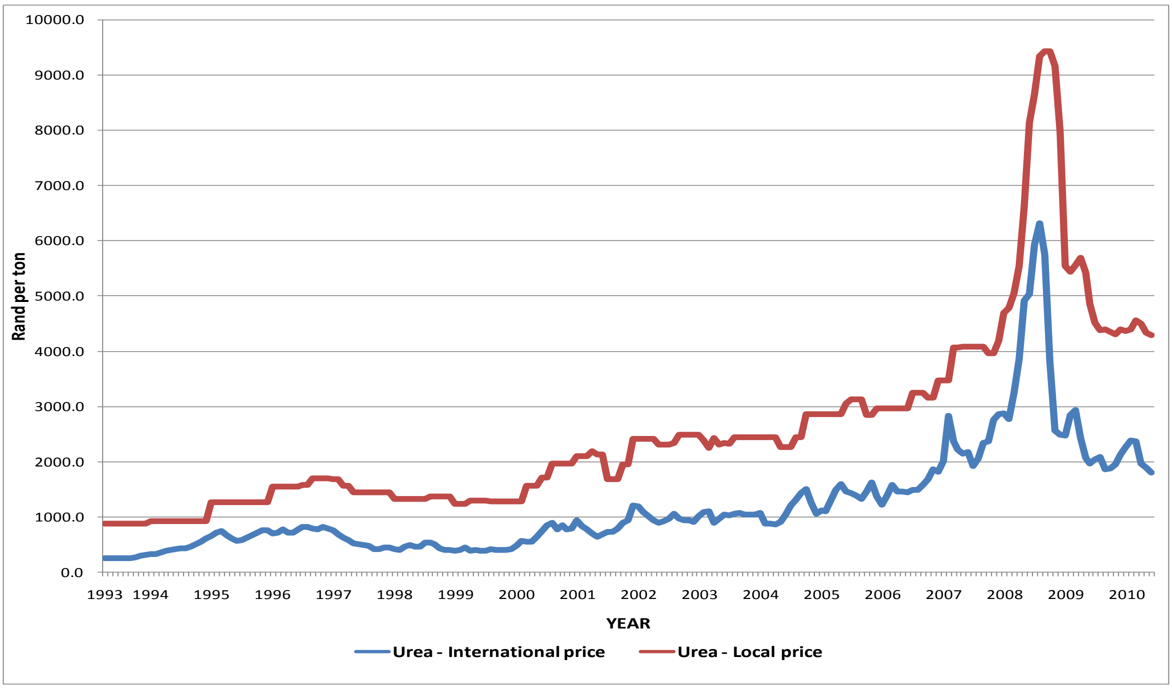

Figure 50: International and local urea price in Rand terms
Source: Grain SA, 2010

International DAP price and the local MAP price

Figure 51 shows the movement between the international Di-Ammonium Phosphate (DAP) price and local the local Mono-Ammonium Phosphate (MAP) price. It is generally known that international DAP and MAP prices are exactly the same. When comparing month-on-month prices, the international DAP price (fob in the US Gulf) and the local MAP price have a +0.97 correlation; while when comparing the international price with the local price a month later, the correlation is +0.99.

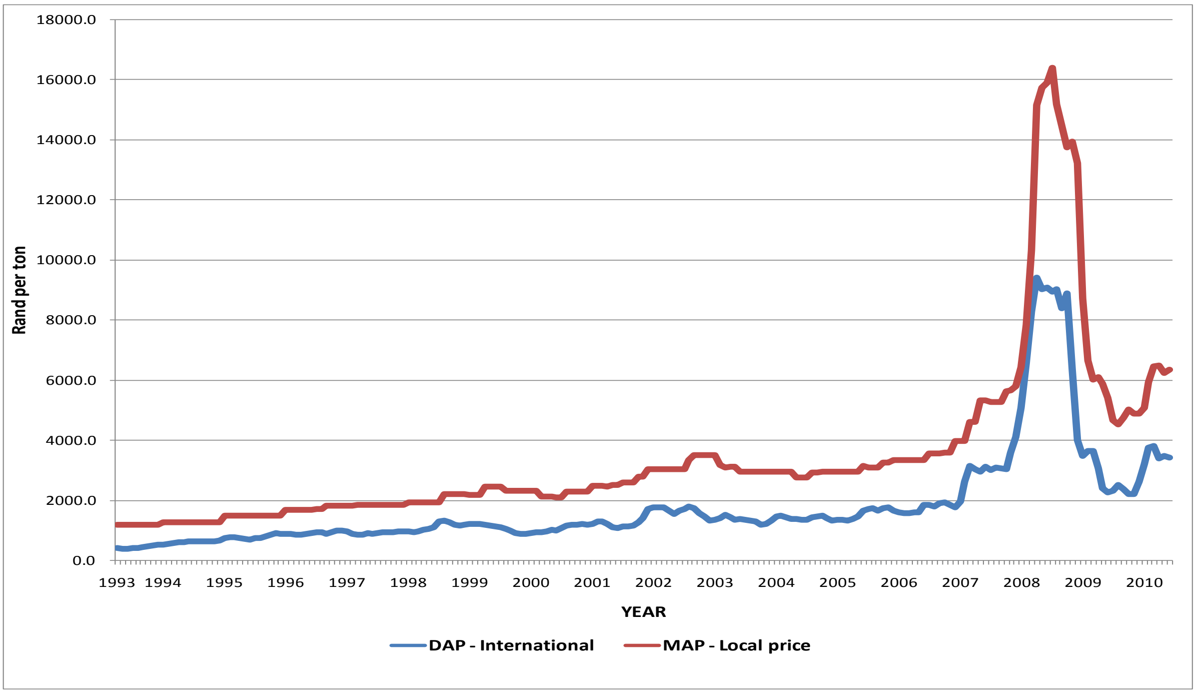

Figure 51: International DAP price and local MAP price in Rand terms
Source: Grain SA, 2010

International and local potassium chloride price

Figure 52 shows the trend in the international (fob CIS) and local potassium chloride prices since 1993. When comparing month-on-month prices, international and local potassium prices have a correlation of +0.97. The correlation, when comparing the international price with the local price of a month later, is exactly the same.

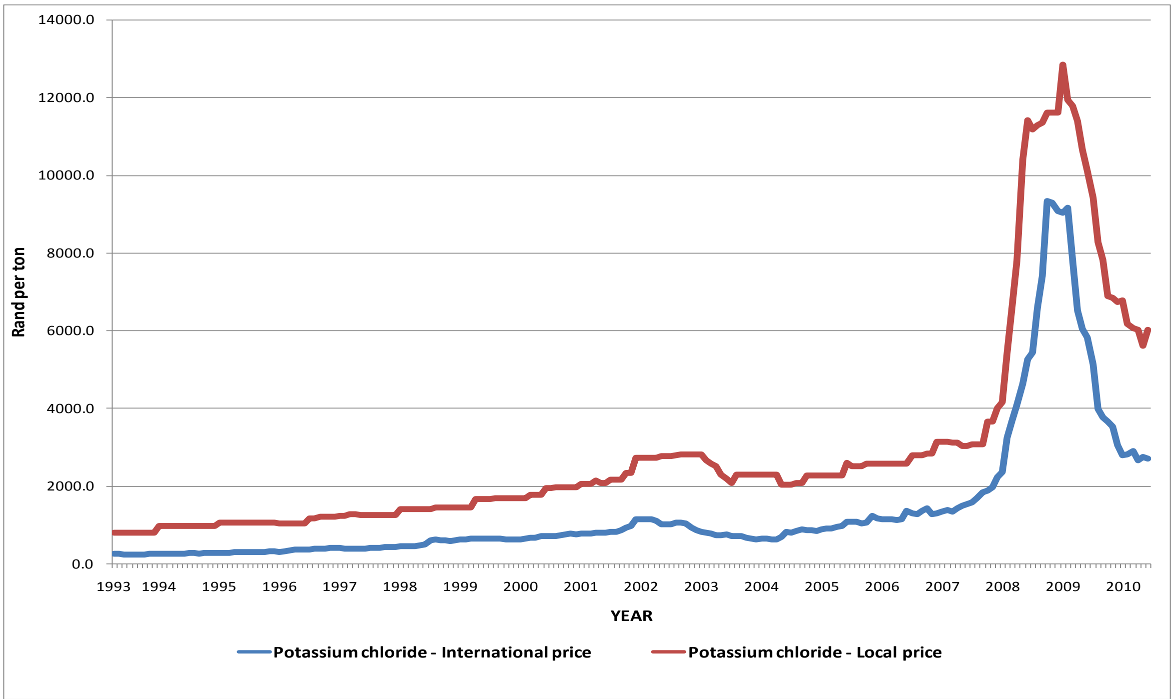

Figure 52: International and local price of potassium chloride in Rand terms
Source: Grain SA, 2010

3.5 Margins, costs and cost distribution (price structure / decomposition)

Margins and cost items that contribute to form South African fertiliser prices are very difficult to determine. The only way to determine the cost contributions that make up the final fertiliser price that the grain producer pays is to work with an import parity price calculation. To calculate the composition of the final fertiliser price, all costs need to be added to a quoted international-based fertiliser price.

The typical added cost items to determine a South African imported fertiliser price are summarised in the following table:

Table 4: Import parity price calculation

International fertiliser price at a specific basis point **– raw material price ($/ton)**
+ **Freight rate** to get those material to a harbour in South Africa **($/ton)**
+ **Insurance (% of $/ton)**
= Cost, insurance and freight **(CIF) ($/ton)**
x **Exchange rate**
+ **Financing cost (Rand/ton)**
+ **Discharging costs:** Durban **(Rand/ton)**
+ **Import tariff (Rand/ton) –** currently zero
= **FOR at Durban (Rand/ton)**
+ **Transport costs** to a central point in the inland (Potchefstroom) **(Rand/ton)**
+ **Stock losses (% of FOR at Durban)**
= **FOR at Potchefstroom (Rand/ton)**
+ **Admin cost** (% of FOR at Potchefstroom) **(Rand/ton)**
+ **Marketing cost** (% of FOR at Potchefstroom) **(Rand/ton)**
+ **Packaging** (% of FOR at Potchefstroom) **(Rand/ton)**
+ **Bad debt** (% of FOR at Potchefstroom) **(Rand/ton)**
+ **Claims** (% of FOR at Potchefstroom) **(Rand/ton)**
= **Final product price** in Potchefstroom

The difference between this calculated price and the price that the grain producer pays for the fertiliser can be interpreted as the margin taken by the fertiliser company. Final prices that grain producers pay for fertiliser are extremely difficult to get hold of on a continuous basis and for this reason, fertiliser list prices of companies are used to calculate the average price that producers paid for their fertiliser. Industry sources indicated that fertiliser companies, on average, give grain producers a discount of 12 % on the fertiliser pricelists. Thus, by subtracting 12 % from the list prices of fertiliser companies, one would obtain a better idea of the margins[3] of fertiliser companies. As every company has its own cost and discount structures, it still remains difficult to interpret this margin as a pure profit margin.

- **Calculated composition of the South African urea price**

As mentioned above, all of South Africa's urea needs are imported. Figure 53 shows the calculated composition of the South African urea price in Rand terms. From this graph, the final price variations over time can be seen as well as the variation in the costs that make up this price.

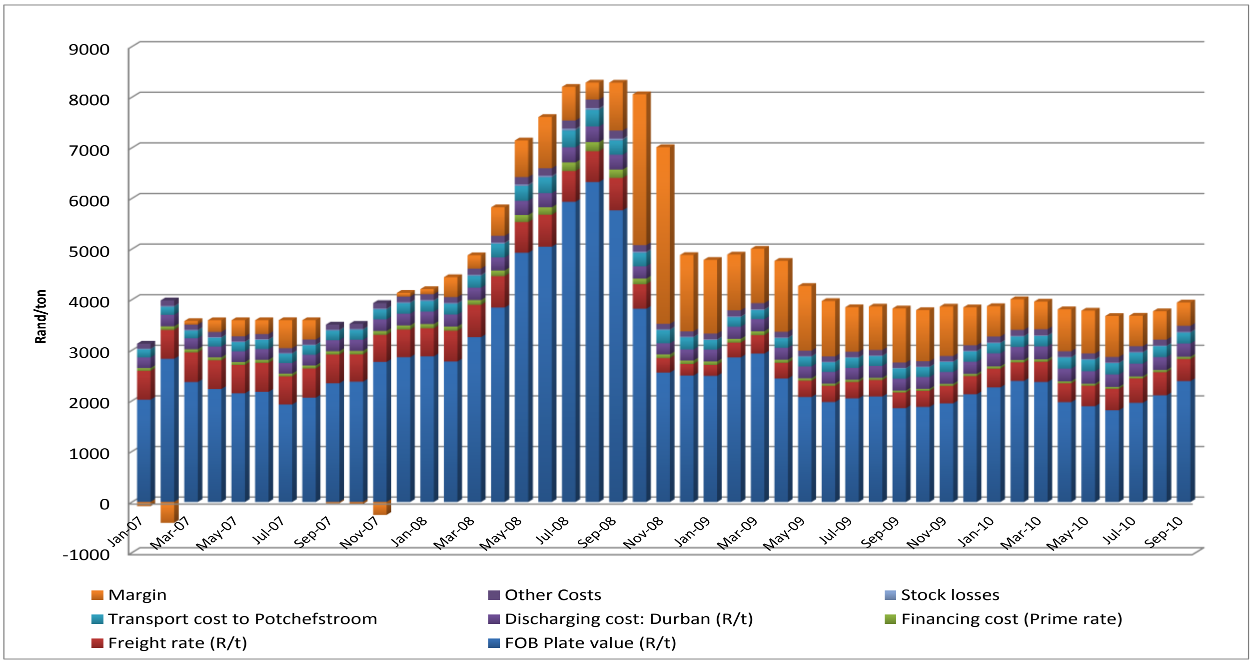

Figure 53: Calculated composition of the South African urea price in Rand terms
Source: Grain SA, 2010

Figure 54 shows the percentage contribution of each cost item to the urea price (without discount) being paid in South Africa. Calculated from price statistics since 2004, the urea basis price (international price at a specific basis) contributed on average 50 % to the price reported on local fertiliser companies' pricelists. On average, freight rates contributed 9 % to this price, while insurance, financing cost, stock losses, discharging costs and others contributed 8 % to the urea price of fertiliser companies reported on pricelists. The transport costs to the inland on average contributed 4 %. The average calculated margin, which is the difference between the list price and the landed price, was 27 % since 2004.

[3] Although as many costs as possible were included in the calculation, it remains difficult to interpret margins as a pure profit margin – for this reason the report only refers to "margins".

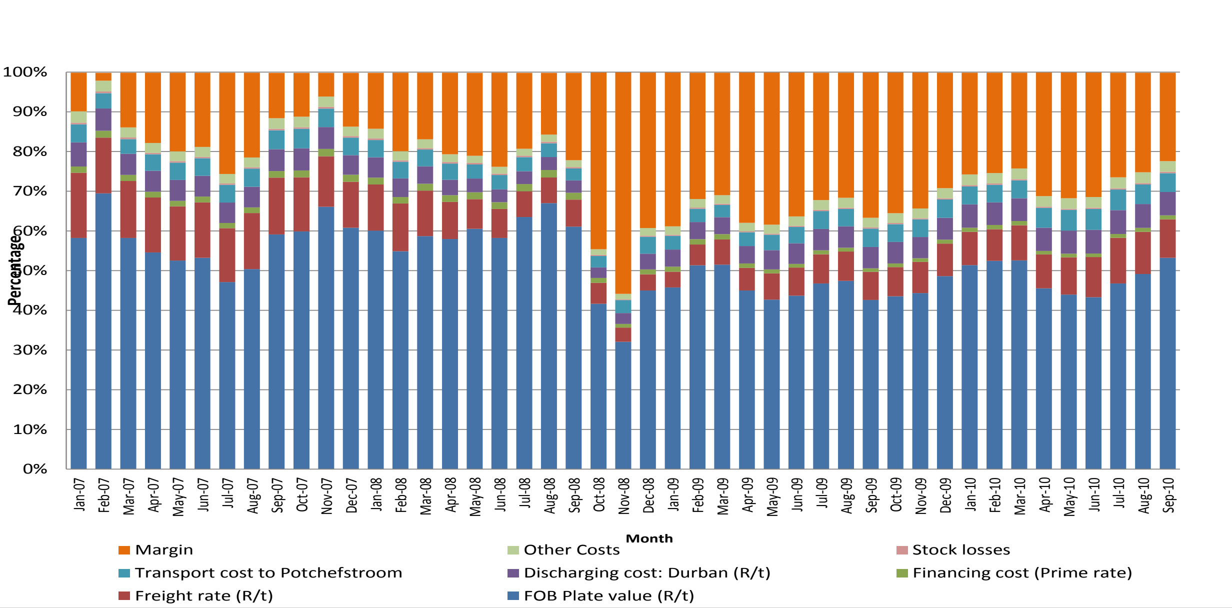

Figure 54: Composition of South African urea price (discount excluded) – % contribution
Source: Grain SA, 2010

Figure 55 shows the percentage contribution of each cost item to the urea price where an average discount of 12 % has been considered. With the discount considered, the contribution of the basis price of urea contributes 56 % on average since 2004, while the calculated margin is now 17 % on average.

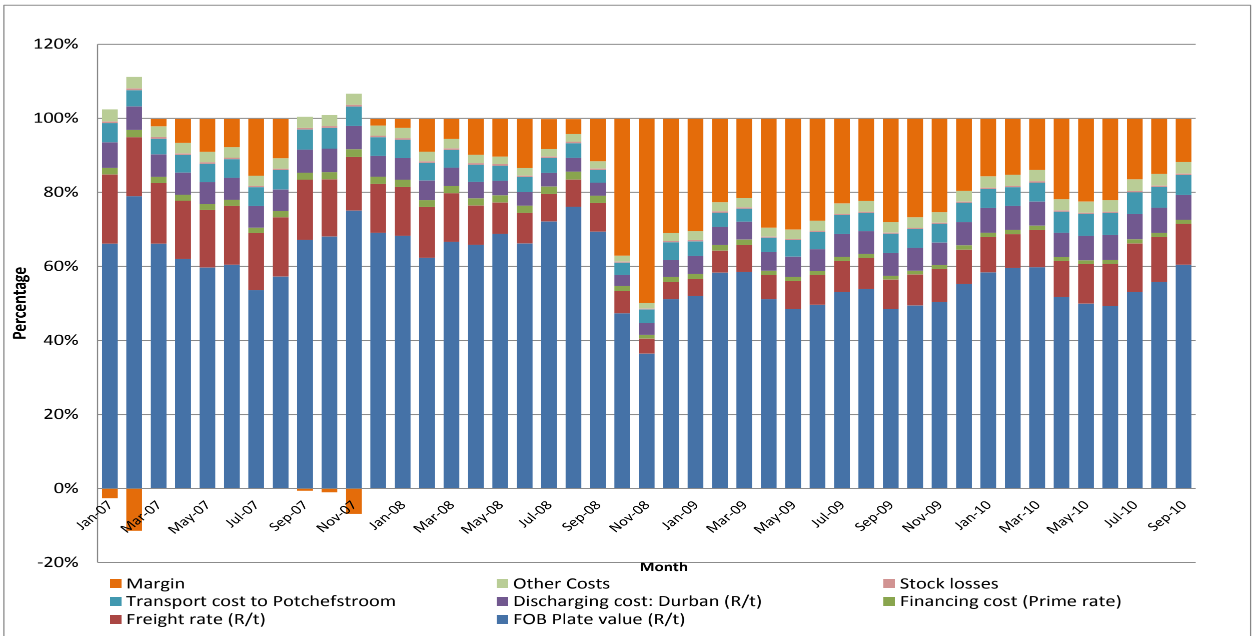

Figure 55: Composition of South African urea price (discount included) – % contribution
Source: Grain SA, 2010

- **Calculated composition of the South African DAP price**

Figure 56 shows the calculated composition of the South African DAP price in Rand terms. From this graph, the price variations over time can be seen as well as the variation in the costs that make up this price. Although in South Africa mostly MAP is used, it is generally accepted that the price of DAP and MAP is the same.

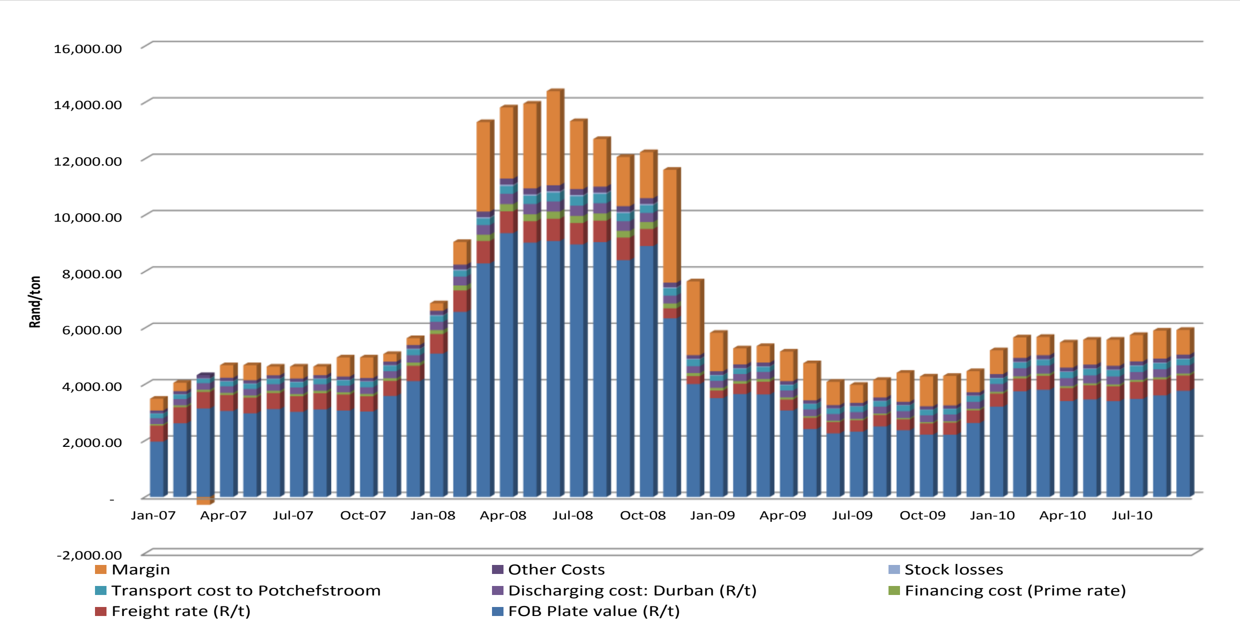

Figure 56: Calculated composition of the South African DAP – price in Rand terms
Source: Grain SA, 2010

Figure 57 shows the percentage contributions of each cost item to the DAP price (without discounts) being paid in South Africa. Calculated from price statistics since 2004, the DAP basis price (international price at a specific basis) contributed on average 53 % to the price reported on local fertiliser companies' pricelists. On average, freight rates contributed 8 % to this price, while insurance, financing cost, discharging costs, stock losses and other costs together contributed 8 % to the DAP price of fertiliser companies reported on pricelists. Transport costs to the inland on average contributed 4 %. The difference (margin) between the list price of DAP and the calculated landed price is 27 %.

Figure 58 shows the percentage contributions of each cost item to the DAP price where discounts have been considered. With a discount of 12 % considered, the contribution of the raw material to the price of MAP is 60 %, while the contribution of freight rate costs rise to 9 %. The calculated average margin since 2004 is now 17 %.

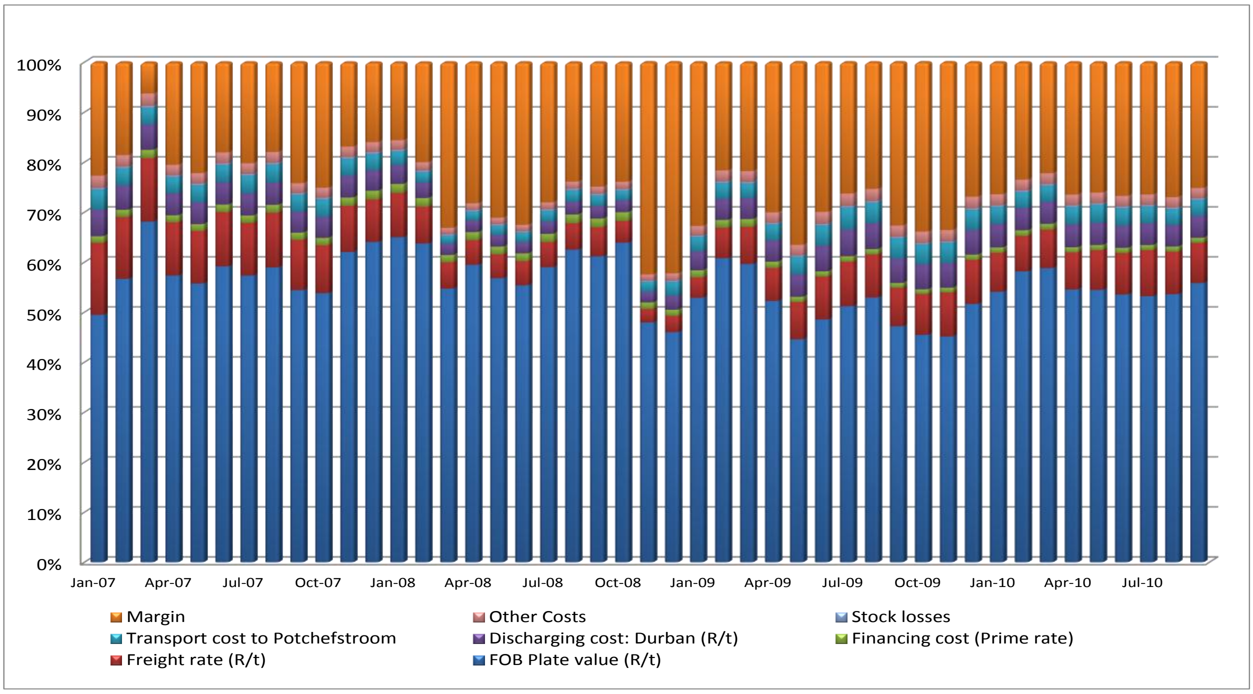

Figure 57: Composition of South African DAP price (discount excluded) – % contribution
Source: Grain SA, 2010

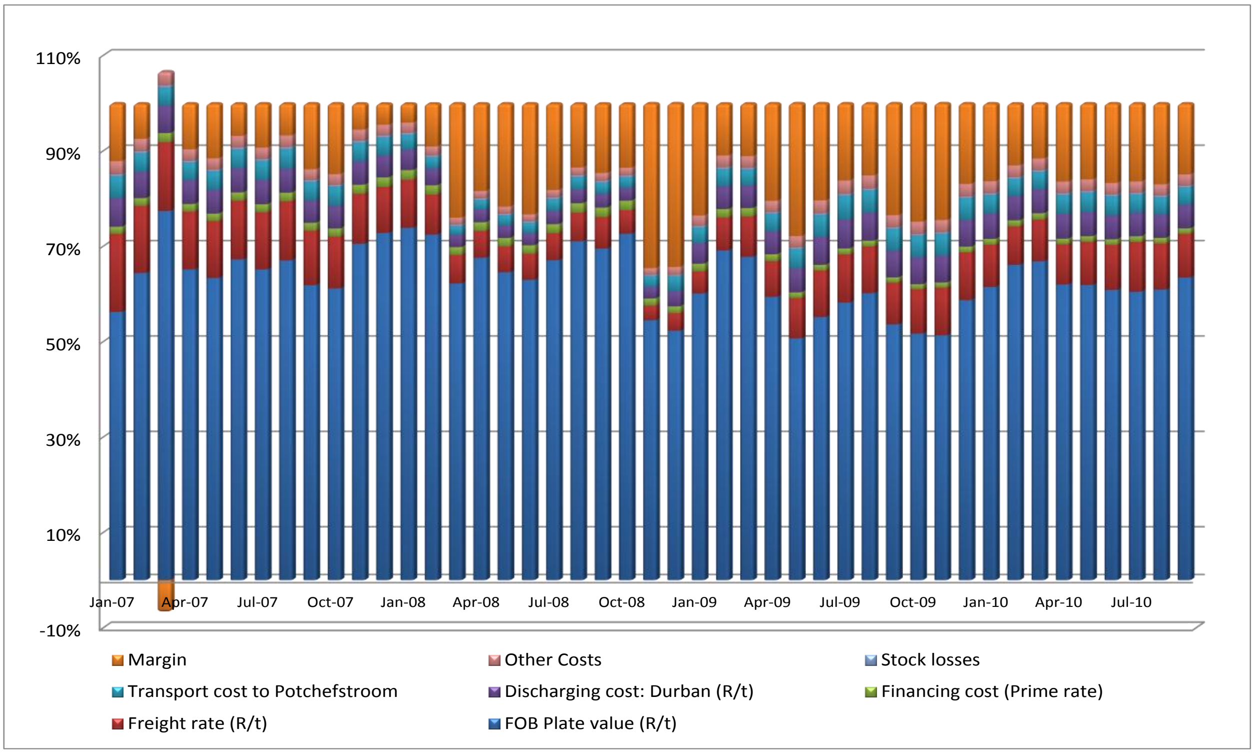

Figure 58: Composition of South African DAP price (discount included) – % contribution
Source: Grain SA, 2010

- **Calculated composition of the South African potassium chloride price**

All of South Africa's potassium chloride (KCL) is imported. Figure 59 shows the calculated composition of the South African KCL price in Rand terms. From this graph, the final price variations over time can be seen as well as the variation in the costs that make up this price.

Figure 60 shows the percentage contributions of each cost item to the KCL price being paid in South Africa without discounts being considered. Calculated from price statistics since 2004, the KCL basis price (international price at a specific basis) contributed on average 47% to the price reported on local fertiliser companies' pricelists. On average, freight rates contributed 8% to this price, while insurance, financing cost, discharging costs, stock losses and others together, contributed 10 % to the KCL price of fertiliser companies reported on pricelists. Transport costs to the inland on average contributed 4%. The difference (margin) between the list price of KCL and the calculated landed price is 30%.

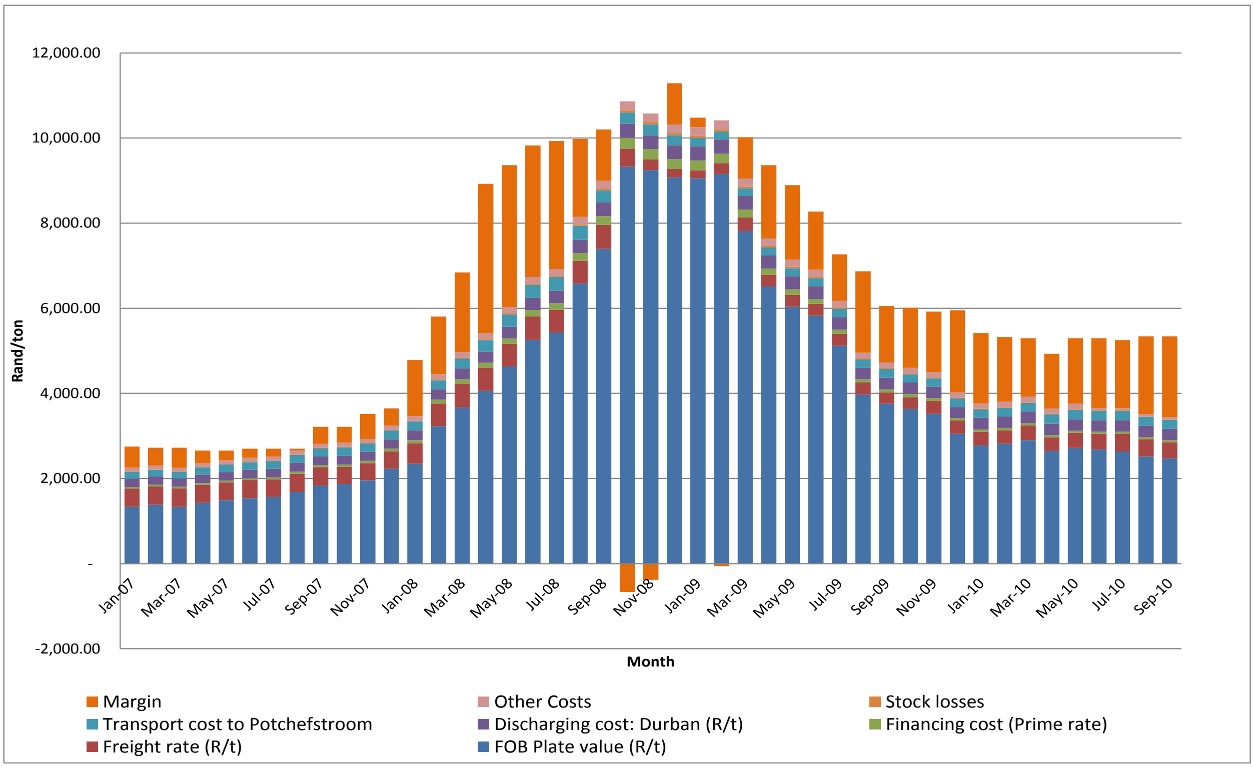

Figure 59: Calculated composition of South African KCL – price in Rand terms
Source: Grain SA, 2010

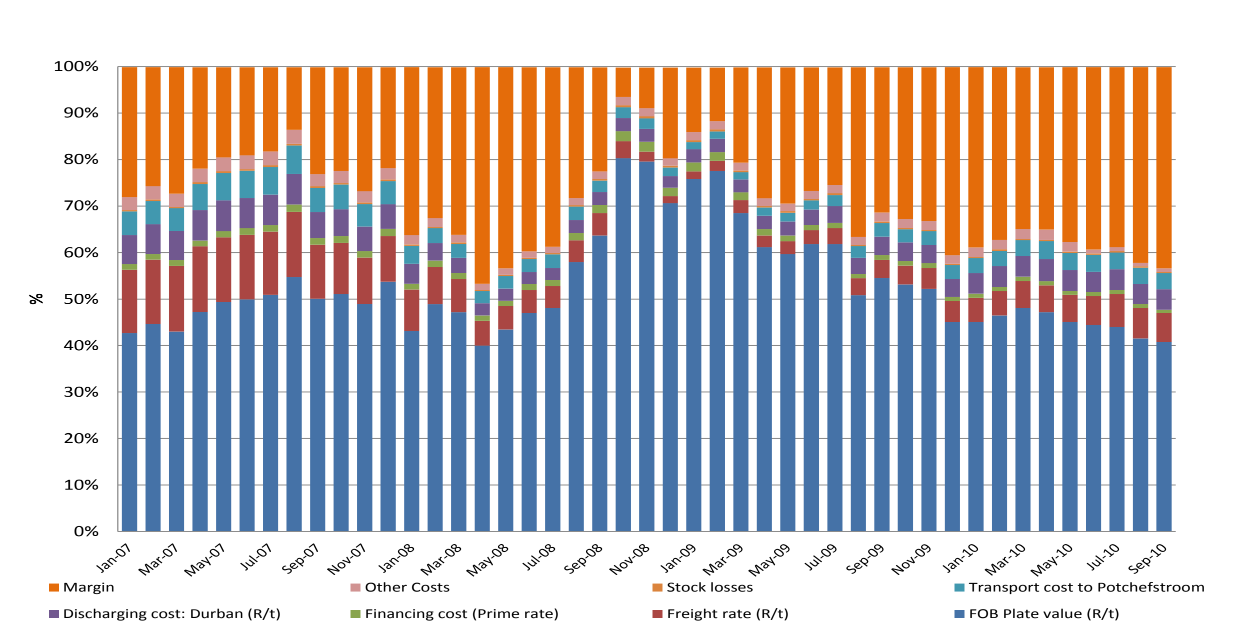

Figure 60: Composition of South African KCL price (discount excluded) – % contribution
Source: Grain SA, 2010

Figure 61 shows the percentage contributions of each cost item to the KCL price where discounts have been considered. With a discount of 12 % considered, the contribution of the raw material to the price of KCL is 60 %, while the contribution of freight rate costs rise to 10 %. The calculated average margin since 2004 is now 21 %.

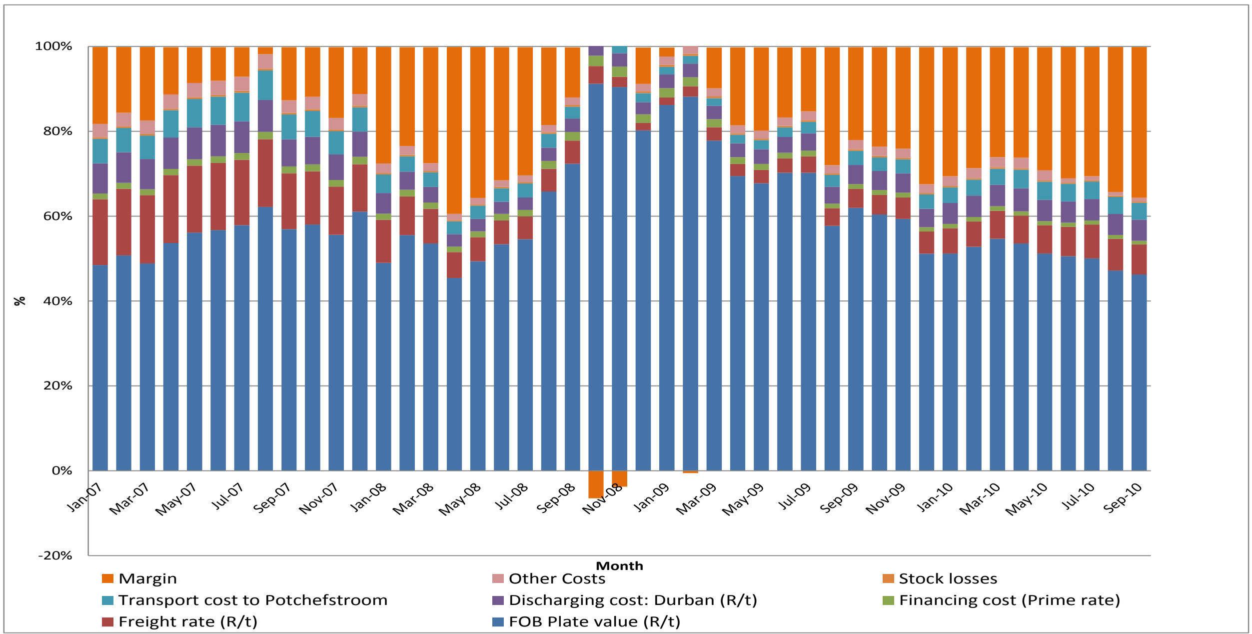

Figure 61: Composition of South African KCL price (discount included) – % contribution
Source: Grain SA, 2010

Calculated composition of the South African Limestone Ammonium Nitrate (LAN) price

South Africa provides in all its LAN (28) needs, although some is imported for use in coastal regions, where it is cheaper to import than to transport the LAN from the inland. Because of the fact that through Sasol, South Africa has the ability to produce large quantities of LAN from its production of ammonia, it is expected that the local price of LAN would be highly competitive with imports in terms of price.

Figure 62 shows the calculated composition of the South African LAN price in Rand terms. From this graph, the final price variations over time can be seen as well as the variation in the costs that make up this price. It is clear that in many occasions, the margin goes into the negative, which means that in these specific months, the LAN list price was lower than the calculated import parity price, verifying the expectations we had earlier.

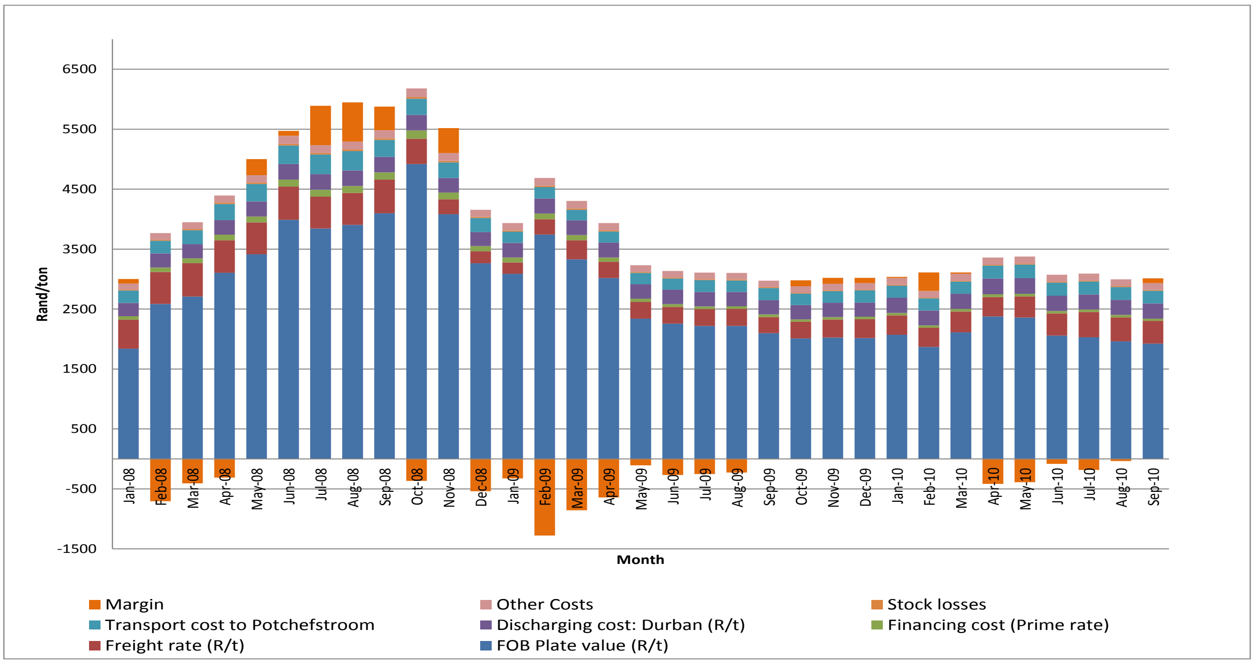

Figure 62: Calculated composition of South African LAN (28) – price in Rand terms
Source: Grain SA, 2010

Figure 63 shows the percentage contributions of each cost item to the LAN price being paid in South Africa without discounts being considered. No international quoted prices could be found, and so physical imported prices were used in the calculation, as imported through the Durban harbour. The difference between the average list price of LAN since 2008 and the calculated landed price is 8 %. It remains an interesting occurrence that the list prices are on average 8 % higher than import parity prices. In theory, the price of a locally-produced product such as LAN should not be higher than that of the import parity price – it would make local LAN uncompetitive and competitive companies would start importing. This could mean that LAN producers have large discounts on the list prices; or it could point to market structure barriers.

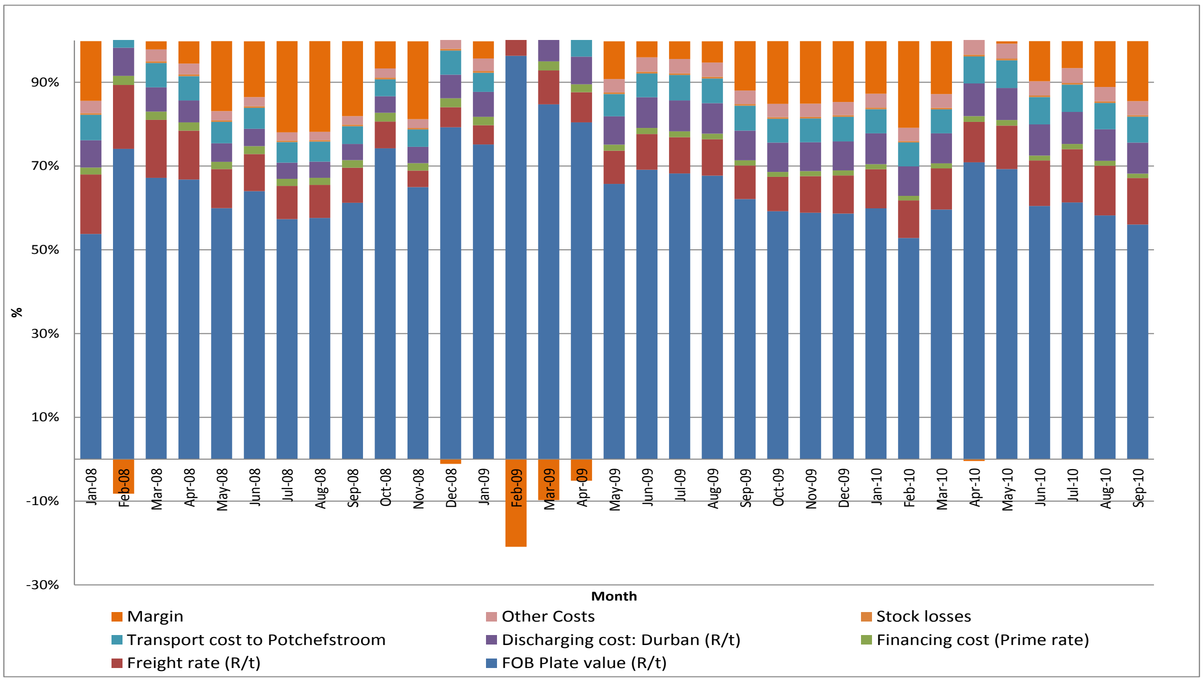

Figure 63: Composition of South African LAN price (discount excluded) – % contribution
Source: Grain SA, 2010

Figure 64 shows the percentage contributions of each cost item to the LAN price where discounts have been considered. With a discount of 12 % considered, the average margin became negative (-5 %). These results were expected as the local LAN production / product needs to compete with imports. In this case, it is difficult to determine the cost or price structure of the local industry because South Africa can produce its own LAN via Sasol's local ammonia production. This means that no matter what the physical costs of producing LAN, local companies would be able to set prices on levels just below the cost of import LAN, and would still remain competitive.

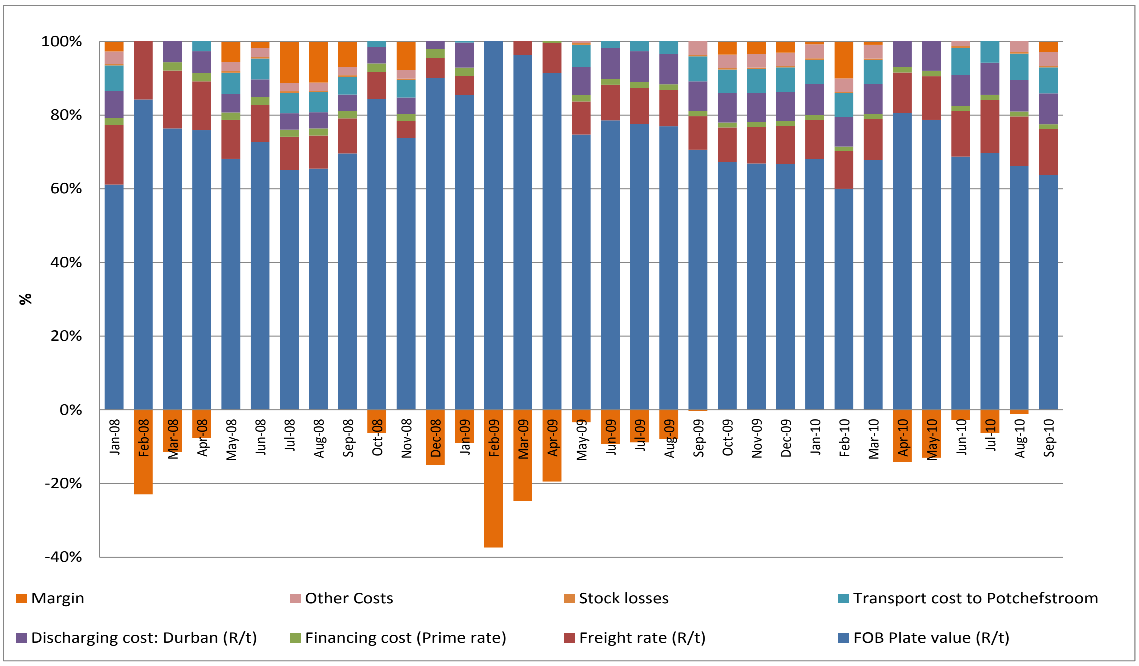

Figure 64: Composition of South African LAN price (discount included) – % contribution
Source: Grain SA, 2010

3.6 Conclusions

Since its development in the early 1990s, the fertiliser industry in South Africa has seen several structural changes that were driven by, amongst others, the development of the local fertiliser industry, the fertiliser industry going in and out of price control eras, profitability and competition. There are currently (according to statistics in 2008) three companies that hold 86 % of the shares in the South African fertiliser industry, when looking at revenues. The recent announcement of Sasol to divest from five of its regional fertiliser blending plants and its agreement with the Competition Commission to terminate all its fertiliser retail agency agreements (and therefore only operate as a wholesaler) will once again significantly change the structure of the local industry.

It is alarming that the fertiliser industry currently needs to import more than 60% of its NPK nutritional needs, when as recently back as the late 1990s, South Africa was a net exporter of fertilisers. This is regardless of the fact that South Africa has the resources to be self-sufficient in at least N and P fertilisers. All of South Africa's urea needs are imported – Kynoch closed its urea plants at Modderfontein and Milnerton in 2000 when production became uncompetitive with imports due to aging plants. It is especially the phosphate (MAP and DAP) imports that are worrying because of the fact that South Africa is one of the largest phosphoric acid producers, with its own phosphate mining and chemical processing operations. Recently, Sasol and Omnia also sold and mothballed their phosphoric acid plants.

Correlations estimates to determine the relationship between local and international prices showed that local fertiliser prices are highly correlated with their international counter products. The next chapter, however, will further address the relation between local and international fertiliser prices.

To determine the typical price structure of fertiliser at the farm gate, an import parity calculation was used. This calculation is easy to do and to interpret the results when a product is indeed physically imported; but not so when a product is locally produced, because the cost of production is not easily determined. The results showed that when importing a product, the product itself costs approximately 50% of the final price quoted on price lists (excluding an average 12% discount). The rest of the costs are made up by freight and inland transport costs (12%); insurance; financing costs; discharging costs and others. Included in these calculations is a margin, which is the difference between the import parity calculation and the price the grain producer paid for the product. When considering an average discount of 12% on the pricelist prices, a farm gate price could be determined. After taking an average 12% discount into consideration, an average 17% margin was calculated for imported urea from January 2004 to date. With imported MAP, the margin was also 17%, while a margin of 21% was calculated for

KCL. Without the discount, the margins for urea, MAP and KCL were 27%, 27% and 30% respectively.

A price structure calculation for LAN showed that local LAN production is competitive with the imported product. When no discount on the list price was considered, a margin of 8% was shown. When a discount of 12% was considered however, the margin was negative (-5%). This means that it would be cheaper to purchase LAN from local companies that manufacture LAN rather than to import it. As stated earlier, this finding was expected, because South Africa, through Sasol's ammonia production, can produce large quantities of LAN and be competitive with international markets. Because all of South Africa's LAN is locally produced, it is difficult to draw conclusions about the price structure and margins companies receive in the LAN market. Companies, however, as seen in the import parity calculations, can push their prices just below the import costs of LAN, and would still stay competitive.

The results with LAN price calculations and margins raised questions about the price structure of MAP. Both LAN and MAP are locally produced, but the average margin for MAP is 17% (with discounts included) while for LAN the margin is negative (-5%). Therefore, the local price structures, within the whole phosphate chain, require further investigation.

CHAPTER 4

PRICE TRANSMISSION BETWEEN INTERNATIONAL AND LOCAL FERTILISER PRICES

4.1. Introduction

In Chapter 3, using correlation tests, results showed that there are strong positive relationships between local fertiliser prices and that of their international counter products. This chapter analyses the various aspects surrounding the relationships between local and international prices of fertiliser. Four types of fertilisers commonly used in South Africa are considered. These are LAN compared with the international ammonia price; urea compared with the international urea price; MAP compared with the international DAP price; and MOP compared with the international MOP price. The focus of this chapter is to determine exactly how international fertiliser price changes are filtered through into local fertiliser prices and to uncover the reasons for the widening gap between local and international prices, which was seen after the international market witnessed an unprecedented surge in energy prices (Figure 66).

Several studies have analysed the links between energy prices and prices of commodities of their choice. In this chapter, the interest goes beyond that. The questions that need answering are: Why has the gap between local and international prices of fertiliser been increasing (Figure 66)? What factors are driving the increase in the price gap? What roles do border (international prices, landed in an international harbour) prices and the exchange rate play in this regard?

The increase in the gap has the implication that changes in international prices are not passed through completely. The question that begs an answer is whether this presumed incomplete price transmission is true. If it is, is it symmetrical, i.e. do local prices respond similarly to both upward and downward movements in the international fertiliser prices? Such discrepancies have welfare implications and provide a *prima facie* case for policy intervention. It is referred to in the literature as Asymmetric Price Transmission (APT). Two related questions were also considered in this chapter: What factors contribute to APT in cases where APT is confirmed? What contributions do fluctuations in the exchange rate and world prices make to the overall change in the price gaps on an individual basis?

To answer the questions posed in this chapter, two complementary sets of methods, yet with varying degree of precision, were applied. The results are summarised as follows:
In general, changes in local prices (caused by movements in the exchange rate and world prices) are caused to a greater extent by non-policy factors (Figure 67). The literature defines non-policy factors as those relating to deficiencies in market (market power), physical (transportation and storage), commercial (market information), and institutional (credit and regulating laws) infrastructure. This study also found that changes in international prices are not completely transmitted to local prices (Table 6) and that much of the increase in the price gaps is attributable to fluctuation in the exchange rate (Figure 68).

Next, the above results were re-examined using econometric techniques. Notable results from this exercise are that local prices depend positively on contemporaneous as well as lagged values of the world price and the exchange rate (Table 7); shocks, regardless of their origin, driven by the exchange rate or world price or both, affect local prices (Table 7); local prices respond more quickly to negative shocks (price increases) than to positive shocks (price decreases), implying that those involved in local fertiliser trading react more quickly to shocks that squeeze their profit margin than to those that stretch them (Tables 7 and 8); and finally, that it takes more or less the same length of time for shocks emanating from changes in the border price and the exchange rate to be completely eliminated (Figures 69 and 70), implying that both play an important role for movements in local prices.

4.2 Background

South Africa relies on imports to satisfy more than one half of its fertiliser needs. This makes local prices dependent on movements in the international price in Rand terms (after the exchange rate is applied to the international price at an international harbour price quoted in US dollars in the international market). Landed prices (international price in Rand terms) are affected by movements in the exchange rate and border price (international harbour price quoted in US dollars). The exchange rate and border price, although to varying degrees, contribute to movements in local prices. Studies show that fluctuation in the exchange rate explains much of the variation in the local prices in developing countries. Figure 65 shows the relationship between landed and local prices. It is evident from the figure that local prices have followed landed prices throughout the study period.

As demonstrated by Figure 65, local and landed prices trended positively until they entered episodes of spikes in 2008. It is notable that the year 2008 marks the beginning of a crisis in the energy market. Its effect was translated into fertiliser prices through its first and second round effects, which had an impact on the demand for and supply of fertiliser in the international market.

However, the trends have taken a different twist since 2008. This is confirmed by Figure 66, which shows movements in the price gaps, defined as the difference between local[4] and landed prices. According to Figure 66, the price gaps are getting bigger for all fertiliser types considered.

As its major objective, this chapter looks at the relationships between local and landed prices of four fertiliser types – ammonia (International) / LAN (Local); urea (International) / urea (Local); DAP (International) / MAP (Local); and MOP (International) / MOP (Local). In the process, it will address the following specific questions: Does the increase in the price gaps alluded to above have anything to do with incomplete transmission of changes in the international price to the local price? In cases where changes are not passed through completely, how do local fertilisers prices react to increases and decreases in the landed prices? Do border prices and the exchange rate affect local prices differently?

This chapter attempts to answer these and other related questions in two stages. The first stage analyses trends in local and international fertiliser prices, price gaps, and the contribution of non-price factors to the widening price gaps. This will be done by decomposing price gaps. The second stage estimates a host of competing econometric models to quantify dynamic relationships between local and international prices, to conduct a formal statistical test to check for the presence or absence of asymmetry in price transmission, and to determine whether positive or negative asymmetric price transmission best characterises the way local prices respond to changes in world prices and the exchange rate.

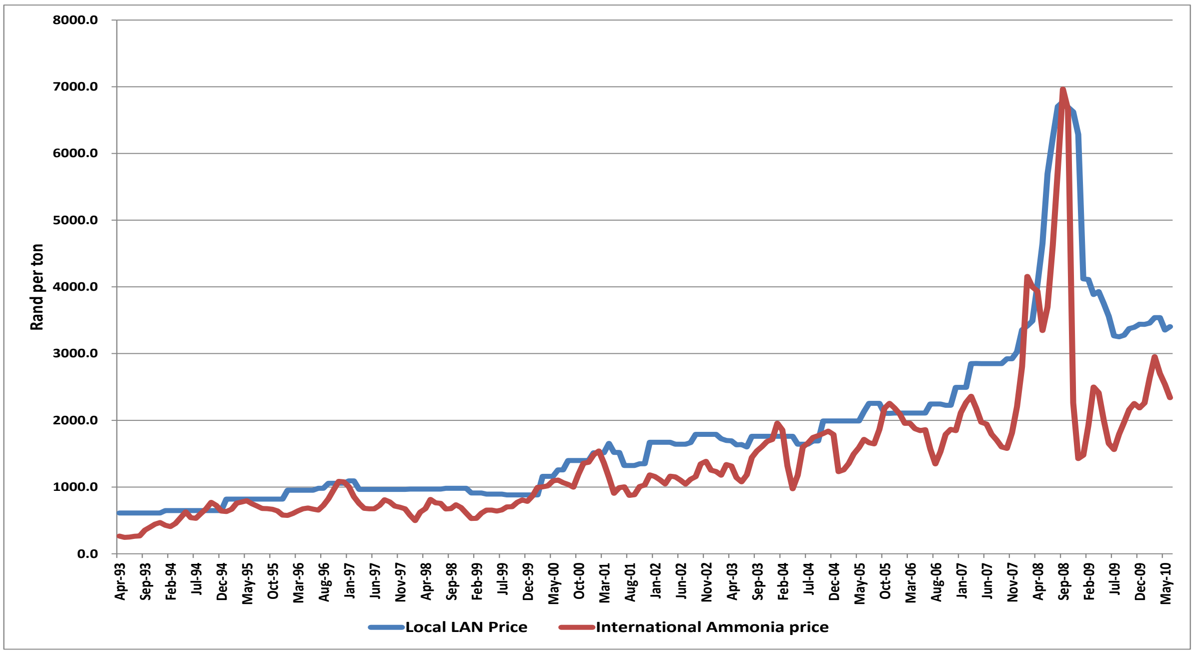

Figure 65a: International ammonia price and local LAN price
Source: Grain SA, 2010

[4] Local price in this context is an average price calculated of the price lists of the different fertiliser .

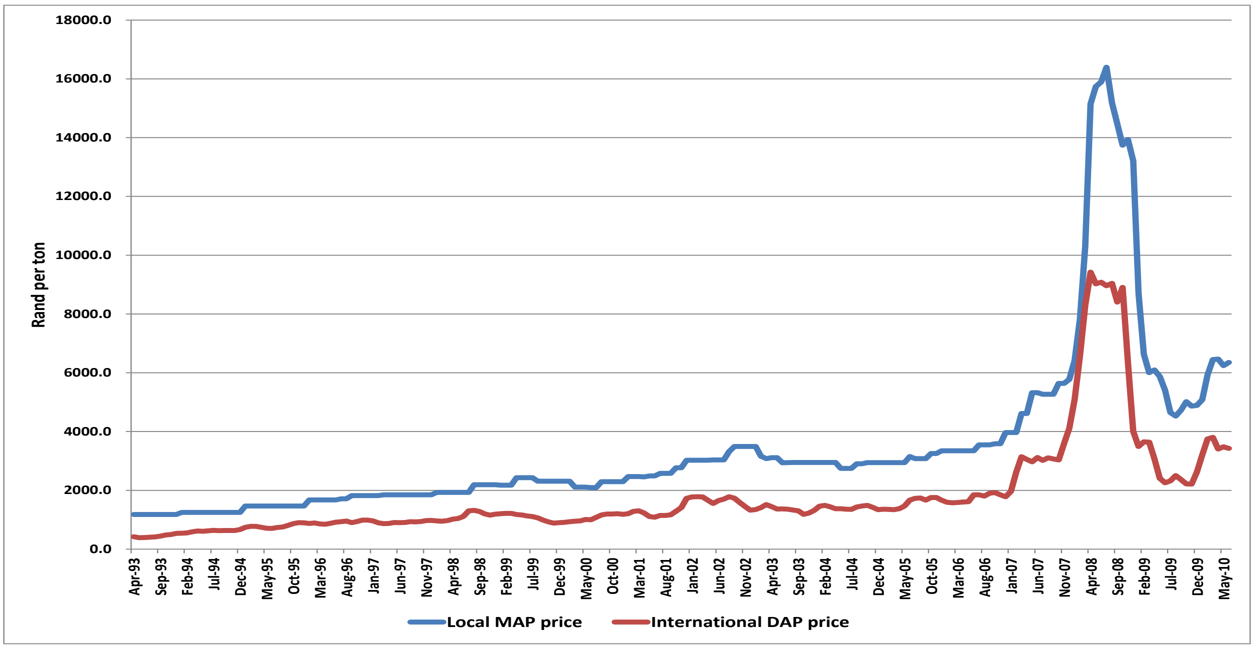

Figure 65b: International DAP price and local MAP price
Source: Grain SA, 2010

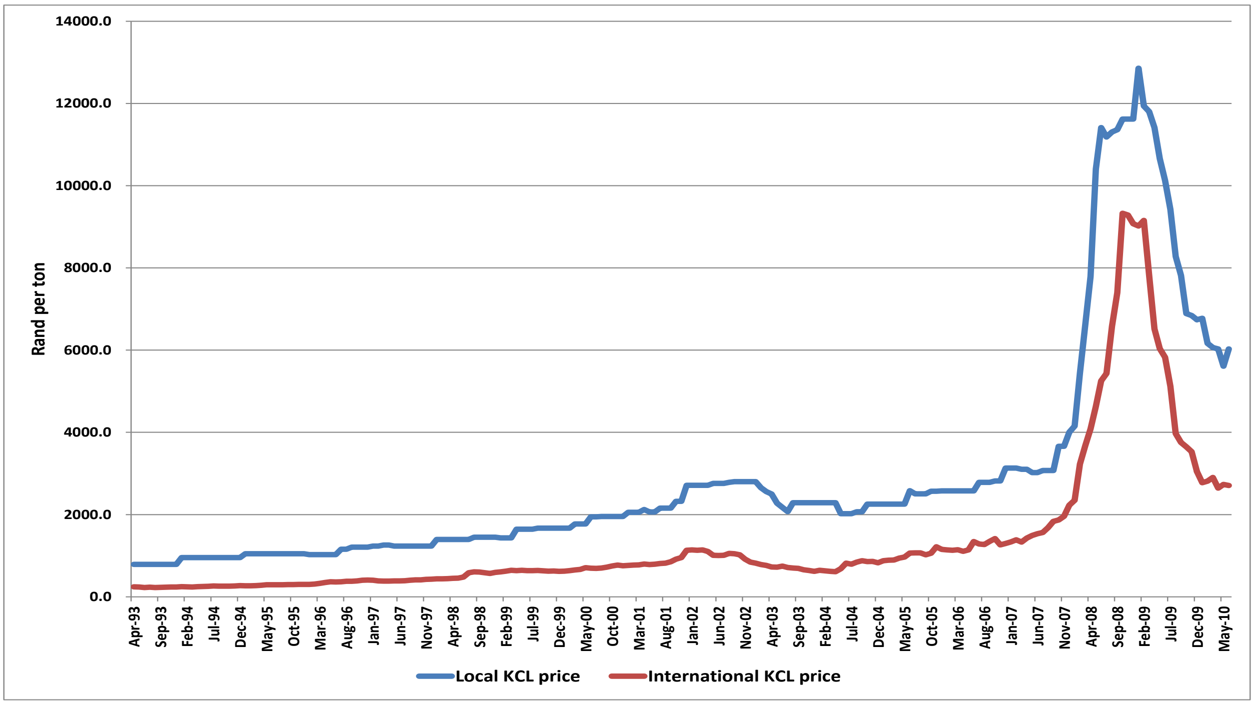

Figure 65c: International and local KCL (MOP) prices
Source: Grain SA, 2010

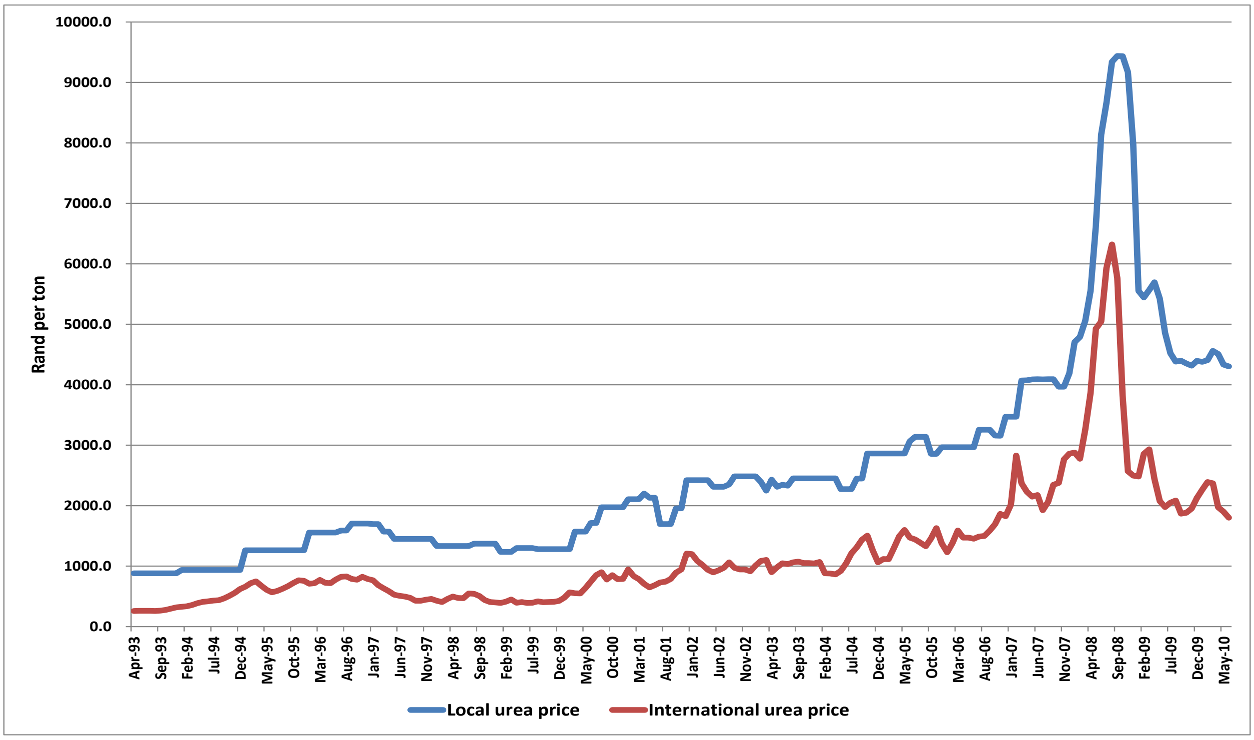

Figure 65d: International and local urea prices
Source: Grain SA, 2010

4.3. Fertiliser price trends

The fertiliser industry is one of the oldest industries in South Africa. It has supplied the local market with different types of fertilisers for many years. These include raw materials like ammonia, urea, MAP and MOP.

Local prices of fertilisers have shown a marked increase during 2008. This has been attributed to international market conditions, and is to be expected as more than half of South Africa's current fertiliser demands are met though imports. Except for urea and MOP, which are entirely sourced through imports, demand for ammonia and MAP is met through local production.

Available literature on the subject classifies the conditions responsible for the hike in fertiliser prices in the international market into two groups – demand and supply. On the demand side, as discussed in Chapter 2, increase in crop prices was considered as one of the major reasons. The increase in crop prices was directly attributed to a host of factors, such as increases in income of people living in fast-growing economies like China and India, bad weather conditions in major food producing countries, and implementation of protectionist trade policies by major exporting nations. This led to an increase in the demand for fertiliser. The working of substation effects in the global energy market is also partly to blame. Attracted by increases in the price of Brent crude oil in the world market, increased production of alternative sources of energy, such as biofuel, has put upward pressure on the demand for crops as food crops are used in biofuel production.

Table 5: Factors affecting international fertiliser prices

Variable	Ammonia		KCL		Dap		Urea	
	Pearson	Spearman	Pearson	Spearman	Pearson	Spearman	Pearson	Spearman
Ammonia	-	-	-	-	.454**	.244	.479**	.420**
Natural gas	.351**	.400**	-	-	-	-	.238	.207
Brent crude	.427**	.374**	-	-	.288*	.201	.411**	.195
USA maize	.140	.066	.515	.014	.286*	.064	.220	.074
GDP Global	.288*	.202	449**	.158	.467**	.400**	.391**	.402**
Stock	.354**	-.024	.632**	.080	.384**	.066	-.085	-.175
Sulphur	-	-	-	-	.589**	.412**	-	-
Phosphate Rock	-	-	-	-	.705**	.339**	-	-

*, ** represent level of significance at 5 % and 1 % respectively.

On the supply side, increases in the costs of production of nitrogen-based fertiliser types (ammonia, urea and DAP) played an important role. Ammonia (NH_3) is used as a major input in the industrial production of urea and DAP. It is made up of nitrogen (N) and hydrogen (H_3). Hydrogen is produced from natural gas, which accounts for the greater proportion of the total cost of ammonia production. The price of natural gas increased significantly during this time. This was not attributed to a decline in the production or stock of natural gas but due to an increase in its demand following an increase in the price of Brent crude oil, its major substitute.

Table 5 summarises results of the relationship between international prices of fertilisers and factors affecting demand for and supply of fertiliser in the international market. Growth in the world Gross Domestic Product (GDP) and the USA maize price are used as proxies for factors affecting international prices of fertilisers on the demand side. According to the results found, growth in the world economy has a significant effect on the prices of all types of fertilisers considered in this study. Increase in crop prices measured by an increase in USA maize prices, however, has only a significant effect on the price of DAP. Although the *a priori* expectation was that urea and the USA maize price would be highly correlated, according to Table 5, this is not the case, as the USA maize price only shows a high level (significant) of correlation with KCL (MOP) and DAP.

On the other hand, the study assumed that supply of maize in the international market depends on factors that have a direct effect on the costs of the production of fertilisers. Results indicate that the international price of ammonia is significantly affected by the price of natural gas, available stock, the price of Brent crude oil; the price of DAP by the prices of ammonia, phosphate rock, sulphur, and by Brent crude oil; and the price of urea by the price of ammonia and Brent crude oil, etc.

Figures 65a to 65d summarise the relationships between local and international fertiliser prices. They show that local prices responded positively to changes in the international fertiliser prices. It is evident from the same figures that during the months between December 2007 and August 2008, fertiliser prices showed large increases. These could be attributed to the influence of external factors such as above-average hikes in oil prices in the world market (as discussed in Chapter 2). It is also evident from the figures that local fertiliser prices responded differently to corresponding increases (December 2007 to August 2008) and decreases (after August 2008) in international prices.

4.4. Factors contributing to increasing price gaps: Price decomposition

This section analyses whether price gaps between local and international prices have shown any systematic movements over time. As price gap is defined as the difference between the local price for fertiliser and its border price in terms of domestic currency. It is an indicator that can be used to measure the level of gains from fertiliser trade through effective integration of the local market into the world market. A local fertiliser market is said to be well integrated if local and border prices are similar after some adjustments for domestic transaction costs are made. Therefore, measuring the price gaps and identifying variables contributing to the change in the gaps is crucial in better understanding the fertiliser market.

Figures 66a to 66d provide measures of price gaps for the four fertiliser types. Results show that the gaps are widening. This is especially so after December 2007. To be able to determine what variables contribute to the increasing gap, the study decomposed the changes in the gaps into a number of variables, labelled differently in the literature as policy and non-policy variables.

Policy-related variables could be further categorised into explicit and implicit policy. Examples of explicit policy include support for local fertiliser producers in the form of budgetary (e.g. subsidy) and non-budgetary (e.g. tariff) mechanisms to keep local prices well above border prices. Implicit policy, on the other hand, refers to those changes in the gap attributable to interactions among the exchange rate, the world fertiliser price and a policy variable. Examples of a policy variable include tariff and trade quota. This study assumes that policy factors play no role. This is because domestic fertiliser producers in South Africa receive no support from the government.

In addition to policy, non-policy variables could explain part of the change in the price gaps. Researches show that non–policy variables play an important role in developing countries. Broadly speaking, they include deficiency in market conditions attributable to poor market infrastructure. They cause price gaps by impeding transmission of changes in the world price and the exchange rate into the local price. This could occur through a number of channels. The most important ones, relevant to a developing country like South Africa, include the presence of market power in the fertiliser market, which allows economic agents not to pass the changes completely from border prices to local prices; and deficient physical (transportation and storage), commercial (market information), and institutional (credit and regulating laws) infrastructure.

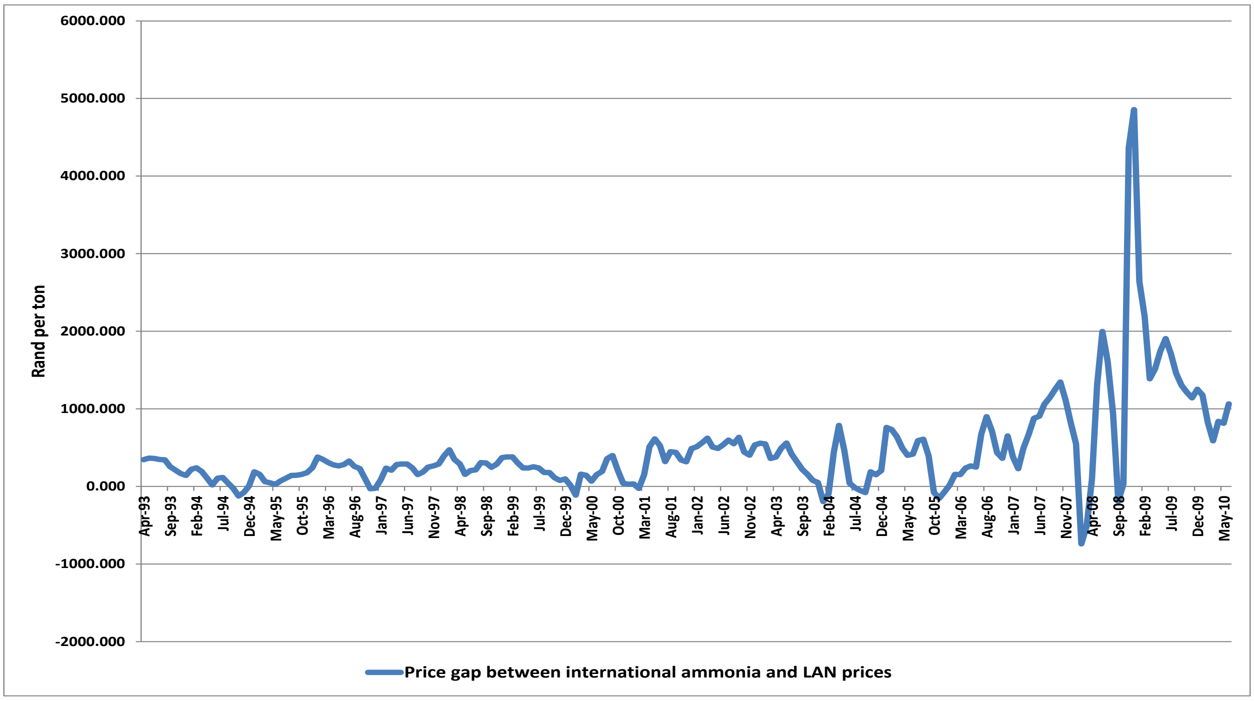

Figure 66a: Price gaps between the international ammonia and local LAN prices
Source: Grain SA and Prof Alemu, 2010

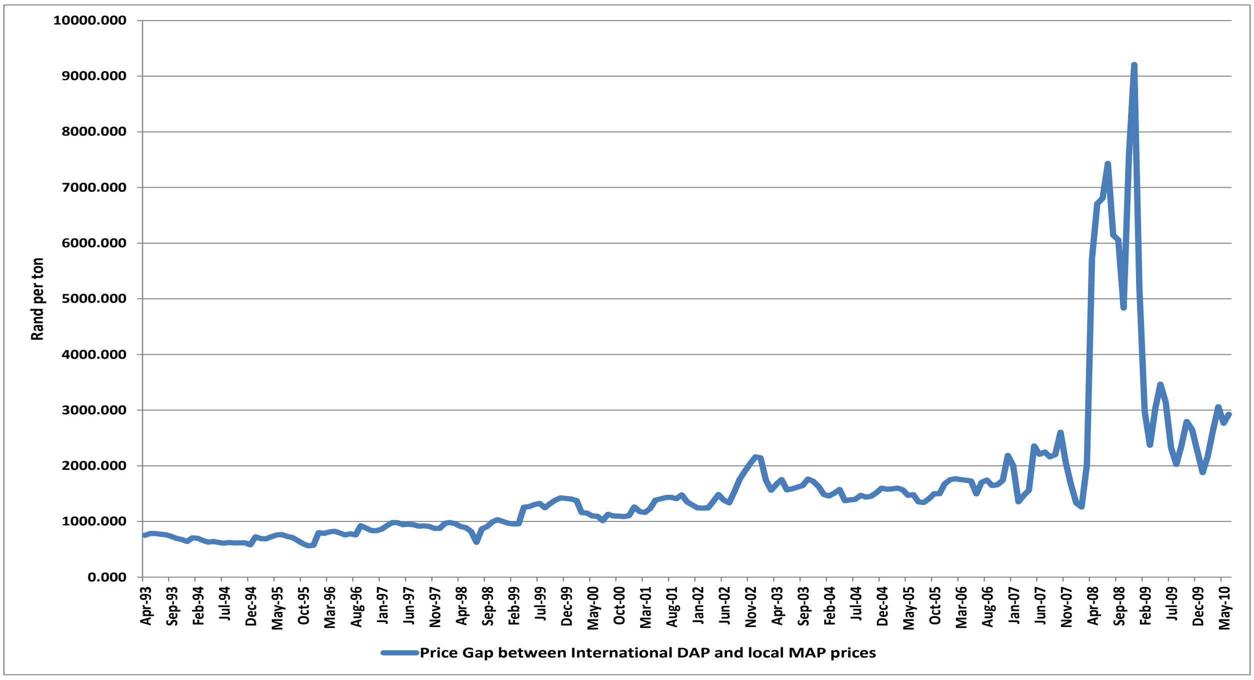

Figure 66b: Price gaps between the international DAP and local MAP prices
Source: Grain SA and Prof Alemu, 2010

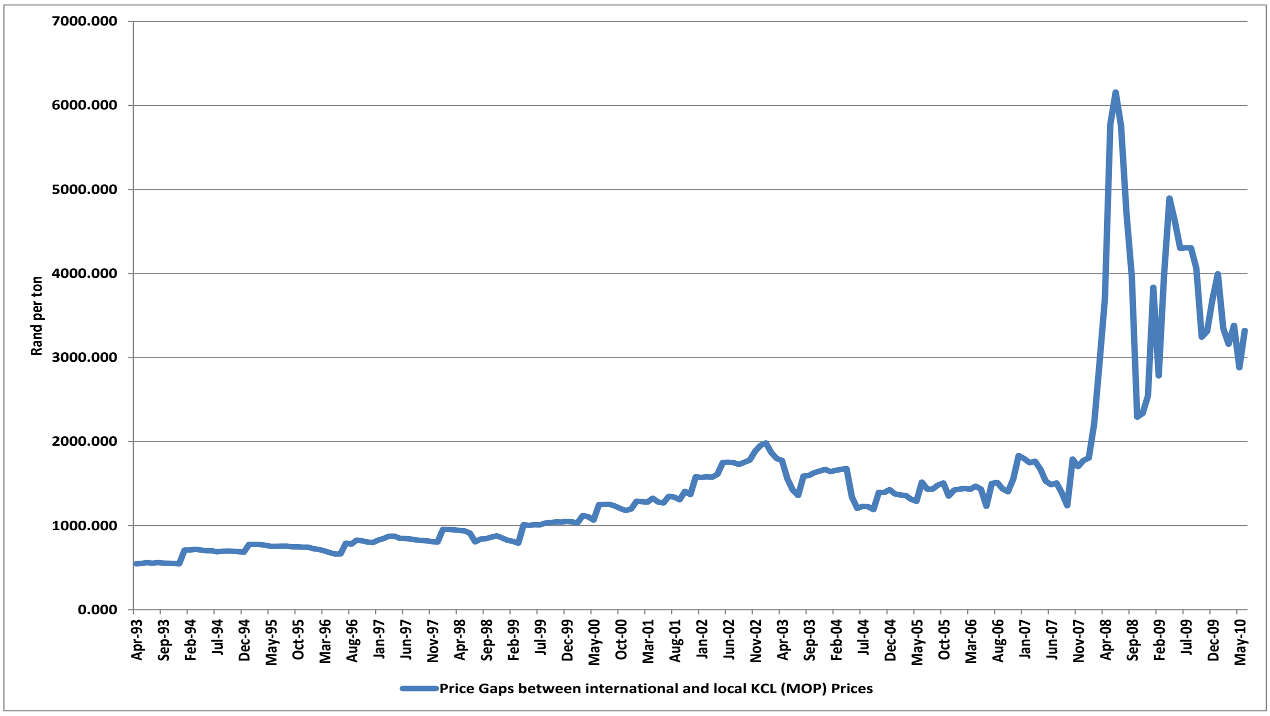

Figure 66c: Price gaps between international and local KCL (MOP) prices
Source: Grain SA and Prof Alemu, 2010

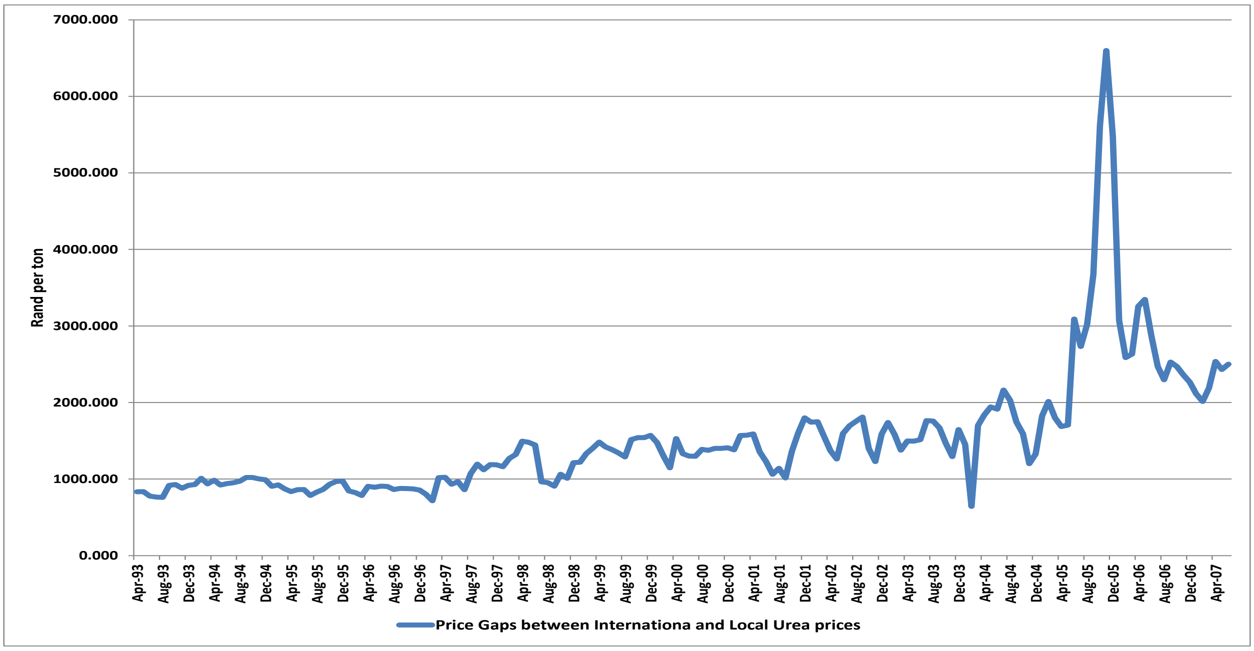

Figure 66d: Price gaps between international and local urea prices
Source: Grain SA and Prof Alemu, 2010

The exchange rate is one of the factors that would directly affect local prices. A fluctuation in the exchange rate alone could therefore contribute to a larger price gap. A trend analysis on the exchange rate indicated that this is indeed the case in the South African fertiliser market – trends in the price gaps correspond, *inter alia*, with a fluctuating exchange rate. This has been particularly evident since 2006. If combined with important causes of incomplete price transmission such as market power and deficient market infrastructure, its effect on price gaps could be much greater.
The methodology applied to decompose price gaps is explained in Appendix B. It was originally developed by the Organization for Economic Cooperation and Development (OECD). This methodology had the objective of determining the support that governments give to local producers, which could come in the form of, for example, the introduction of a managed price policy to prevent price transmission from international (hereafter referred to as landed price, as it is the product of world price and the exchange rate) to the local price. The methodology was later expanded by Liefert (2009) to go beyond the calculation of Producer Support Estimates (PSE). This is to allow identification of the degree to which changes in specific variables (policy or non-policy) drive changes in commodity price gaps.

Figures 67a to 67d summarise these results. They show the contributions that policy and non-policy factors make to changes in price gaps for the four fertiliser types. Since South African fertiliser producers receive no support from the government, the policy factors refer to changes in the price gap attributable to price disparities (fluctuation in the world price and the exchange rate). The non-policy factors, on the other hand, refer to deficiency in market conditions which impede price transmission and thus cause incomplete price transmission of changes from border price to domestic (local) price. Incomplete price transmission refers to changes in price gaps attributable to non-policy factors. Price disparity, on the other hand, refers to those changes in the price gaps that arise as a result of policy-related factors. The figures show that much of the changes in the price gaps occurred as a result of incomplete price transmission (non-policy factors). This has particularly been the case since December 2007.

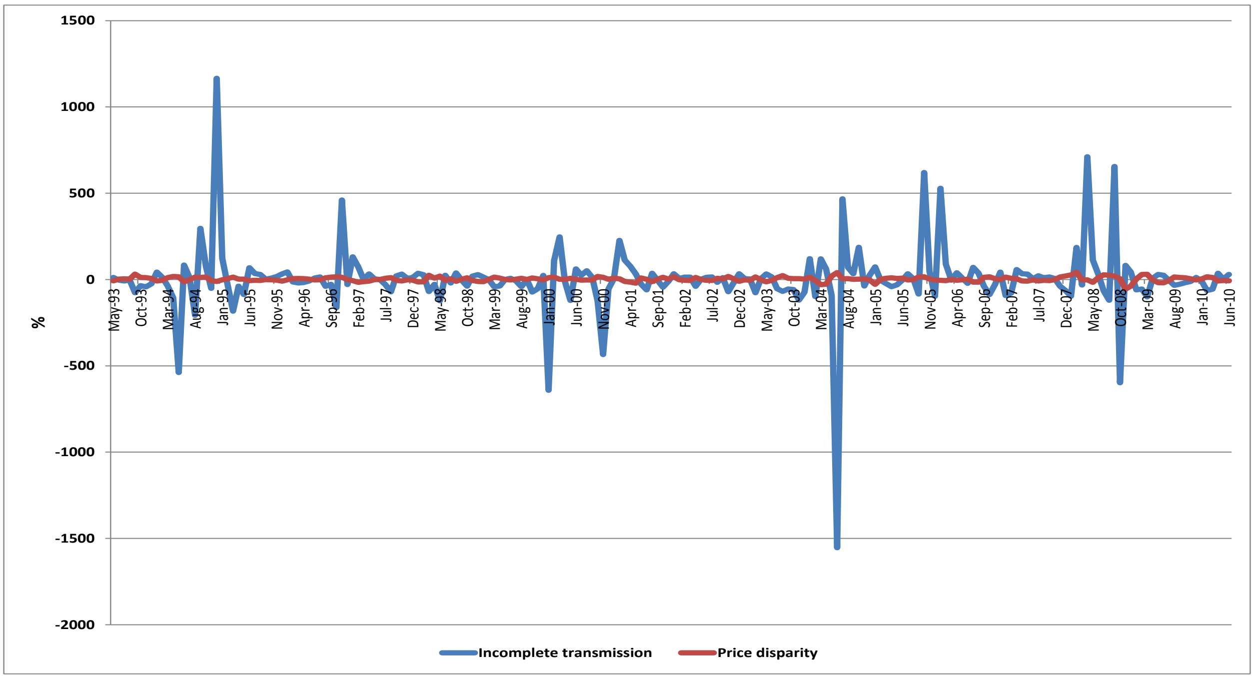

Figure 67a: Ammonia – price disparity and incomplete price transmission
Source: Grain SA and Prof Alemu, 2010

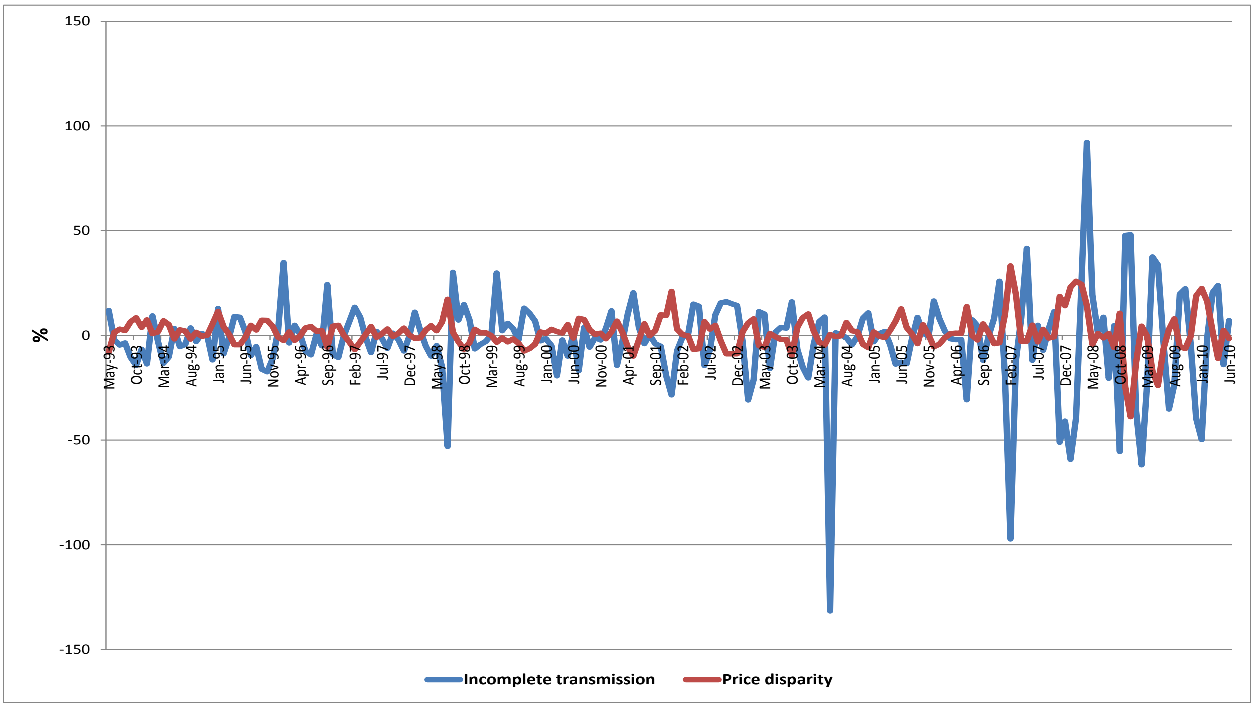

Figure 67b: DAP – Price disparity and incomplete price transmission
Source: Grain SA and Prof Alemu, 2010

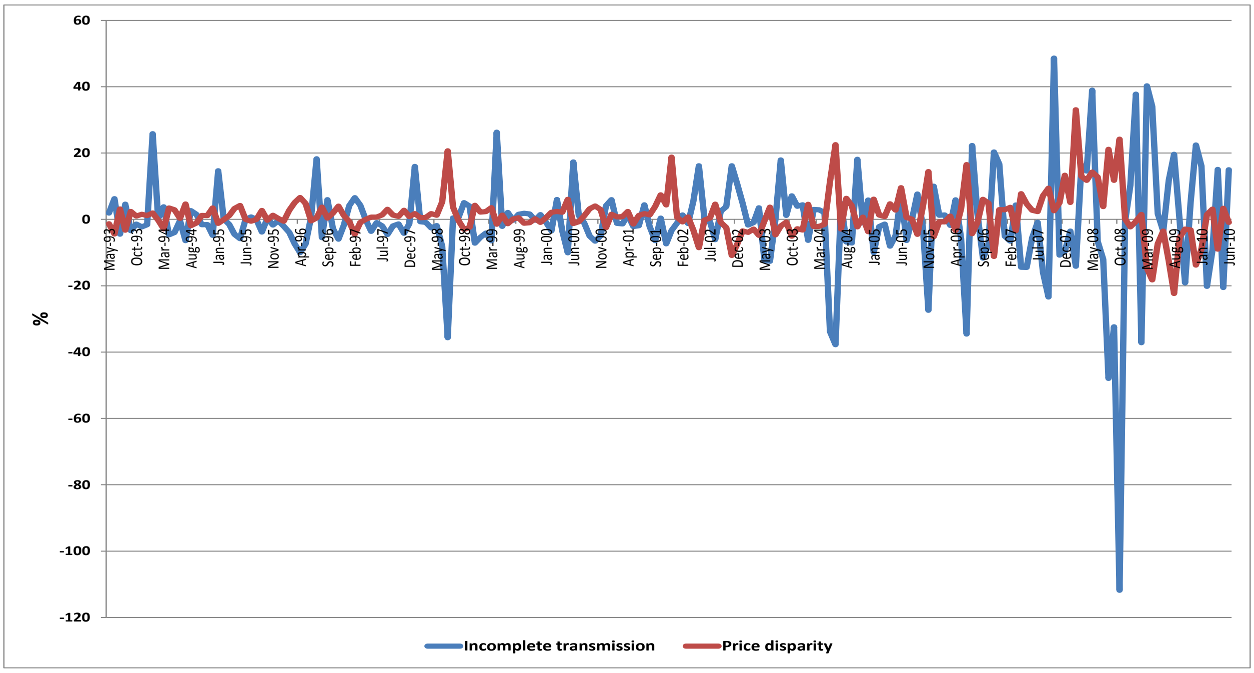

Figure 67c: MOP – price disparity and incomplete price transmission
Source: Grain SA and Prof Alemu, 2010

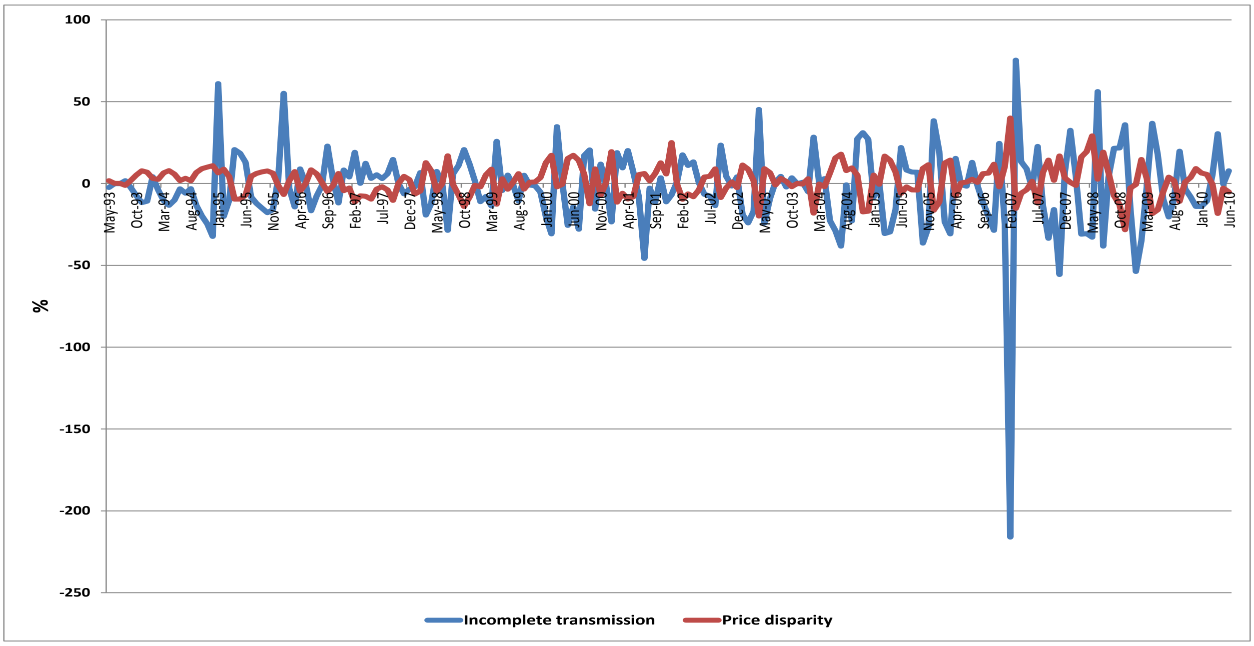

Figure 67d: Urea – price disparity and incomplete price transmission
Source: Grain SA and Prof Alemu, 2010

Next, the study asked whether the incomplete transmission found earlier had to do with asymmetry in price transmission (APT). If so, the study considers whether Peltzman's (2000) approach of classifying asymmetry positive or negative APT – characterises the local fertiliser market. The other criteria could be to classify APT on the basis of speed and magnitude of price transmission or both. See Meyer and Cramon-Taubadel (2004) for graphical explanation on this.

APT has redistribution and welfare implications. These provide a *prima facie* case for policy intervention (Meyer & Cramon-Taubadel, 2004). The redistribution effect emanates from the possibilities that some groups benefit from price reduction (fertiliser consumers) or increase (fertiliser producers and middle men) than would otherwise be the case under conditions of symmetry. The welfare effect, on the other hand, arises out of the existence of market power, which under normal circumstances could lead to welfare losses.

A preliminary investigation was conducted to determine if changes in border prices of fertiliser are completely transmitted to local fertiliser prices. This was simply to crudely verify *a priori* expectation that there is incomplete transmission. The verification is crude in the sense that it falls short in describing APT in terms of positive/negative and size/magnitude. These are matters that would be taken up later with the application of robust econometric techniques. For the time being, the relationship between local and border price is analysed using a Price Transmission Elasticity (PTE) described in Appendix B.

The PTE could take a value equal to 1, the case of symmetric price transmission (SPT), or a value different from one, the case of asymmetric price transmission (APT). The literature distinguishes between two types of APT – positive and negative – depending on how suppliers respond to the effect a shock exerts on their profit margin.

Positive APT occurs when local price is more responsive to shocks that increase the landed price. Negative APT, on the contrary, is the case where suppliers in the domestic market react more quickly to shocks that decrease landed price. Positive APT is common in market structures characterised by market power which could lead to anticompetitive behaviour. Negative APT, on the other hand, is characteristic of an oligopolistic market structure.

Table 6: The responsiveness of local fertiliser prices to changes in landed prices

	1 % increase in $P_t^w X_t(1+t)$				1 % decrease in $P_t^w X_t(1+t)$			
Type	e=0	0<e<1	e=1	e>1	e=0	0<e<1	e=1	e>1
Ammonia	32	59	0	9	25	56	0	19
Urea	32	44	0	24	18	54	0	28
DAP	33	42	0	25	27	40	0	33
MOP	37	39	0	24	24	52	0	24

Source: Prof Alemu, 2010

Table 6 provides a summary of results from price transmission elasticity estimates. It covers the period January 2005 to June 2010 – a period characterised by marked fluctuations in local and world fertiliser prices. According to the results found, neither the positive nor the negative changes in the landed prices was completely transmitted to the local prices (P_t^d). This is according to Columns 4 and 8 of Table 6, which demonstrates outright rejection of unitary price transmission. This confirms that APT characterises South African fertiliser markets.

However, the evidence provided in Table 6 is not conclusive. It does not aid to classify the behaviour of the markets as a positive or a negative APT. For example, consider how ammonia suppliers responded to an increase and decrease in landed prices. According to Table 6, responses were inelastic (i.e. 0<e<1) in 59% and 56% of the cases, respectively. This gives inconclusive results, as it satisfies the characteristics of both negative and positive APT. A positive (negative) APT is a situation where PTE is elastic (inelastic) when price increases and inelastic (elastic) when it decreases.

The discussions hitherto indicated that much of the changes in the price gaps could be ascribed to non-policy factors. This is to be expected since those engaged in fertiliser production get little protection from external competition by the government. The study also found that changes in landed prices are not completely transmitted to local prices. The question that remains yet to be answered is the role that changes in the exchange rate and world price have played to the upward trend in the price gaps between local and landed price. To answer this, the study decomposed the net effect of policy and non-policy factors to the change in the price gap into those that occurred due to changes in the exchange rate and world prices. Results are summarised in Figures 68a to 68d. According to the results found, the exchange rate plays the dominant role. For example, in May 2008, the price gap for ammonia increased by approximately 98%. The exchange rate and the world price accounted for approximately 79% and 19 % respectively of the change (Figure 68a).

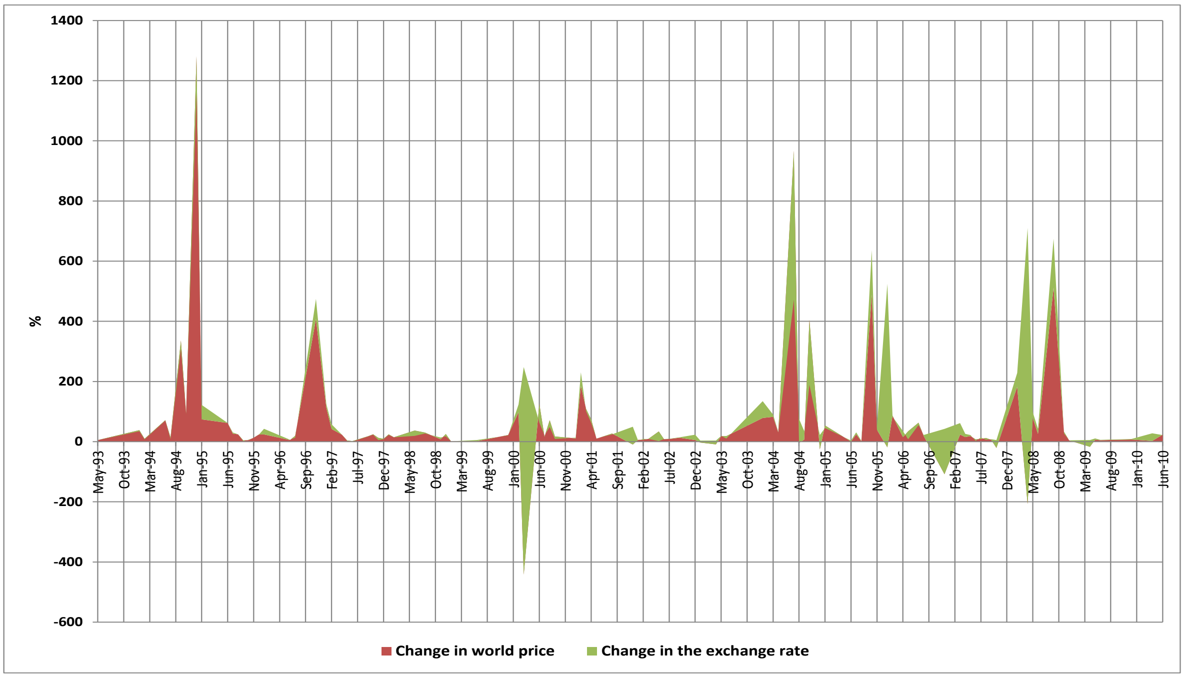

Figure 68a: Ammonia – contribution of world price and exchange rate to price gaps
Source: Prof Alemu, 2010

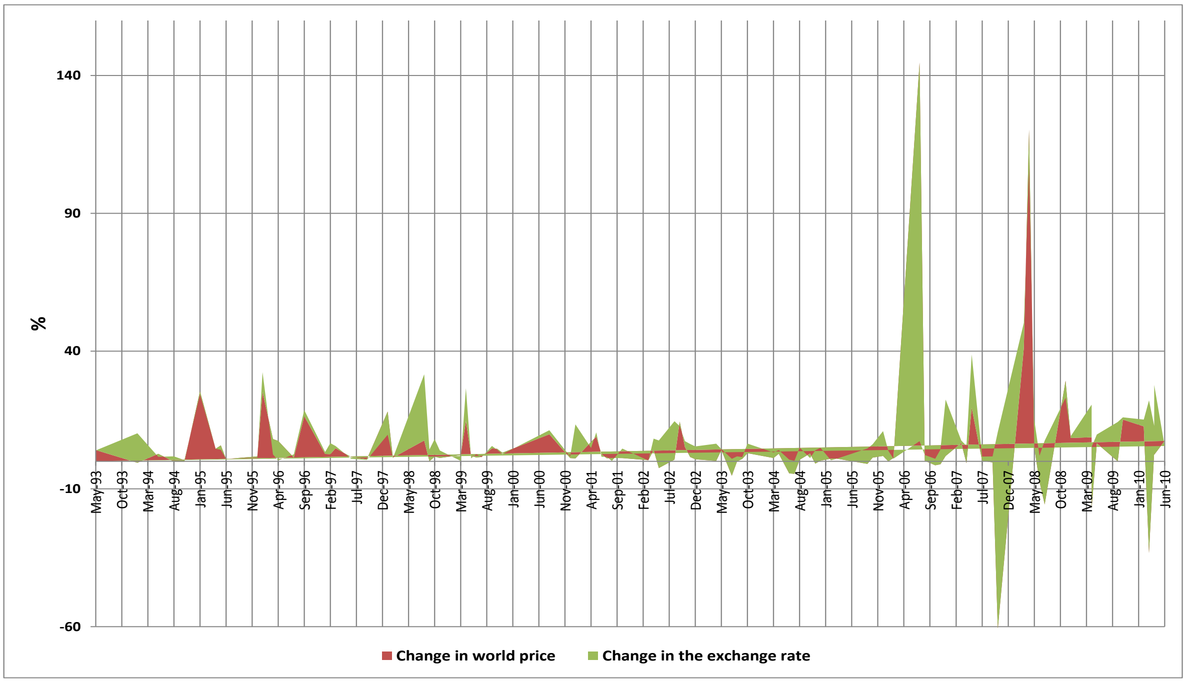

Figure 68b: DAP – contribution of world price and exchange rate to price gaps
Source: Prof Alemu, 2010

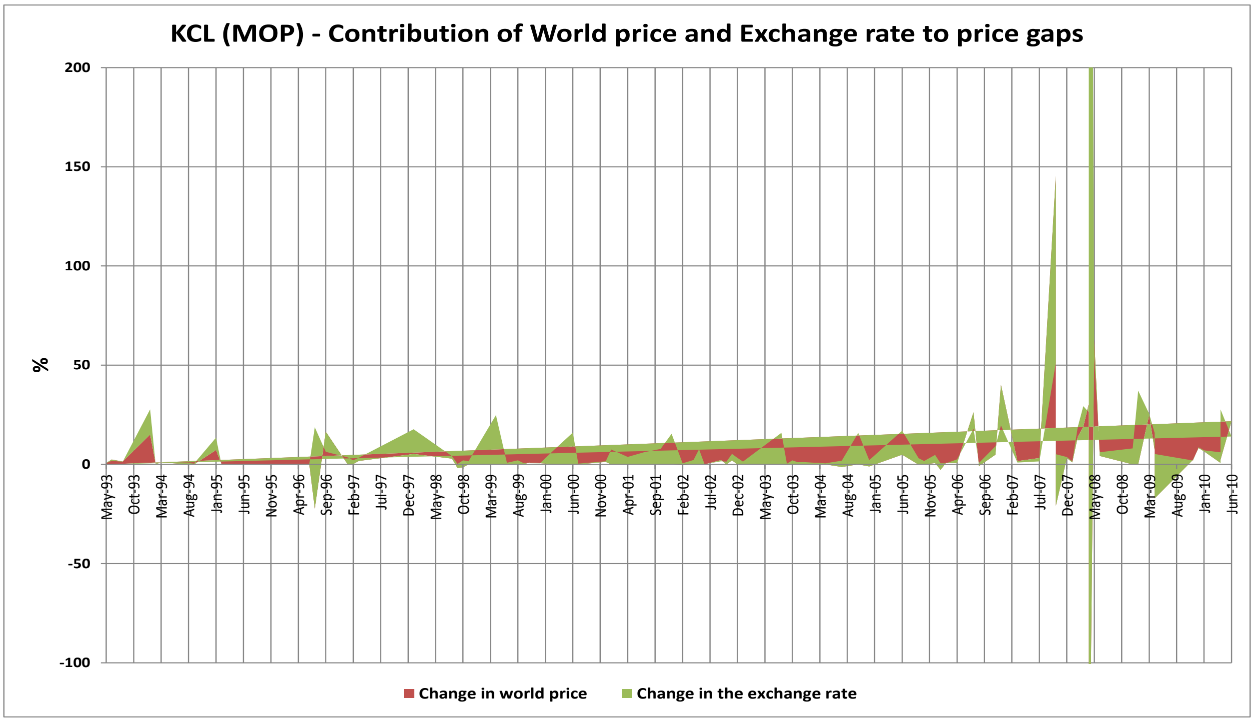

Figure 68c: MOP – contribution of world price and exchange rate to price gaps
Source: Prof Alemu, 2010

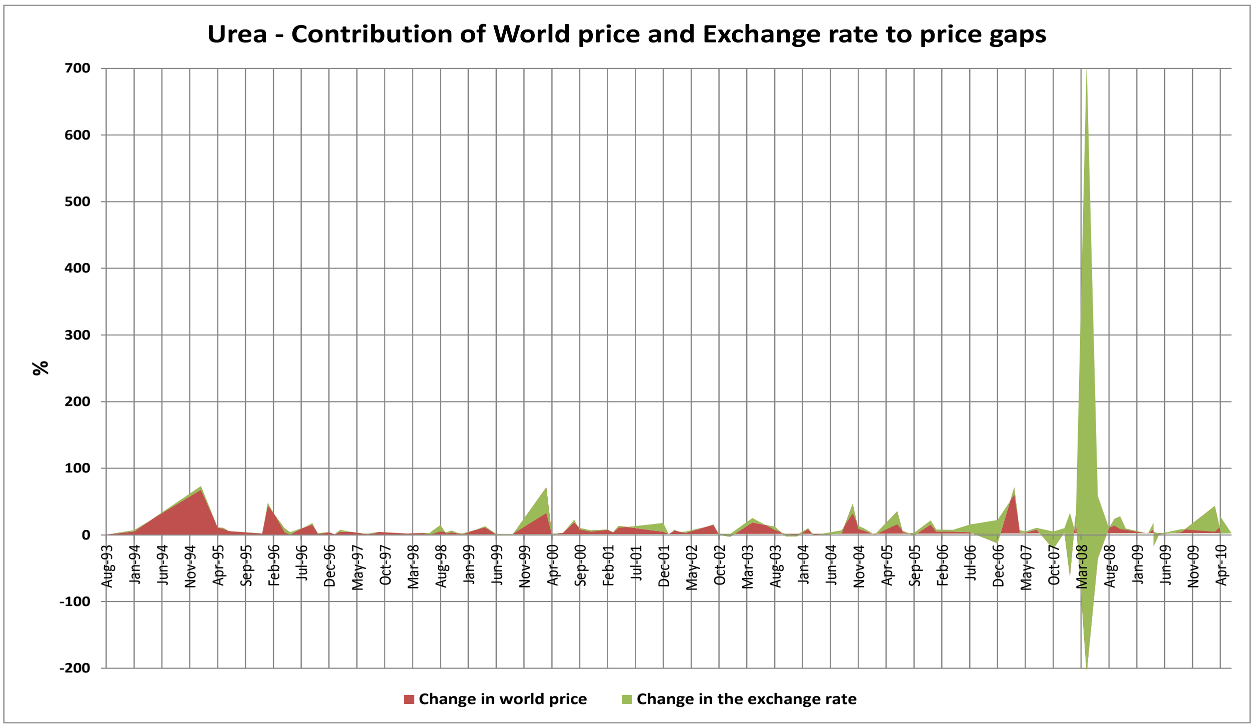

Figure 68d: Urea – contribution of world price and exchange rate to price gaps
Source: Prof Alemu, 2010

4.5 Measuring price transmission: Econometric approach

In the previous section, it was found that changes in landed prices are not completely transmitted to local prices. However, it was not possible to further investigate the result to determine whether local prices respond differently to increases and decreases in the landed prices, due to constraints by the method applied to ascertain the presence of asymmetric price transmission. To help determine whether suppliers respond differently to positive and negative shocks, a different methodology was applied. Appendix C describes the methodology used in this study.

Next, results from the econometrics study were analysed. The method helped to provide far clearer answers to questions raised earlier, i.e. the presence or absence of incomplete price transmission. If there is a presence, how do traders react to positive and negative changes in landed prices? How long does it take for positive and negative changes in the world price and the exchange rate to be eliminated? Which criterion of APT is better suited to fertiliser markets in South Africa – negative or positive APT? Answers to these and other related questions could give insight into the type of market structure that characterises the local fertiliser industry and the level of importance that one could attach to the exchange rate compared with the world price.

Table 7 summarises price transmission estimates for the four fertiliser types studied. The results are based on Momentum Consistent Threshold Autoregressive Models (MC-TAR). The MC-TAR model was selected with the help of some goodness of fit criteria which is discussed at some length in Appendix C.

Table 7: Price transmission

Variable	Ammonia	Mop	Urea	Dap
$\square_1^{a}$	0.097	-0.121**	-0.096**	-0.269**
$\square_2^{a}$	-0.177**	-0.359**	-0.533**	-0.723**
$\square^{b}$	14.111	11.871	29.751	12.503
$\square_1 = \square_2^{c}$	9.796**	6.201**	26.54**	2.808***
$\square^{e}$	-0.078	-0.047	0.008	-0.065

Source: Prof Alemu, 2010
*, **, *** represent level of significance at 1 %, 5 %, and 10 % respectively.

The second and third rows of Table 7 give the degree of persistence of positive and negative discrepancies from equilibrium. For example, in the case of MOP, 88 % of the positive and 64 % of the negative discrepancies in profit margin persist to the following month. To explain how it works, assume you are in equilibrium at time t. When a shock arises (positive or negative) you will no longer be in equilibrium at time t but you will move towards equilibrium (due to demand and supply interactions). This means that as you move towards equilibrium, part of the discrepancy from equilibrium will be eliminated (12 % of the positive and 36 % of the negative) every month. This means that the remaining 88 % of the positive and 64 % of the negative discrepancies from equilibrium persist to the following month. This means that local prices react far more quickly to increases rather than to decreases in the landed price. The implication is that the local fertiliser industry responds far more quickly to shocks that squeeze its profit margins than to shocks that stretch them. This is typical of positive asymmetric price transmission. This incomplete price transmission, according to the literature, could be the result of a deficiency in the market infrastructure that characterises the fertiliser industry.

Next, an error correction model (ECM) is estimated. Here, parameter estimates of dynamic variables (current and lagged variables) are analysed. These allow analysis of causal relationships between local prices, the exchange rate and the world prices. Adjustment coefficients are also analysed. They indicate how quickly long-run disequilibria are corrected. According to Table 4, all the variables have the expected signs. A look into the level of significance of contemporaneous and lagged value changes of the world price and exchange rate shows the presence of dynamic relationships. Local prices are affected positively by their own lagged values, contemporaneous and lagged values of the world price, and contemporaneous and lagged values of the exchange rate.

Following this, the adjustment parameters are analysed. Their sign and size help to determine how local prices react to positive and negative shocks emanating from changes in the world price and the exchange rate, and how quickly the effect of such shocks on the local price could be eliminated. Positive shocks are shocks that affect profit margins of those involved in local fertiliser trade positively (i.e. decrease in the international price). Negative shocks, on the other hand, affect profit margin of local fertiliser traders negatively (i.e. increase in the international price of fertiliser). According to the results found, shocks, regardless of their origin, affect local prices. It was found that adjustment coefficients are significant and have the right sign. This indicates that positive and negative disequilibria are corrected. In addition, results show that the adjustment parameters have different sizes to the one for negative adjustment being the greatest in absolute terms. This implies that local prices respond more quickly to negative shocks than to positive shocks. Negative shocks could emanate from increase in either the world price or decrease in the value of the local currency. They squeeze profit margins of those involved in local fertiliser trade. This, as indicated earlier, is typical of positive asymmetric price transmission.

Table 8: Error correction model

	Ammonia	Map	Urea	Dap
Constant	0.002	0.003	-0.0008	0.003
ΔLP_{t-1}	-0.004	0.105***	0.061	0.152
ΔLP_{t-2}	0.122**	0.182*	0.116**	0.057**
ΔWP_{t}	0.076**	0.273*	0.001	0.046
ΔWP_{t-1}	0.006	0.068	0.04	0.194**
ΔWP_{t-2}	0.148*	0.094	0.096**	0.154**
ΔX_{t}	0.12**	0.077	0.158*	0.061
ΔX_{t-1}	0.136**	0.004	0.05	0.083
ΔX_{t-2}	0.203*	0.081	0.098	0.126**
err^{+}_{t-1}	0.094	-0.143*	-0.114*	-0.174*
err^{-}_{t-1}	-0.118*	-0.15*	-0.449*	-0.398*
Adj. R^2	0.29	0.344	0.437	0.551
DW	1.92	2.03	1.984	2.012
F-Statistic	9.48*	11.643*	16.788*	25.943*

Source: Prof Alemu, 2010

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

Next, the results presented in Table 7 were used to conduct impulse response analysis. Impulse response analysis is useful because it helps to uncover the time period it takes for a unit shock in either the world price or the exchange rate to be eliminated. This was done for the four types of fertilisers covered in this study. Figures 69a to 69d summarise the response of local price to a unit increase (negative shock) and decrease (positive shock) in the world price. The effect of one unit increase and decrease in the exchange rate on local price was also analysed. Results are summarised in Figures 70a to 70d.

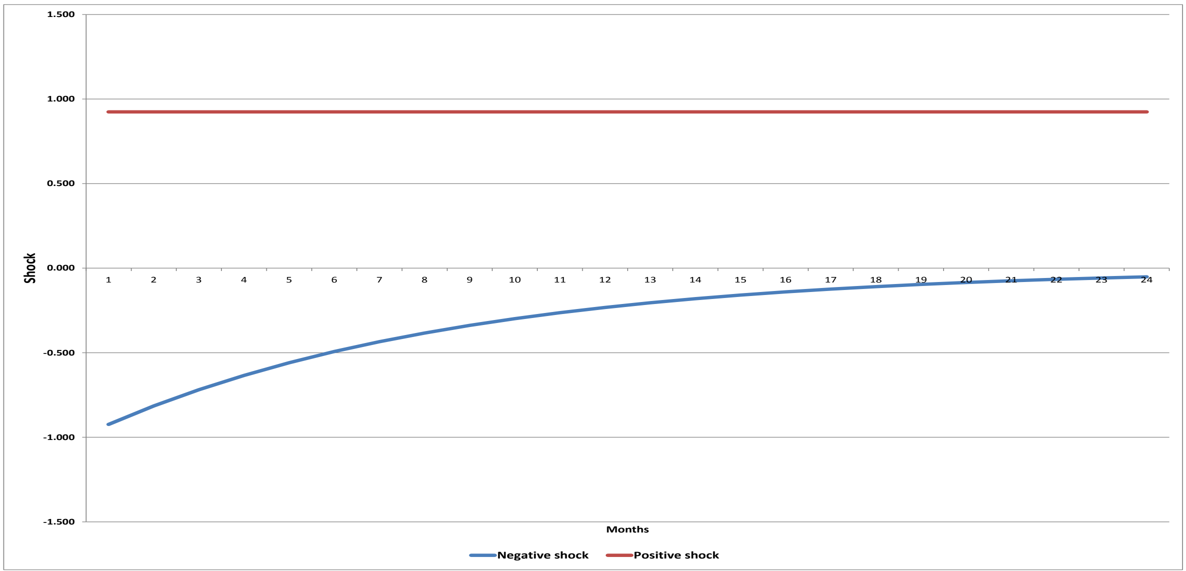

Figure 69a: LAN – impulse response analysis from international price shock
Source: Prof Alemu, 2010

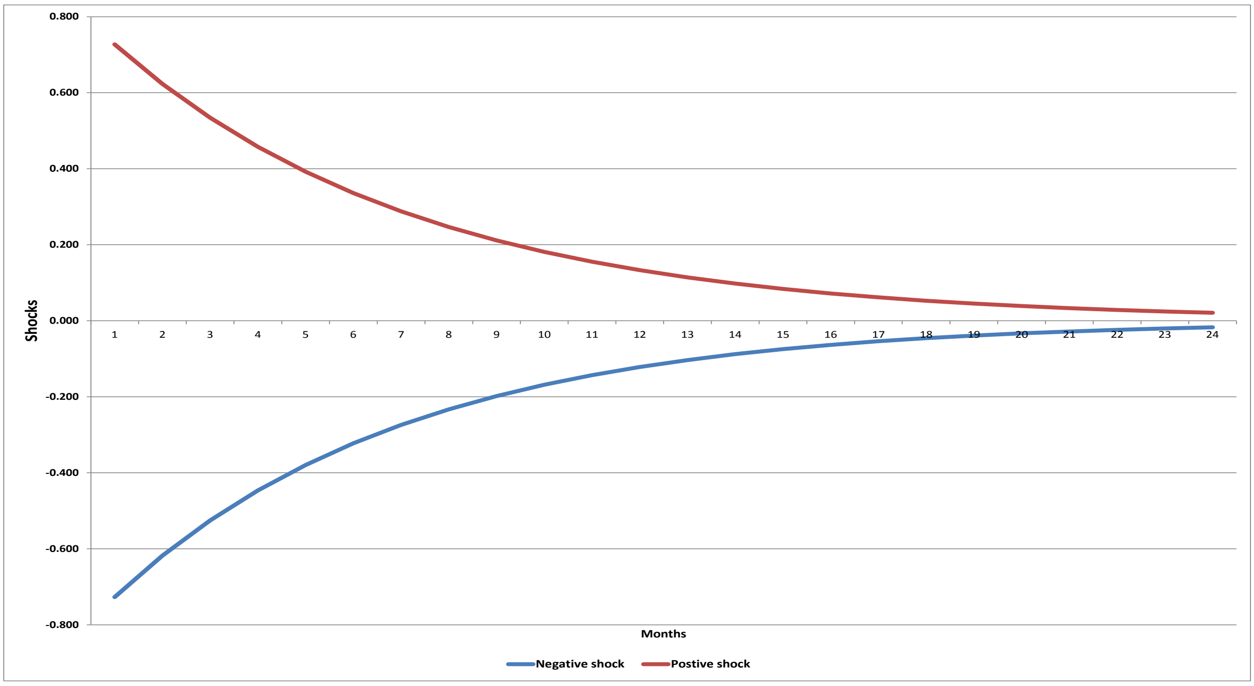

Figure 69b: MOP (KCL) – impulse response analysis from international price shock
Source: Prof Alemu, 2010

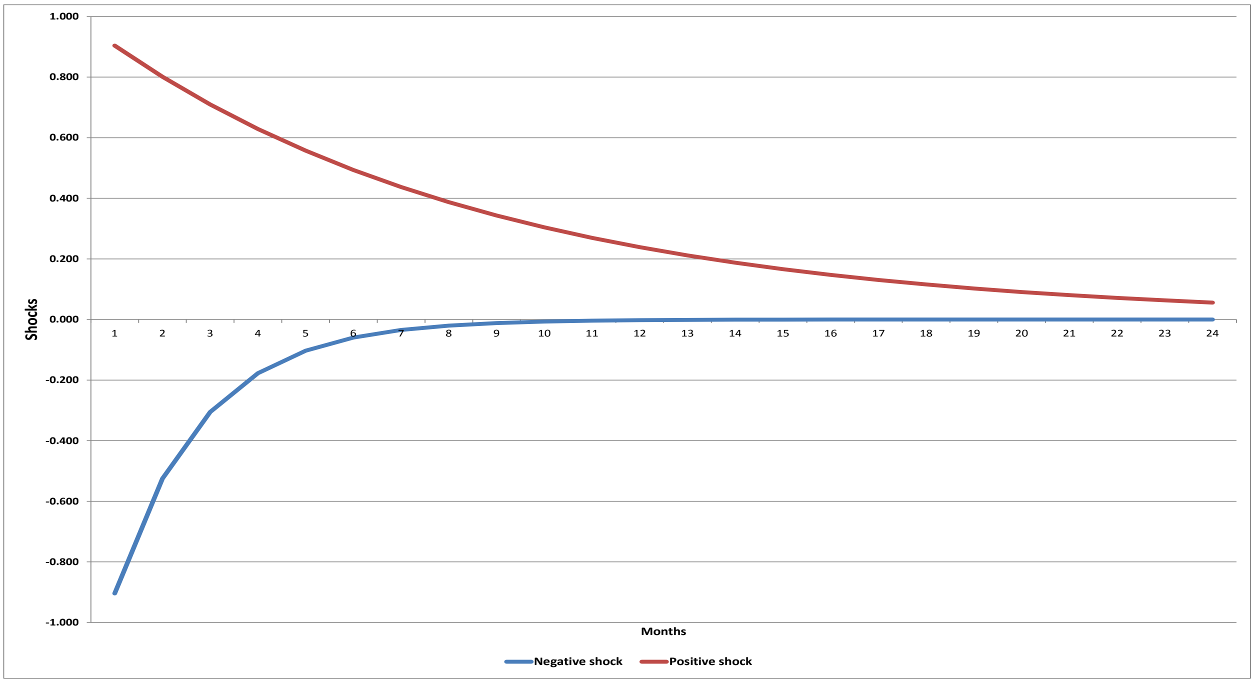

Figure 69c: Urea – impulse response analysis from international price shock
Source: Prof Alemu, 2010

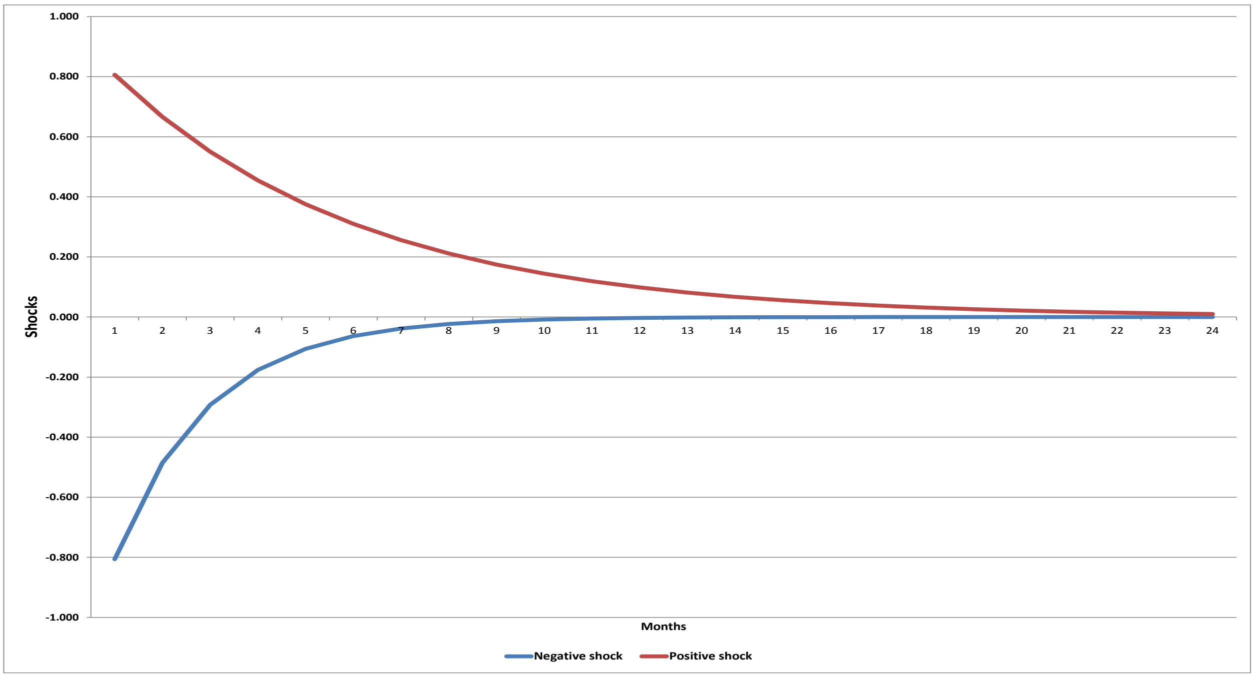

Figure 69d: MAP – impulse response analysis from international price shock
Source: Prof Alemu, 2010

To fix ideas, the study demonstrates how the impulse function was estimated using ammonia as example. A unit increase in world price (a negative shock to traders' marketing margin) decreases the profit margin by about 0.92 units. This is corrected by a factor of 0.12 every month. What it means is that if world price increases by one unit, the local price of ammonia will increase by 0.076 units (see Column 2 Row 11 from bottom of Table 8). This means that the profit margin will decrease by 0.92 units (because your cost increased by one unit but you are able to increase the price of ammonia by only 0.076). The decrease in profit margin (0.92) is corrected by 0.0118 (Column 2, Row 4 from below) or equivalently by 0.12 every month.

Similarly, an increase in the exchange rate (a negative shock to the marketing margin) will result in a decrease in the marketing margin by about 0.88 units. In both cases, the disequilibria are corrected by a factor of 0.12 every month. Applying similar approaches, this time assuming a unit decrease in the world prices and exchange rates (examples of positive shocks), one finds that in general, in the long run, the margin in the ammonia industry is corrected more rapidly when squeezed than when it is stretched (Figures 69a and 70a). With ammonia/LAN, looking at the graphs, it is clear that a positive shock (a decrease in international prices or a strengthening of the exchange rate), statistically has no significant relation. This means that statistically, there is no significant relation between a price decrease in the international price of ammonia or appreciation of the Rand and the price of local LAN (limestone ammonium nitrate). This occurrence points to possible irregularities in the local ammonia and downstream products.

In general, Figures 69 and 70 show that it takes less months for negative shocks to be eliminated than positive shocks. In addition, results indicate that the world price and the exchange rate exhibit a similar pattern of adjustment for negative and positive shocks. For example, the number of months it takes to eliminate a negative world price shock is not much different from what it takes to eliminate a negative shock in the exchange rate.

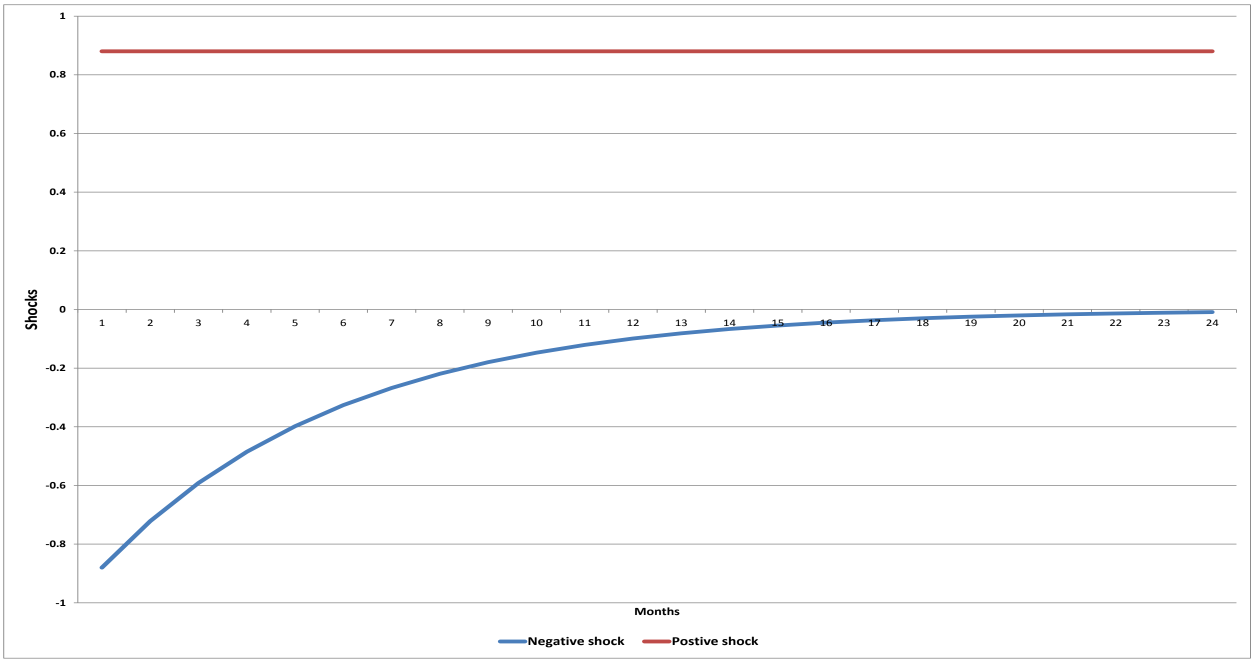

Figure 70a: LAN – impulse response analysis from exchange rate shock
Source: Prof Alemu, 2010

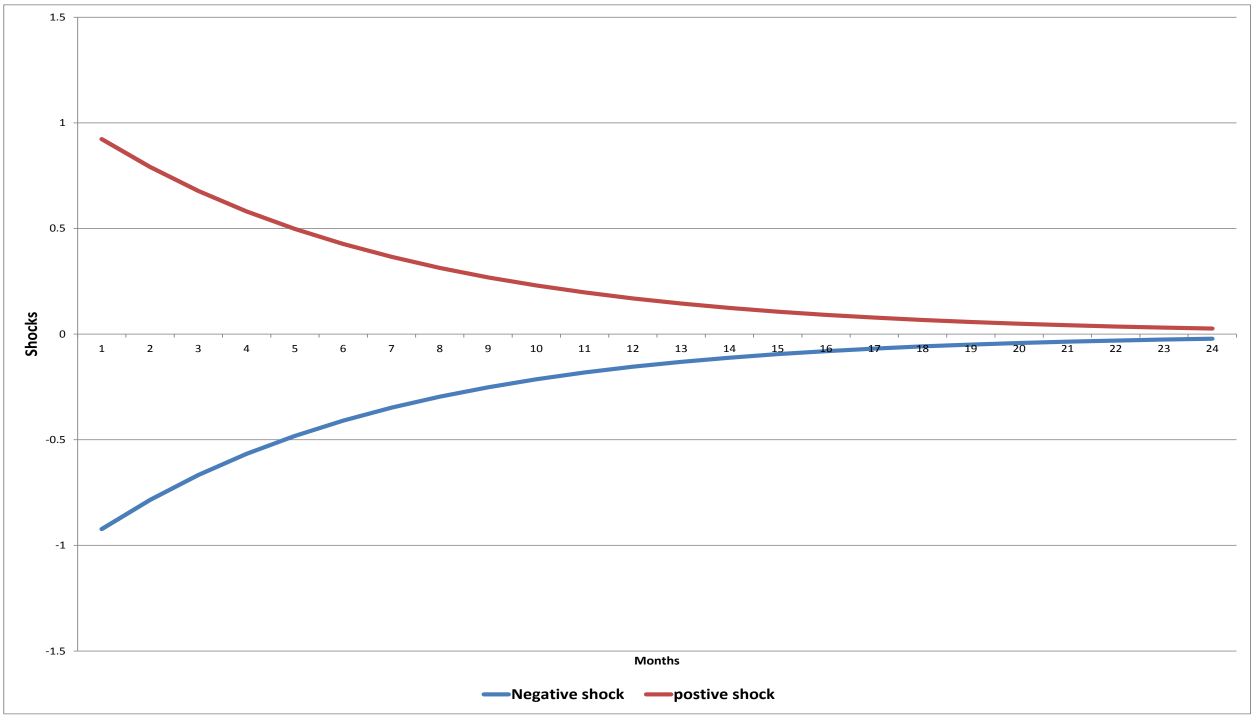

Figure 70b: MOP (KCL) – impulse response analysis from exchange rate shock
Source: Prof Alemu, 2010

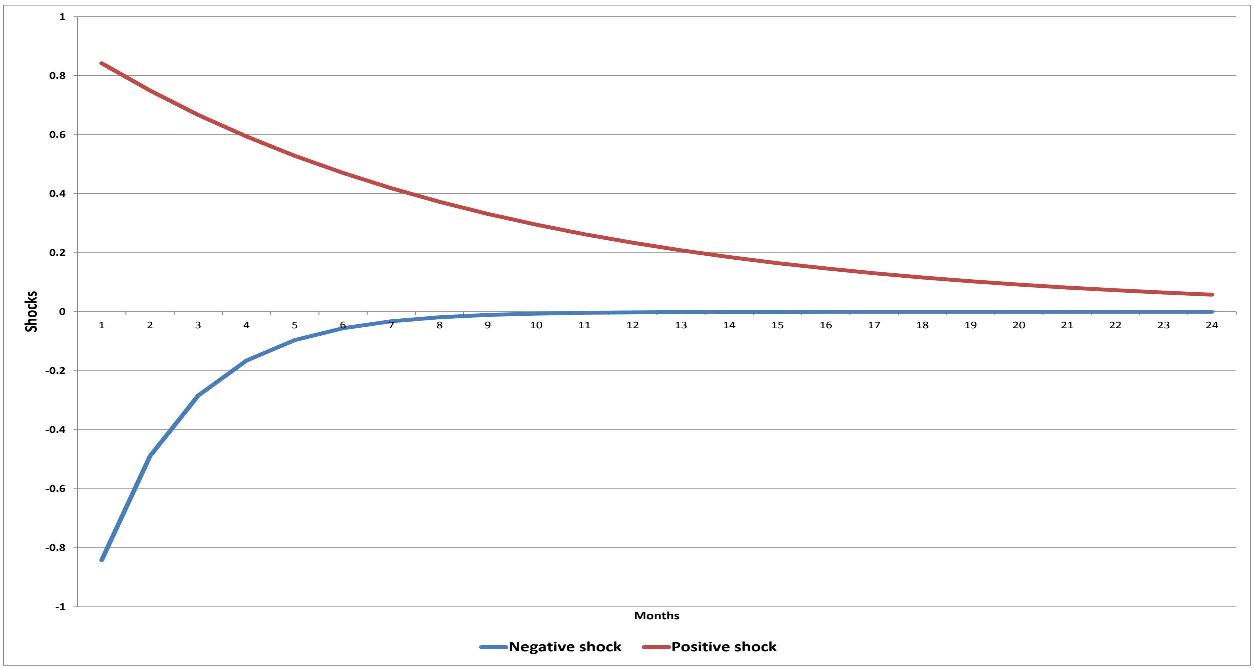

Figure 70c: Urea – impulse response analysis from exchange rate shock
Source: Prof Alemu, 2010

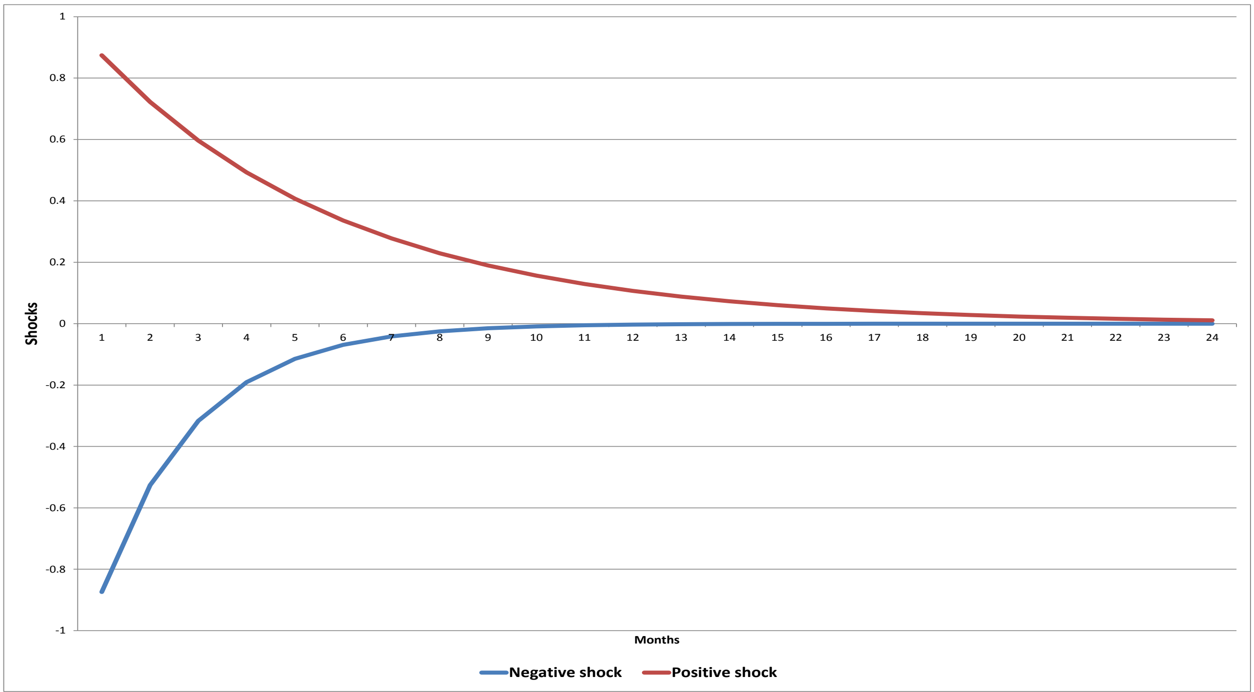

Figure 70d: MAP – impulse response analysis from exchange rate shock
Source: Prof Alemu, 2010

4.6 Summary of results and conclusions

Tests done with demand and supply-related factors, thought to be affecting international fertiliser prices, showed that on the supply side, the cost of producing fertiliser had significant effects on all the different fertiliser types; while on the demand side, only change in income measured by world GDP growth rate had a significant effect. Two sets of results are presented here – based on price decomposition and estimation of econometric models. Results from price decomposition show that changes in the price gap are to a larger extent dominated by non-policy factors – *non-policy factors can be deficiencies in market (market power), physical (transportation and storage), commercial (market information), and institutional (credit and regulating laws) infrastructure*. Price transmission estimates indicate that the relationship between local and landed prices is characterised by incomplete price transmission; and that compared with the world (border) price, much of the variation in the price gaps occurs as a result of the exchange rate.

The following provides a summary of results from the application of econometric techniques, which reinforce the ones expounded on earlier: local price depends positively on contemporaneous as well as lagged values of the world price and the exchange rate; shocks, regardless of their origin (driven by the exchange rate or world price or both), affect local prices; local prices respond more quickly to negative shocks than to positive shocks, implying that those involved in fertiliser trading react more quickly to shocks that squeeze their profit margin than those that stretch them; and it takes more or less a similar number of months for positive (negative) shocks emanating from changes in the border price and the exchange rate to be completely eliminated, implying that both play an important role for movements in local prices. The incomplete price transmission that was found in the results, according to the literature, could be the result of deficiency in the market infrastructure in the fertiliser industry.

Further, in comparing the international price of ammonia and the local price of LAN, it is clear that with a positive shock (a decrease in international prices or a strengthening of the exchange rate), there is statistically no significant relation. This occurrence points to possible irregularities in the local ammonia market and downstream products.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1. Introduction

Internationally fertiliser prices have experienced significant fluctuations in recent years. For example, from September 2007 to September 2008, the international ammonia, urea, Di-Ammonium Phosphate (DAP) and Muriate of Potash (MOP) prices increased by 285 %, 118 %, 143 % and 257 % respectively. However, from September 2008 to September 2009, international fertiliser prices decreased significantly. Prices of ammonia, urea, DAP and MOP decreased by 70 %, 65 %, 70 % and 46 % respectively. The aforementioned trends also affected the South African fertiliser market. Moreover, from September 2007 to September 2008, South African LAN, urea, Mono-Ammonium Phosphate (MAP) and Muriate of Potash (MOP) prices increased by 138 %, 131 %, 175 % and 270 % respectively. From September 2008 to September 2009, prices of local fertiliser materials decreased significantly – local prices of LAN, urea, MAP and MOP decreased by 52 %, 53 %, 67 % and 31 % respectively. High price fluctuations or volatility in the fertiliser market makes management and planning very difficult, not to mention the impact it may have on the profitability and sustainability in grain and oilseed production.

Fertiliser as production input makes up a significant proportion of a grain and oilseeds producers' production costs (i.e. 30 % to 50 % for grains and 15 % to 25 % in the case of oilseeds). Understanding the manner in which the fertiliser value chain operates is therefore vitally important for all role players, and especially for producers who are users of fertiliser, in order to ensure optimal usage and purchasing behaviour. Moreover, a proper understanding of the fertiliser value chain should foster a better relationship between up and downstream stakeholders in this chain, but should also ultimately result in a more efficient chain in terms of structure, conduct and performance. In a business environment characterised by high concentration on both the input and outputs sides of the agricultural value chain, while producers are price takers, there is marginal room for inefficiencies, since ultimately all stakeholders depend on each other to maintain profitability and sustainability. Availability of accurate information and the timely dissemination thereof is hence vitally important to all stakeholders involved. Within the ambit of the aforementioned, this study contributes towards a better understanding of the fertiliser industry, which should ultimately result in better relations at each level of the fertiliser value chain, a better understanding of business systems and price formation, and inform stakeholders to better position themselves strategically.

The primary objective of this study was to investigate the structure, conduct and performance of the fertiliser industry in South Africa. Due to the open market structure and the natural constraint as far as the availability of certain feedstock's to produce fertilisers in South Africa, it was also necessary to understand the global market for fertilisers, since international fertiliser prices are ultimately transmitted to the domestic market. For example, understanding the factors that influence international fertiliser prices will provide insight and understanding of fertiliser's spill-over effects onto the domestic market. It will also provide valuable pointers in terms of how local prices are likely to change.

The following concludes the study:

5.2. International fertiliser industry

From Chapter 2, it is clear that the sharp rise in international fertiliser prices in 2007 and 2008 was caused by a few global economic factors converging, causing a "perfect storm". The reasons why fertiliser prices increased in 2007 and 2008 has been cited by various authors and organisations. This report also investigated trends in selected fertiliser prices. The most important factors that affected fertiliser prices can be summarised as follows:

- Nitrogen:
  - ✓ Low nitrogen inventories;
  - ✓ Higher demand for nitrogen driven by an increase in the area planted to grain crops;
  - ✓ The overall economic situation caused production costs of nitrogen to increase:
    - Brent crude oil prices influenced transport costs and freight rates;
    - Brent crude oil price influenced the natural gas price which is the main feedstock for nitrogen fertiliser; and
  - ✓ China imposed export taxes which meant that its nitrogen was only available to the rest of the international market at higher prices.

- Phosphates:
  - ✓ Higher demand for phosphates due to high grain prices and larger areas planted to grain crops;
  - ✓ Prices of phosphate rock, sulphur and ammonia, which are the three primary materials used in producing DAP, increased significantly;
  - ✓ Brent crude oil prices resulted in rising cost of transport and freight rates; and

- ✓ In contrast to nitrogen, phosphate stocks and DAP prices is not suggesting a strong relation. In fact, stock levels were significantly higher compared to the previous years at the time that prices were at record levels. One can however postulate that very low stock levels in 2006 and 2007 contributed to the increase in DAP prices, and that the industry subsequently reacted by producing more phosphate.

- Potassium:
  - ✓ The concentration within the potassium industry – only a few companies control the stock; and
  - ✓ High demand caused by an increase in grain crop plantings.
  - ✓ The start of the MOP price hike in 2007 coincided with a 10 year low in potassium stocks. Although stock levels rebounded in 2008, it was not enough to slow the MOP price increasing until end-2008;

Within the ambit of the aforementioned it is important to note that most of the factors mentioned above are derived from global trends such as increasing population, higher per capita incomes in developing countries, changes in consumer tastes and preferences towards more protein based diets, etc. In other words, it is important to also take cognisance of broader global developments as well, in an attempt to understand trends (current and future) in the fertiliser industry.

Although the study was initially started because of the high rise in fertiliser prices in 2007 and 2008, the findings also helped in explaining why prices decreased significantly after this period. The conclusion that was made from Chapter 2, which looked into factors influencing international fertiliser prices, is that it was both supply and demand-driven factors causing prices to increase sharply during 2007 and 2008. With regards to supply, it was low fertiliser stocks and production cost items increasing in costs that had an impact on prices; while on the demand side, the expansion of crop planting caused fertiliser prices to rise.

As indicated above, there are potentially a myriad of complex and interrelated factors that could affect movements in fertiliser prices; but in most instances, the exact relation is not entirely clear. It is for this reason that it was decided to determine whether any statistically significant relation exists between the factors mentioned and the price movement of different fertilisers. The statistical analysis showed the following:

- The following factors, namely the prices of ammonia, natural gas, Brent Crude oil, Sulphur, Phosphate rock and the available stocks of the different fertiliser products can all be considered as supply side drivers and were all statistically significant. In other words, changes in these factors will have an impact on fertiliser prices. In terms of ammonia the natural gas price, the Brent Crude oil price and the ammonia stocks available were all statistical significant. In the case of potassium, the potassium stocks available proofed to be significant. With regards to DAP, the prices of ammonia, natural gas, Brent Crude oil, Sulphur and Phosphate rock were significant. The available stocks of DAP were also significant. In the case of Urea, the prices of ammonia, natural gas and Brent Crude oil also proofed to be statistical significant.

- On the demand side, only change in income measured by world GDP growth rate had a significant effect on the prices of the different fertiliser products.

- The results (from chapter 4) showed further that USA maize prices did not have a significant effect on fertiliser prices. This is in contrast with findings and comments several authors and organisations made pertaining to the reasons why fertiliser prices increased. However, one can postulate that the expansion of hectares towards grain production impacted on the demand for fertilisers. The increase in hectares planted is in turn derived from high grain prices that incentivised producers to plant more hectares.

5.3. Local fertiliser Industry

5.3.1. Structure of the fertiliser industry in South Africa

Since 1903, the start of the fertiliser industry in South Africa, the industry has seen major developments and restructuring. The fertiliser industry, without any support measures and open to developments in international markets, should be able to compete globally; one can postulate that structural changes in the domestic industry were aimed at achieving this. The aforementioned, however, also resulted in a highly-concentrated fertiliser supply chain. In 2008, according Frost and Sullivan (2008), 86 % of the market share in terms of revenue in the fertiliser industry was shared between only three companies – at the time Sasol, Omnia and Yara. With Profert included, four companies shared 94 % of the market as far as revenue is concerned (note that in the process of writing this report, Yara has become Kynoch again and Sasol, as in 1992, decided to concentrate on wholesale production and to stop selling fertiliser as retailers). The constant restructuring of the fertiliser supply chain appears to have evolved in a sub-optimal manner; leading to practices in contravention of the Competition Act in South Africa. This was confirmed by several cases investigated by the Competition Commission and agreements have already been reached by some of the parties involved. In the one case, Sasol came to an agreement with the

Competition Commission regarding its part in colluding with Yara and Omnia and its abuse of dominance in the fertiliser market. Other cases are still on-going.

This concentration within the industry can dramatically change with the agreement between Sasol and the Competition Commission that was reached in 2010. Sasol agreed to sell five of its regional blending plants and will in future only supply the market on a wholesale level from Sasol Nitro Secunda and three distribution centres within a 100 km radius of Secunda and Sasolburg.

5.3.2. Domestic supply and trade

An increasing concern for local consumers of fertiliser is that according to statistics of the International Fertiliser Association (2010), South Africa is becoming more and more dependent on imports to satisfy the local fertiliser demand. In 1990, less than 20 % of fertiliser needs was imported; in 1999, 40 % of the demand was imported; and in 2008, over 65 % of South Africa's nutritional fertiliser needs was imported. This situation presents a considerable risk for the agricultural industry (in particular the grain crop sub-sector) in that it could cause (i) more and higher price volatility spill over effects onto the South African market for fertilisers and (ii) possible shortages as a result of unforeseen global events that could affect global fertiliser availability. This will in turn impact negatively on the sustainability and profitability of the sector which will put further pressure on South Africa to maintain and improve food security levels.

5.3.3. Domestic price trends

Due to the fact that South Africa imports over 60 % of its local fertiliser demand and that the local industry operates in the free market, international price trends will filter into the South African market.

Correlation estimates to determine the relationship between local and international prices showed that local fertiliser prices are highly correlated with their international fertiliser products. This confirmed the a priory expectations that local and international fertiliser prices are closely linked due to the high import quantities needed to satisfy the local demand. The strongest correlations were found for (i) international and local urea, (ii) international DAP and local MAP and (iii) international KCL and local KCL.

In order to determine a proxy for margins[5] in the fertiliser industry, an import parity price approach was used. This is not far-fetched given South Africa's level of fertiliser imports. In other words, the assumption underlying this approach is that import parity pricing will prevail in the case where South Africa is a significant importer of a particular product. The calculation is however more difficult to interpret in the case where the majority of a specific product is produced locally.

The results showed that when importing a product, the product itself costs approximately 50 % of the final price quoted on price lists (excluding average 12 % discount). The rest of the costs are made up by freight and inland transport cost (12 %); insurance; financing costs; discharging costs; and others (see calculation in Chapter 3). Included in these calculations is a margin, which is the difference between the import parity calculation and the average price on pricelists for the product. When considering an average discount of 12 % on the pricelist prices, a farm gate price could be determined. After taking an average 12 % discount into consideration, an average margin of 17 % was calculated for imported urea from January 2004 to date. With imported MAP, the margin was also 17 %; while a margin of 21 % was calculated for KCL. Without the discount, the margins for urea, MAP and KCL were 27 %, 27 % and 30 % respectively.

A price structure calculation for LAN showed that local LAN production is competitive with the imported product. When no discount on the list price was considered, a margin of 8 % was showed. When a discount of 12 % was considered however, the margin was negative (-5 %). This means that it would be cheaper to purchase LAN from local companies that manufacture LAN rather than to import it. This finding was expected because South Africa, through Sasol's ammonia production, can produce large quantities of LAN and can be competitive with international markets. Because all of South Africa's LAN is locally produced, it is difficult to make conclusions about the price structure and margins companies receive in the LAN market. Companies, however, as seen in the import parity calculations, can push their prices just below the import costs of LAN, and would still stay competitive.

A noteworthy issue that emerge from the analysis is the difference between the calculated margins between LAN and MAP. The reason is that the a priory expectation was that these margins will be more or less of the same order in light of the fact that both products are produced locally. The reason for this expectation is that South Africa is in fact a net exporter of phosphoric acid, the main raw material for MAP. The local price structures, within the whole phosphate chain, therefore require further investigation.

[5] Margin in this context does not necessarily imply net profit, but is used to indicate a derived margin when taking into account as many as possible variables that could affect margins in the industry.

5.4. Price transmission between international and local fertiliser prices

In earlier chapters of this study, it was confirmed that there is a relation between local and international fertiliser prices. It is, however, important to better understand the nature of this relation, since this will provide valuable insights into how price formation takes place. For example, is international price transmission symmetric or asymmetric? When price transmission is symmetric, it indicates that local prices respond similarly to both upward and downward movements in the international fertiliser prices. However, when price transmission is asymmetric, then it could be indicative of local prices reacting differently to increases in international fertiliser prices than to decreases. In order to analyse the nature of price transmission, econometric tools were used, more specifically, the Threshold Autoregressive Models, the Momentum Threshold Autoregressive Models (M–TAR), the Momentum Consistent Threshold Autoregressive Models (MC-TAR) and the Error Correction Models.

The results from the analysis show that price transmission between international and local fertiliser prices is incomplete. This means that changes in international fertiliser prices are not completely passed through to local fertiliser prices. It was found that much of the differences between international and local price changes was caused by non-policy factors, such as deficiencies in the market (market power); physical (transport and storage); commercial (market information); and institutional (credit and regulating laws) infrastructure. Price transmission estimates indicate that the relationship between local and landed prices is characterised by incomplete price transmission; and that compared with the world (border) price, much of the variation in the price gaps occurs as a result of the exchange rate.

The results further showed that price transmission between international and local prices is asymmetrical. In other words, local prices respond differently to upward movements in international prices than to downward movements. The results showed that local prices respond more quickly to international price increases or the depreciation of the value of the Rand than to international price decreases or the appreciation of the value of the Rand. This means that fertiliser companies react more quickly to changes in international fertiliser prices that put their profit under pressure (price increases) than to international price changes (price decreases) that stretch their profits. What was also found, was that there was statistical no significant relationship between a decrease in the international price of ammonia and the local price of LAN. This means that the local LAN price does not normally react to an international price decrease in ammonia. This result can mean one of two things:

1. The local LAN price may not be reacting to a change in the international ammonia price because of the fact that South Africa is completely self-sufficient in terms of LAN. The

question that comes to mind with this argument is, why does the LAN price not react to a decrease in the ammonia price, but reacts when the price increases? Another argument that comes to mind is that South Africa needs to import some of its ammonia to be able to satisfy the local demand and, therefore, part of the production costs of LAN may be on import parity.

2. The fact that the results show that the local LAN price mechanism is asymmetric in nature emphasises that the structure and conduct in this chain requires further investigation.

5.5 Recommendations

- **Recommendations to Government**

Due to the fact that the Competition Commission has already pointed out irregularities in the local fertiliser market in terms of competition, that there are still on-going investigations and that fertiliser makes up such a large proportion of a grain producer's production costs, monitoring of competition within the industry should be a permanent process. The results from the report also shows that market power within the fertiliser industry can be one of the contributing factors to price disparity in the industry and it also showed that local prices respond more quickly to international price increases than to international price decreases. It is therefore recommended that the Competition Commission should either continuously monitor the fertiliser industry or help to put mechanisms in place for industry role players to monitor the industry themselves.

As mentioned above, much of South Africa's infrastructure that is used to produce primary fertiliser materials is very old and very expensive to replace. However, it is important to bear in mind that the trends show that South Africa is importing increasing amounts of fertiliser on an annual basis to satisfy the local demand. South Africa's urea producing plants were already closed in 2000 because of the fact that the old infrastructure could not compete with imports. Years in which there is an international shortage of fertiliser could affect South Africa's ability to produce enough food because of a shortage of fertiliser, and could affect food security in South Africa. It is therefore recommended that Government (in particular DTI and the IDC) consider mechanisms to revitalize the local fertiliser industry. The risks of being increasingly reliant on imports to satisfy local fertiliser demand should be sufficient motivation to engage in such an endeavour. To be solely dependent on imports can also have a negative effect on prices and therefore also the grain producers' ability to produce affordable food for the country.

Multi-national fertiliser companies state that the high level of uncertainty prevailing in South Africa, and failure of Government to implement policies that are supposed to create a conducive business environment, constitutes a major challenge for them to make huge capital and long-term investments in the South African fertiliser industry. For example, Yara, one of worlds the largest multi-national companies, left the South African market in 2010.

Because of the fact that approximately 70 % of all fertiliser needs in South Africa are imported, transport and distribution costs of fertiliser becomes a significant contributor to the price of South African fertiliser to the farmer. The results from the price transmission models in chapter 4 also confirm that transport may be one of the major factors distorting local fertiliser prices. Transport is mainly done by road, because rail transport has become unreliable and has deteriorated significantly in the last decade. The rail infrastructure and capacity between Phalaborwa and Richards Bay also impedes on Foskor's ability to move enough phosphate rock to produce phosphoric acid and MAP more cost efficiently. Nationwide, the lack of an efficient rail transport system is also impeding on the transport of ammonia. This needs to be taken up with the National Department of Transport and Public Works.

Information transparency within the fertiliser industry is a concern. Much can be done to make, especially price information, more transparent. It is therefore recommended that the National Agricultural Marketing Council consider mechanisms to increase the flow of information within the fertiliser industry.

- **Recommendations needing further investigation**

Anecdotal evidence suggests that co-ops and agribusiness demand a 3 % to 8 % commission on top of normal finance costs for transactions being financed through them, which was sold directly to the farmer by the fertiliser company. The composition and structure of this commission requires further analysis since it constitutes a significant additional cost to the farmer.

As mentioned above, the local price structure within the whole phosphate value chain requires further investigation.

The fact that results showed that the local LAN price mechanism are asymmetric in nature, emphasises that the structure and conduct in the local nitrogen chain also requires further investigation.

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Appendix A

1. Nitrogen

1.1 Selected companies

During 2007, South Africa imported 57 % of its nitrogen needs from Saudi Arabia and 41 % from Qatar. In the following section, the companies of importance to the South African industry are discussed.

Saudi Basic Industries Corporation (SABIC) - Saudi Arabia

SABIC is one of the world's leading manufacturers of chemicals, fertilisers, plastics and metals. These materials are supplied to other companies, who then use them to produce final products. The fertiliser segment consists of approximately 12.5 % of the total production of SABIC, which accounts for approximately 7 million tons of fertiliser. SABIC has three fertiliser affiliates, Saudi Arabian Fertiliser Company (SAFCO), Al-Jubail Fertiliser Company (AL-BAYRONI) and National Chemical Fertiliser Company (IBN AL-BAYTAR). They have a sales office in Cairo, Egypt and a distribution and storage centre in Durban, South Africa. They produce a wide range of fertilisers that include urea, ammonia, Di-Ammonium Phosphate (DAP), sulphuric acid, and compound and liquid fertilisers (Sabic, 2009).

Qatar Fertiliser Company (QAFCO) - Qatar

QAFCO was founded in 1969 as a joint venture between the State of Qatar, Norsk Hydro Norway, Davy Power Gas, and Hambros Bank to produce ammonia and urea by utilising Qatar's abundant gas resources. The company is currently owned by Industries Qatar (IQ), as 75 % shareholder, and Yara International, as 25 % shareholder.

During 2008, QAFCO registered record production figures for both ammonia and urea. Ammonia production at QAFCO exceeded its budgeted target by 4.5 %, as 2.18 million metric tons of ammonia was produced; while urea production was determined at 2.99 million metric tons which was 2.7 % more than the target.

QAFCO's ammonia exports reached India, Jordan, the USA, China, Australia, Korea and other markets. India and Jordan accounted for 46 % and 29 % respectively of their total ammonia export. India and South Africa are the major importers of urea from QAFCO. South Africa imported 10 % of their total urea which was exported, which accounts for approximately 0.309 million tons (QAFCO, 2008).

1.2 Capacity

The 2009 market is characterised by a search for new nitrogen capacity. IFA stated that capacity development between the period of 2008 and 2013 will take place due to optimistic prospects for fertiliser demand growth, differential input costs, downstream developments and export opportunities.

Ammonia

Global ammonia capacity is expected to increase by 20 % from 180.9 million tons ammonia (NH3) in 2008 to 217.8 million tons NH3 in 2013. IFA (2009) stated that a third of this increase will come from revamping activities and that the remaining two thirds will be from new developed plants worldwide, with the establishment of 55 new units. Global ammonia capacity will increase by approximately 7 million tons per year but close to 10 million tons during 2012 (IFA, 2009). Figure 71 shows expected world NH3 capacity from 2009 to 2013.

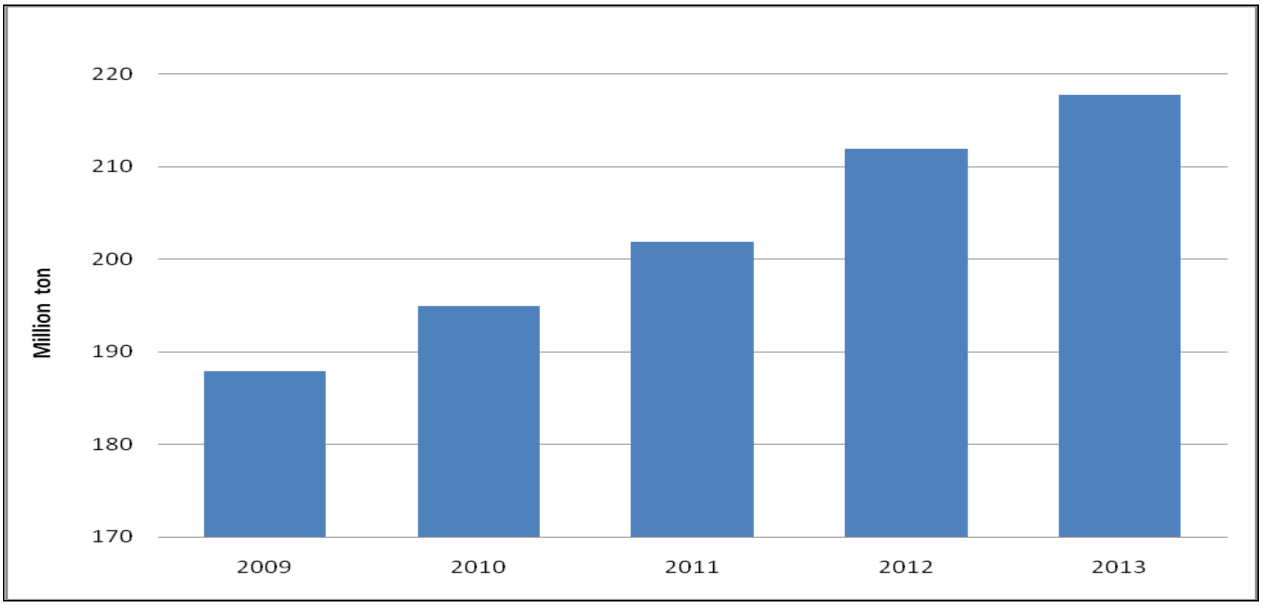

Figure 71: World ammonia capacity from 2009 to 2013
Source: IFA, 2009

Urea

According to IFA (2009), none of the urea projects developed during 2008 and 2009 was cancelled, although they suffered some delays in establishment and construction. Approximately 50 new plants are planned to come on stream between 2009 and 2013, of which approximately 20 are located in East Asia. Global urea capacity is forecasted to grow by a net 30.9 million tons between 2009 and 2013. Figure 72 shows expected world urea capacity from 2009 to 2013.

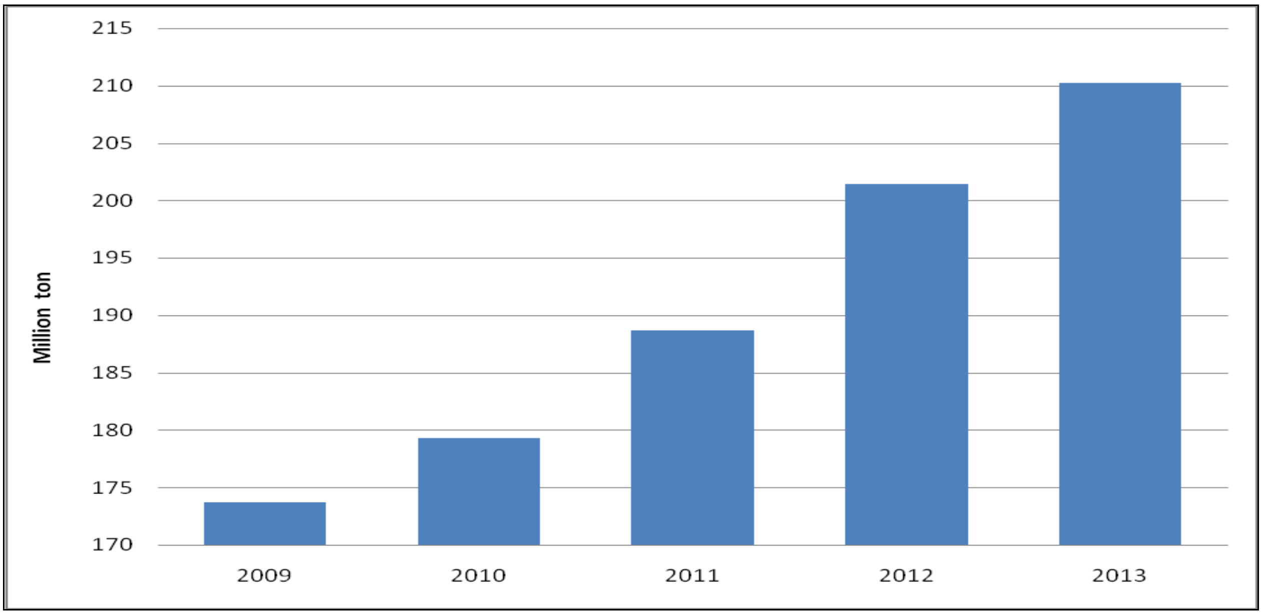

Figure 72: World urea capacity from 2009 to 2013
Source: IFA, 2009

2. Phosphate

2.1 Selected companies

Mosaic - United States of America (USA)

The Mosaic Company is one of the world's leading concentrated phosphate and potassium crop nutrients producers and marketers. It provides phosphates, potash and nitrogen fertilisers for the global agriculture industry. Mosaic operates key distribution facilities in 11 countries and serves customers in 33 countries. Mosaic operates port terminals, warehouses, and blending and bagging facilities in nine countries. Mosaic also operates 16 phosphate rock mines and plants, five potash-production facilities and a nitrogen-production facility.

Foskor - South Africa

Foskor is primarily a producer of phosphoric acid and phosphate-based fertilisers while also distributing lower volumes of sulphuric acid. It is one of the world’s largest phosphate and phosphoric acid producers.

Foskor's phosphate rock and granular fertiliser products are mostly domestically consumed with limited exports; while phosphoric acid is mostly exported with limited domestic consumption. Foskor's export markets include India, Japan, Brazil and Australia (Foskor, 2009).

2.2 Capacity

Global physical phosphoric acid capacity is forecasted to increase by 9.2 million tons to 55.3 million tons phosphorus pentoxide (P2O5) between 2009 and 2013. According to IFA, the main additions to domestic capacity will occur in China, Saudi Arabia and Morocco. Figure 73 shows the expected capacity expansions for phosphoric acid from 2009 to 2013.

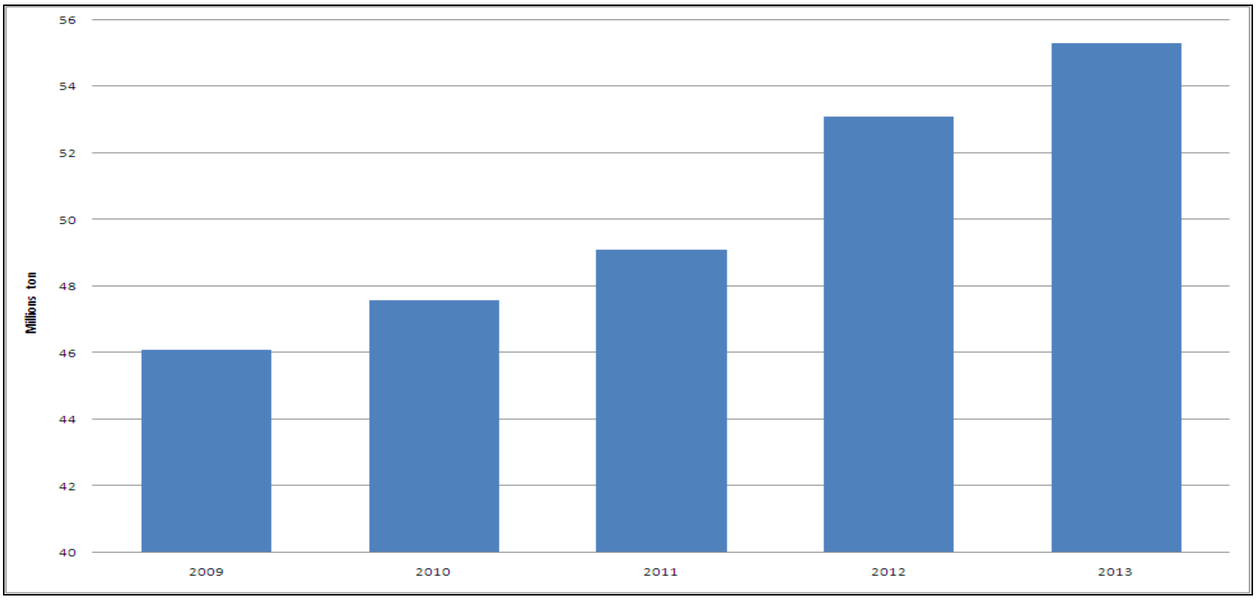

Figure 73: World phosphoric acid capacity from 2009 to 2013
Source: IFA, 2009

IFA (2009) projected world phosphate rock capacity in 2013 at 248 million tons, which represents a 30 % growth compared to 2008. Several capacity expansion projects for new mines have been postponed due to rising costs and delays in addition with new downstream production.

According to IFA, world-processed phosphate capacity would reach an estimated 42.5 million tons P2O5 during 2013. This is a total increase of 9.1 million tons compared to 2008.

Close to 40 new Mono-Ammonium Phosphate (MAP), Di-Ammonium Phosphate (DAP) and Triple-Super Phosphate (TSP) units will be developed in ten countries, which include 18 plants in China alone. New facilities are planned in Africa, West Asia, East Asia and Latin America. The largest product capacity development will be for DAP, which is projected to increase by approximately 1.1 million tons P2O5 per year during the next five-year period (IFA, 2009).

During 2005, the USA was the world's largest DAP producer, followed by India and China. Africa is also a large DAP producer and is ranked in fourth place (PotashCorp, 2005). Figure 74 shows the DAP production as well as the space for excess capacity by country for 2005.

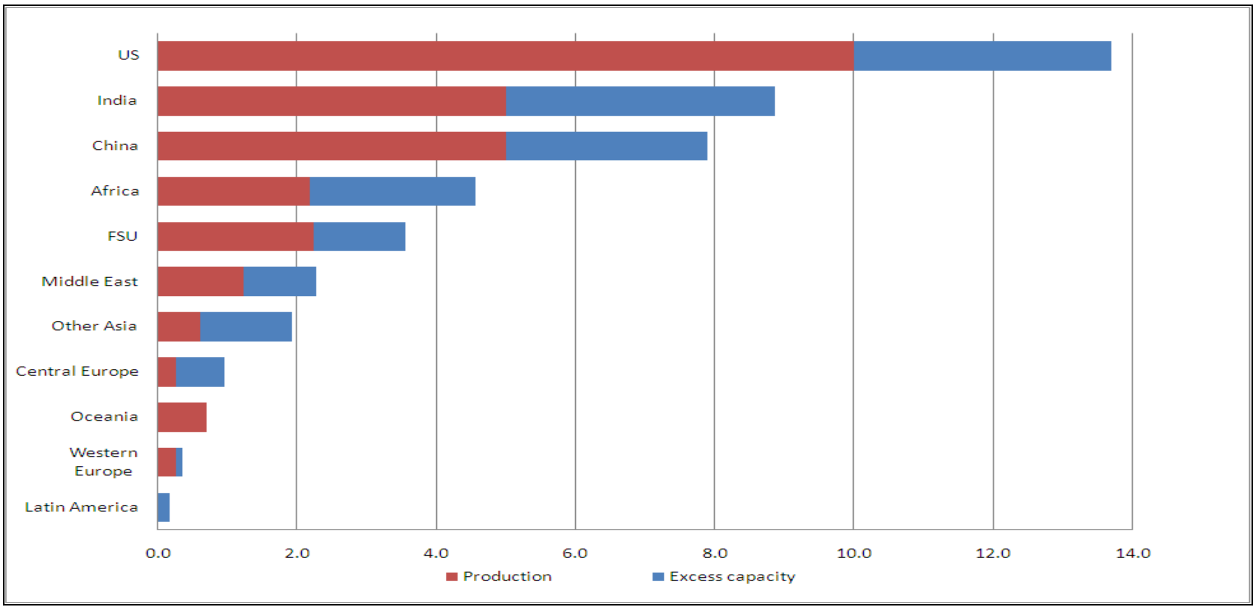

Figure 74: World DAP production and access capacity by country (million tons product) for 2005
Source: Potash Corp (2009)

3. Potassium

All South Africa's potassium requirements are imported and imports are mainly from Germany, Belarus, Chile, Israel and Jordan, with around 80 % of imports coming from Germany and Israel.

3.1 Selected companies

Potash Corp - Canada

PotashCorp is the world's largest fertiliser company by capacity, producing all three of the primary crop nutrients (N, P and K). It is the world's leading potash producer and is responsible for approximately one quarter of the global capacity. PotashCorp is an international key player with operations and business interests in seven countries.

There are 13 global competitors in the potash market sector. They are (from largest to smallest): Potash Corporation (PotashCorp) of Canada; Belaruskali (Belarus); Mosaic (Canada, USA); Silvinit (Russia); Uralkali (Russia); ICL (Israel, Spain, UK); Kali+Salz (Germany); Sinofert (China); APC (Jordan); Agrium (Canada); Intrepid (USA); Companhia Vale do Rio Doce (Brazil); and SQM

(Chile). PotashCorp holds 32 % of SQM, 28 % of APC, 22 % of Sinofert, and 11 % of ICL. In total, PotashCorp controls 22 % of global potash capacity.

The first ten of the companies listed above jointly hold more than 95 % of global capacity and nearly 95 % of global potash production is used as fertiliser (Cambell, 2009).

PotashCorp has few competitors, since the fertiliser industry has significant barriers to entry and economies of scale. Its two main competitors are Mosaic Company and Agrium. Table 9 shows that Mosaic Company is the second largest potash producer, and the largest phosphate producer, with 15 % and 16 % of global market share respectively. Agrium also produces potash and phosphate like its competitors, and is the leading nitrogen producer (Wikinvest, 2009).

Table 9: Leading fertiliser producers for 2008 (annual nutrient capacity, million tons)

Company	Phosphate	Potash	Nitrogen
Potash Corporation	2.4	13.2	3.5
Mosaic Company	9.4	10.4	0.5
Agrium	1	2.1	5

Source: Wikinvest, 2009

Although PotashCorp and its competitors have similar revenues, it has the ability to set favourable prices by controlling the limited supply of potash, which puts PotashCorp ahead of its competitors in terms of net income and margins. Table 10 shows the three companies comparing their financial information for 2008 (Wikinvest, 2009).

Table 10: Leading fertiliser producers for 2008 (financial comparison, US$)

Company	Revenue	Net income	Profit margin	Operating margin
Potash Corporation	$9.4 B	$3.5 B	37.00 %	49.07 %
Mosaic Company	$9.8 B	$2.1 B	21.23 %	28.60 %
Agrium	$10.3 B	$1.3 B	12.87 %	19.34 %

Source: Wikinvest, 2009

3.2 Capacity

Many potential producers were urged to invest in potash exploration and capacity expansion programmes due to the market circumstances of the recent years and strong demand forecasts in the medium term. There are more than 65 potash-related projects in more than 20 countries, although only a few will take place during the next five years (IFA, 2009).

Capacity additions will be restricted in 2009 but will accelerate thereafter on an annual basis and the majority of these new potash capacities will be made for MOP (IFA, 2009).

Global potash capacity is estimated to increase from 41.8 million ton potassium oxide (K2O) in 2009 to 54.7 million ton K2O in 2013. This represents an extra 12.9 million tons of capacity, mostly in Canada, Russia and China; along with new tonnage in Israel, Jordan, Argentina and Congo. Although world potash supply is planned to increase, more than 60 % of this increase will only take place after 2011 (IFA, 2009). It is expected that supply will remain tight and prices will continue to rise, which means that the world will be relying on existing idle capacity (IFA, 2008).

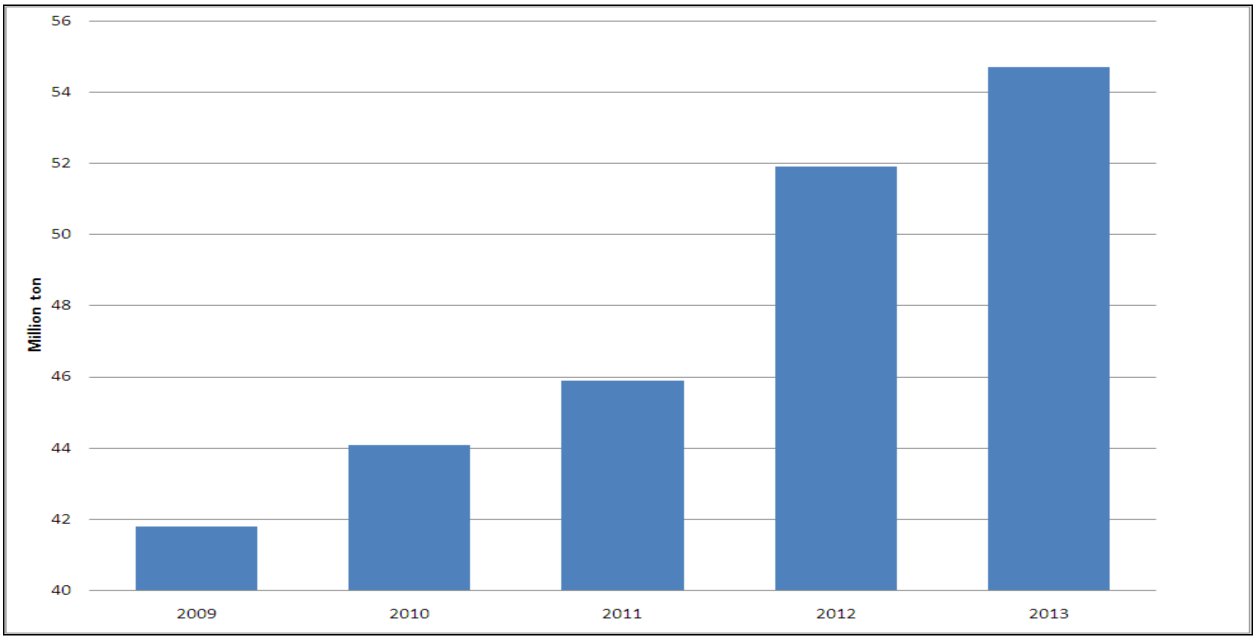

Figure 75: World potash capacity from 2009 to 2013
Source: IFA, 2009

Appendix B: Price decomposition

The price gap (G) between local and landed price is computed as

[1] $G = p^d - p^w X$

Where G is the price gap after adjustment for domestic transaction costs; p^d is local price of fertiliser; p^w is world (boarder) price expressed in USD; and X is the exchange rate.

To be able to compute factors responsible for over time change in the price gap (G) we difference [1] to get

[2] $\Delta G = \Delta p^d - \Delta(p^w X)$

Multiplying Δp^d by Δp^d by $1 = \left(\frac{p^d}{p^d}\right)$ and $\Delta(p^w X)$ by $1 = \left(\frac{p^w X}{p^w X}\right)$ we get

[3] $\Delta G = p^d \dot{p}^d - p^w X \, \dot{\overbrace{p^w X}}$

We then multiply $p^d \dot{p}^d$ by $1 = \dot{\overbrace{p^w X(1+t)}} \Big/ \dot{\overbrace{p^w X(1+t)}}$ to get [4]. where t is the tariff rate; and

$p^w X(1+t)$ is duty included landed price. The tariff rate t takes a value of zero as South African fertiliser imports are not subjected to tariff.

[4] $\Delta G = p^d e \, \dot{\overbrace{p^w X(1+t)}} - p^w X \, \dot{\overbrace{p^w X}}$

Where $e = \dot{p}^d \Big/ \dot{\overbrace{[p^w X(1+t)]}}$ is the price transmission elasticity (PTE).

To isolate the effect of incomplete transmission, we insert in [4] $(e + k - k)$, where, $k = 1 - e$, such that $e + k = 1$. In addition we replace absolute change by percent change. This gives [5]

[5] $\dot{G} = \frac{p^d \, \dot{p}^d \, \dot{\overbrace{[p^w X(1+t)}}}{p^d - p^w X} - \frac{p^w X \, \dot{\overbrace{p^w X}}}{p^d - p^w X} - \frac{p^d k \, \dot{\overbrace{[p^w X(1+t)]}}}{p^d - p^w X}$

Equation [5] has got three terms in its right hand side. The last term would drop out if transmission from landed price to domestic price were complete (e=1, such that k=0). This means that this term explains variations in price gaps caused by incomplete transmission. By implication the first two terms explain changes in the price gap under conditions that there is complete transmission.

Equation [5] needs to be further decomposed in a manner that the final form of the equation contains not more than one of the terms expressed as a percent change and also that no term contains the percent change of either a sum or a product of two or more of these variables. For details on this see Liefert (2005).

Appendix C: Econometric Approach

We estimate [1] to establish long run relationships between local and international prices.

[1] $P_t^d = \partial + \partial_1 p_t^w + \partial_2 X_t + \varepsilon_t$

Where, P_t^d ,P_t^w, and X_t are local price, world (boarder) price, and the exchange rate respectively, and ε_t is the error term. Conventionally, the presence of a long-run relationship among the variables is tested by estimating [2].

[2] $\Delta\varepsilon_t = \rho\varepsilon_{t-1} \sum_{i=1}^{k} \Delta\varepsilon_{t-i} + v_t$

Where, ρ is adjustment parameter, and ε_t is as defined before. Cointegration is said to exist when the null hypothesis of no co integration, i.e. $\rho = 0$ in [2] against its alternative hypothesis of co integration, i.e. $-2 < \rho < 0$ is rejected.

However, the conventional methodology is criticised because of the assumptions it makes about adjustments towards equilibrium. It assumes (implicitly) that adjustment is symmetric. This may not be true when local fertiliser prices respond differently to changes in the world price and the exchange rate. This is true when the nature of the market structure allows local fertiliser traders to respond more quickly to shocks that squeeze their profit margin than those that stretch them.

To address this shortcoming, Enders & Siklos (2001) extended [2], with asymmetric adjustment toward equilibrium being made part of the alternative hypothesis. This requires estimation of [3].

[3] $\Delta\varepsilon_t = \rho_1 I_t \varepsilon_{t-1} + \rho_2 (1 - I_t)\varepsilon_{t-1} + \sum_{i=1}^{k} \Delta\varepsilon_{t-i} + v_t.$

Where, ε_t is as defined before, ρ_1 & ρ_2 are adjustment coefficients, k is the lag length whose value is determined using the Akiake (AIC) and Swartz (SC) information criteria; and I_t is the Heaviside indicator which takes a value of 1 and zero depending on the relationships between ε_t and τ see [4].

[4] $I_t = \begin{cases} 1 \; if \; \varepsilon_{t-1} \geq \tau \\ 0 \; if \; \varepsilon_{t-1} < \tau \end{cases}$

Where, τ is the threshold and taking any value depending on the type of model estimated. In the case of a Threshold Autoregressive Model (TAR) it takes a value of zero. This makes [5] different from [4] in that it allows actors in the market to respond differently to upward and downward swings in the exchange rate and world prices.

The necessary and sufficient conditions for cointegration are that ρ_1 & ρ_2 be less than zero and that $(1+\rho_1)(1+\rho_2)<1$ for any value of τ (Petrucelli & Woolford, 1984, as cited in Enders & Siklos, 2001).

In addition to TAR, Enders & Siklos (2001) introduced two other competing models with alternative adjustment specifications but within the threshold frameworks. These include the Momentum Threshold Autoregressive Model (M-TAR) and Momentum Consistent Threshold Autoregressive Models (MC-TAR).

M-TAR allows the threshold to depend on changes in previous levels of ε_t. It is appropriate when deviation from the long run exhibits more 'momentum' in one direction than the other. It also comes handy in cases when monetary authorities react more to inflationary situations that increases the deviation but not decrease it. This requires specifying the Heaviside indicator as [5]

[5] $$M_t = \begin{cases} 1 \; if \; \Delta\varepsilon_{t-1} \geq \tau \\ 0 \; if \; \Delta\varepsilon_{t-1} < \tau \end{cases}$$

Where, M_t is the Heaviside indicator and ε_{t-1} is as defined before.
The theoretical justification for estimating MC-TAR is similar to that of M-TAR. The only difference is with regards to the value of the threshold τ which is no longer fixed at 0. It is considered unknown. It is determined along side with the values of ρ_1 & ρ_2. This is done by searching for it over the potential threshold variable space by minimising the Residual Sum of Squares in [3]. Hence, the Heaviside indicator may be specified as [6].

[6] $$MC_t = \begin{cases} 1 \; if \; \Delta\varepsilon_{t-1} \geq \tau * \\ 0 \; if \; \Delta\varepsilon_{t-1} < \tau * \end{cases}$$

Where, MC_t is the Heaviside indicator, ε_{t-1} is as defined before, and $\tau *$ takes a value different from 0.

Two types of tests are performed on the estimates from [3]. First, to check for co integration by jointly testing for the null hypothesis that $\rho_1 = \rho_2 = 0$ against its alternative hypothesis of $\rho_1 = \rho_2 \neq 0$. Second, to test for symmetry in adjustment by testing the null hypothesis of $\rho_1 = \rho_2$ against its alternative of $\rho_1 \neq \rho_2$.

To conduct the first test, a non-standard testing procedure is recommended as parameters are identified only in the alternative hypothesis. Enders and Siklos (2001) run a Monte Carlo experiment to compute critical values. These critical values are compared against the F-statistics to test the no co integration null hypothesis. They labelled the F-statistic Φ for TAR and M-TAR models and its analog Φ^* for the MC-TAR model. The test statistics Φ and Φ^* are used only on conditions that ρ_1 and ρ_2 satisfy the convergence conditions $\rho_1, \rho_2 < 0$. For the second, standard Wald test is applied. It is found that OLS estimates for ρ_1 & ρ_2 have an asymptotic multivariate normal distribution (Tong, 1990, as cited in Enders & Granger, 2001). Failure to reject the null hypothesis reduces [3] to [2].

Finally, the three competing models are compared to determine the model that best fits the data. The resulting ECM in the context of which impulse response functions are computed takes the form given by [7].

$$[7] \quad \Delta p_t^d = \sum_{i=1}^{k} \beta_i \Delta p_{t-i}^d + \sum_{i=0}^{k} \alpha_i \Delta p_{t-i}^w + \sum_{i=0}^{k} \varphi_i \Delta X_t + \gamma_{11} \epsilon_{t-1}^{+ve} - \gamma_{12} \varepsilon_{t-1}^{-ve} + v_{1t}$$

$$-\gamma_{22} \varepsilon_{t-1}^{-ve} + v_{2t}$$

Where, $\varepsilon_{t-1}^{+ve} = I_t \varepsilon_{t-1}$, $\varepsilon_{t-1}^{-ve} = (1 - I_t) \varepsilon_{t-1}$, v_t is the residual term, and p_t^d, p_t^w ,and X_t are as defined before.

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