SPATIAL PRICE TRANSMISSION AND MARKET INTEGRATION ANALYSIS: THE CASE OF WHEAT MARKET IN SOUTH AFRICA, 2010-2019

BY

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ABSTRACT

Wheat forms part of the most essential grain crop produced in South Africa after maize. In South Africa, most of the wheat produced is used mainly for human consumption while the remaining is used for animal feed and seed. The wheat industry in South Africa is undergoing severe pressure, with drastic decreases in the area planted to wheat production while imports of wheat continued to increase since the year 1997. This has in return affected the performance and competitiveness of the South African wheat industry at the international stage and its ability to produce enough to meet local demand, hence continuous reliance on imports which later affect domestic wheat prices. Regardless of wheat as one of the most essential grain crop produced in South Africa, very little research is done to evaluate the co-movement, magnitude and speed of price transmission from world to domestic wheat market in South Africa.

The study intends to analyse the transmission of world wheat prices to the domestic wheat market in South Africa using average weekly prices for wheat for the period between January 2010 and December 2019. The objectives of the study are to determine the level of cointegration or long run relationship between the world wheat prices and the domestic wheat prices in South Africa, and to assess the degree of world wheat price transmission to the domestic wheat prices in South Africa, with the application of the Error Correction Model.

While several authors indicted that long run relationship does exist between spatially separated markets, this study also finds evidence of cointegration or long run relationship between world wheat markets and the domestic wheat market in South Africa. The results confirmed this priori expectation, that in a long run world wheat prices are ultimately transmitted to the domestic market in South Africa. The results further indicate that the speed of corrections or adjustments towards equilibrium conditions were established to be fairly low for domestic wheat prices.

The study recommends further research with more emphasis on vertical price transmission from wheat to wheat flour and other wheaten products such as bread and cereals. Further recommendation suggested by the study is that government intervention through implementation of Dollar-Based Reference Price and Variable

Tariff Formula for wheat must continue with more caution and improved speed for a quicker response, once there is a newly triggered import duty.

Key words: Price transmission, cointegration, wheat tariff, wheat markets, spatial price transmission, spatial market efficiency, spatial arbitrage, wheat value chain, price asymmetry, wheat prices.

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DECLARATION

I, Molahlegi Aubrey Mphateng, hereby declare that the dissertation submitted to the University of Limpopo for the degree Master of Agricultural Management in Agricultural Economics is my own work and has not previously been submitted by myself for a degree at this or any other university, and that all the material used herein from other authors have been fully acknowledged.

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Signature:

Date:

DEDICATION

This study is dedicated to my parents, Molatelo Maria Mphateng and Ngoako Edwin Mphateng who made huge sacrifices in order to see me and my siblings become successful in this life. Further dedication is extended to my children, Tshepo and Pheladi. I hope and believe that this study will inspire them to work hard, be determined and committed in order to achieve their dreams. My sincere appreciation and gratitude goes to my better half Ledile Sendra Monyepao for being supportive, believing in me and encouraging me to work harder even when it was not easy, you truly are special to me.

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ADF	Augmented Dickey Fuller unit root test
AIC	Akaike Information Criterion
DAFF	National Department of Agriculture, Forestry and Fisheries of the Republic of South Africa
DBRP	Dollar-Based Reference Price
DWP	Domestic Wheat Price
ECM	Error Correction Model
ECT	Error Correction Term
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
ITAC	International Trade Administration Commission
ITC	International Trade Centre
lnWWP	Natural Logarithm of World Wheat Price
lnDWP	Natural Logarithm of Domestic Wheat Price
LOP	Law of One Price
MAP	Marketing of Agricultural Products Act of 1996
NAMC	National Agricultural Marketing Council
NSNP	National School Nutrition Programme
OLS	Ordinary Least Squares
SACU	Southern African Customs Union
SADC	Southern African Development Community
SAFEX	South African Futures Exchange

STATS SA	Statistics South Africa
SIC	Schwarz Information Criterion
SRM	Switching Regime Models
VAR	Vector Auto Regressive Model
VRS	Vector Regime Switching Model
WCB	Wheat Control Board
WWP	World Wheat Price

CHAPTER 1 : INTRODUCTION

1.1. Background

According to (DAFF, 2019), wheat forms a part of the most essential grain crop produced in South Africa after maize. The most produced wheat in South Africa is bread wheat, while very low quantities of durum wheat are also produced in some other parts of the country and used mainly for the production of pasta. In South Africa, most of the wheat produced is used mainly for human consumption (for food products such as bread, biscuits, breakfast cereals, rusks, etc.) and the remaining is used for animal feed and some is retained for seed. Other uses for wheat include the production of non-food products such as alcohol for ethanol, absorbing agents for disposable diapers, adhesives and industrial uses such as starch on coatings (DAFF, 2019). The contribution of the wheat industry to the total gross value of agricultural production is estimated to be roughly 5 billion Rand per annum. According to (DAFF, 2019), the local producers of wheat in South Africa are estimated to be roughly between 3 800 to 4000.

According to (van der Merwe *et al*, 2015), the South African Wheat Industry is a good example of an agricultural industry that is affected not only by the domestic environment but also the global market conditions, of which both continue to affect the competitiveness and performance of the industry. The significance of the South African wheat sector is proven by the fact that wheat is the second most important and heavily consumed crop after maize (Stats SA, 2014). The primary wheat sector together with the domestic wheat processing industry contributes largely to employment and job creation in the country.

Additionally, wheat flour which is used for the baking of bread, is considered to be the second most important food source in South Africa and, as a result, plays a crucial role in the government’s fight against food insecurity (NAMC, 2005). This is further supported by the fact that bread is considered an important portion of the National School Nutrition Programme (NSNP), which has been implemented to eradicate food insecurity and feed school children across the country (ETU, 2012).

The wheat sector is significant not just because of its potential to feed the poor, but also because of the indirect contribution it makes to the domestic economy through poverty reduction, skills development, and job creation for impoverished South Africans. However, recent statistics shows that wheat production in South Africa is under serious strain, with the number of hectares allocated to wheat production declining since 1997 and imports dramatically increasing to satisfy rising domestic demand (van der Merwe *et al*, 2015).

According to Van Schalkwyk and Van Deventer (2005), this is due to the emergence of a new policy environment that has had and continues to have a significant impact on the wheat industry's performance. The wheat sector got a subsidy that was intended to keep consumer and producer prices of wheat and wheat products (flour and bread) stable and as low as possible (Vink & Kirsten, 2000).

All of the control boards were abolished in 1996 after long negotiations with all immediately affected stakeholders and entities in the agricultural marketing environment. The main goals of the then new Marketing of Agricultural Products (MAP) Act of 1996 brought about the intentions to create a more competitive marketing environment. Furthermore, as markets became less protected against imports, the international environment began to play an increasingly crucial role in the local wheat sector. Some researchers (Conforti, 2004; Minot, 2011; Brown *et al*., 2012) were curious how global wheat prices are passed down to domestic food markets. High worldwide food prices have an effect on domestic markets, affecting household purchasing power and food access, particularly for those who are most disadvantaged.

1.2. Problem Statement

Prior to 1997, South Africa's wheat sector was characterised by a single-channel marketing system that was in charge of setting wheat prices (van der Merwe *et al*, 2015). According to the NAMC (2006), this system regulated the movement, pricing, selling, and supply of agricultural products in order to maintain price stability and close the gap between producer and consumer prices. As markets became less protected against imports after deregulation, the global environment began to play an increasingly crucial role in the domestic wheat sector also influencing wheat market prices.

Wheat is South Africa's second most consumed food crop, and bread, a wheat product, is included in the food security basket, therefore transmission of global wheat prices to the local markets might have a significant impact on the wheat sector and consumers. This means that government involvement is required to regulate volatility and lower price risks for a large number of consumers who spend a significant portion of their income on food items such as wheat flour and bread.

Widely traded commodities such as wheat, maize and rice were the quickest to respond to world prices increase, hence leading to rapid and drastic price rises in many countries in 2008, (Keats *et al.,* 2010). This discussion created most scholar's interest in learning how prices are transmitted from international to domestic markets. The transmission of world maize prices to the South African maize markets was studied by Abidoye and Labuschagne (2012), who found that threshold effect exists, meaning that modest changes in world prices are not transferred to domestic South Africa maize markets. However, the study indicated that huge long-run price variances are propagated, with roughly 98 percent of global price variance finally being transmitted.

Therefore, as a net wheat importer, South Africa is influenced by global wheat price change in some way. The link between world wheat prices and South African wheat prices has not been researched thoroughly. Therefore, this study seeks to contribute to the current literature and understanding about the amount and speed of price transmissions between the global and South African prices for wheat. The research aims to find out if there is any co-integration between the global and domestic wheat markets.

1.3. Rationale and scope of the study

Price transmission has been investigated and researched by several authors in the context of the Law of One Price (LOP) or market integration. A study by Minot (2009), looked at the transmission of international food price changes to African markets and their implications on household welfare. A more comparable study was conducted by Tuyishime, (2014) and Davids *et al.* (2016). Other researchers, such as Abidoye and Labuschagne (2012), used the Threshold Cointegration Approach to investigate the transmission of world maize prices to the South African maize market. Small changes in world prices are not rapidly transferred to domestic markets in South African maize markets, according to the study, and only large long-run price variance are transmitted. Furthermore, the results indicate that while the market is trading at export parity, worldwide prices take longer to filter through to South African prices for maize than when the market is trading at import parity.

However, only a handful of studies have looked into the topic of world price transmission in the South African agricultural commodities markets, with a focus on world wheat prices being transmitted to South African wheat prices. Meyer (2006) conducted one of the most well-known research, focusing on model closure and price generation under switching grain market regimes, which also provided some insights on wheat prices and indicated that since South Africa is net importer of wheat, the domestic wheat prices trade closer to import parity prices than to export parity prices.

In addition, Louw *et al.* (2017) studied vertical price transmission and its inflationary implications in South African food chains, with an emphasis on wheat to bread and maize to maize meal price transmissions. The results reveal a full price transmission in the instance of wheat to bread price since prices are decided at the producer and consumer level, where bi-directional transmission occurs. As a result, the study on wheat price transmission is important since bread, a wheat product, is part of South Africa's main food basket. Given the aforementioned, the degree of price transmission is considered significant since it affects the well-being of most disadvantaged consumers and farmers (Keats *et al.,* 2010).

Wheat is the second most significant and heavily consumed grain crop in South Africa, behind maize (DAFF, 2016). Furthermore, wheat flour, which is mostly used in bread baking, is regarded as South Africa's second most important food source, and so plays a critical role in the fight against poverty and food insecurity (NAMC, 2005). The majority of wheat grown in South Africa is bread wheat, with limited amounts of durum wheat grown in some places and used to make pasta.

Wheat is mostly consumed by humans in South Africa (bread, biscuits, breakfast cereals, rusks, and so on), with less than 2% of total consumption going to seed and animal feed. On an annual basis, the wheat sector contributes more than 5 billion Rand to the total value of agricultural production (DAFF, 2018). According to FAO (2009), South Africa is the greatest wheat producer in the SACU and SADC areas, as well as the continent's fourth largest producer. As a result, the value of the South African wheat sector stems not only from its ability to feed the poor, but also from the indirect contribution it makes to the local economy through job creation, skill development and poverty alleviation, etc.

According to Meyer and Kirsten (2005), the past era has resulted in a transition in wheat marketing practices in South Africa, with the transfer of a highly regulated dispensation to an essentially free one. The elimination of the Wheat Control Board (WCB) in 1997 exposed domestic wheat producers even more to international wheat markets, where domestic wheat prices are mostly influenced by global prices.

Additionally, the economic policy also changed dramatically, accompanying the almost world movements towards deregulation and liberalisation of the economy. According to Meyer and Kirsten (2005), this has resulted in a more market-based approach to both agricultural and macroeconomic policy. As a result of the dynamic environment in which local wheat growers and dealers work, it is critical to comprehend the consequences of price transmissions to South Africa's domestic wheat markets. It is against this background that the study on spatial price transmission and market integration for wheat is undertaken.

1.3.1 Aim of the study

The aim of the study was to analyse the transmission of world wheat prices to the domestic wheat prices in South Africa using average weekly prices for wheat for the period between January 2010 and December 2019.

1.3.2 Objectives of the study

The objectives of the study are to:

i. Establish the degree of cointegration or long-term association between the world and domestic wheat prices in South Africa.

ii. Determine the extent to which world wheat prices are transmitted to domestic wheat prices in South Africa.

1.4. Hypotheses

i. There is no long-term association between the world wheat prices and wheat prices in South Africa.

ii. World wheat prices are not transmitted to the domestic wheat price in South Africa.

1.5 Study Limitations

Due to difficulties encountered throughout the data reading procedure, the study heading was altered from the original approved topic in order to avoid spurious results. The topic was authorized based on a data set that spanned the years 2000 to 2018. However, after encountering multiple outliers during the data analysis process, the study's focus was changed to a more manageable data set centered on a shorter period between 2010 and 2019, rather than the original lengthier span. According to Fan *et al,* (2013), Big Data presents unique computational and statistical challenges, such as scalability, storage bottleneck, noise accumulation, spurious correlation, incidental indigeneity, and measurement errors, due to its large sample size and high dimensionality. These difficulties may lead to erroneous statistical inferences and, as a result, erroneous scientific findings and conclusions. The existing data set, on the other hand, is still long enough to produce accurate study results.

1.6 Structure of the report

The next chapter, chapter two provide insights into the review of literature related to conceptual definitions used in price transmission, the model used in estimation of price transmission and market integration, asymmetry in price transmission: the evolution, types and causes as well as the actual empirical evidence of market integration and asymmetry in price transmission. Chapter three provides an overview of the wheat industry, with a focus on the global market environment and a greater emphasis on the wheat sector in South African. Chapter four presents description of methodology while chapter five captures the results of the study. Lastly, chapter six concludes with summary, conclusion and recommendations of the study.

CHAPTER 2 : LITERATURE REVIEW

2.1 Introduction

This chapter covers work on theoretical principles in agricultural price transmission such as market integration, spatial market performance/efficiency, spatial arbitrage, and the Law of One Price, as well as reviews of previous literature relevant to the research. This chapter also discusses some of the models that can be applied in the estimation of market integration and spatial price transmission, to model experimental research on agricultural price transmission.

2.2 Conceptual Definitions

According to Fackler and Goodwin, (2001), the analysis of price transmission sometimes necessitates the use of a variety of economic terms for which there are no commonly accepted definitions in the literature. The most critical ones are briefly discussed below.

2.2.1 Price Transmission and Market Integration

Market integration, according to Barrett and Li (2002), is the tradability and contestability of markets, which involves the market approval process, in which demand, supply, and transaction costs in various markets decide prices, trade flows, and the transmission of price shocks from one market to the other. When it comes to tradability, trade flows are sufficient to show the degree of spatial market integration, but they do not mean price equality. This is consistent with Pareto-inefficient distribution, according to Barrett (2005). Since market integration is such a broad term, many policymakers and economists approach it from a specific perspective. The degree to which markets separated by geographic locations exchange common long-run prices or trade information for a similar product is measured by market integration or spatial price transmission (Amikuzunu, 2010).

The degree to which demand and supply shocks from one market are transmitted to other markets in a different region, or the similarity of prices across spatially divided markets, is referred to as spatial market integration. According to Cirera and Arndt

(2006), two markets may be linked by forming a network or belonging to a state agency that sets prices that are adjusted to regional or national shocks, making it possible that prices will be transferred even though no trade is taking place.

2.2.2 Spatial Market Efficiency

According to Negassa *et al,* (2003), spatial integration of agricultural markets is commonly used as a measure for the efficacy of agricultural markets in research on spatial price analysis. The terms “spatial market efficiency” and “spatial market integration,” for example, are often used interchangeably. A growing body of literature identifies words that are related but not identical, and therefore must be separated (McNew and Fackler, 1997; Barret and Li, 2002). Spatial market efficiency is a state of equilibrium in which all potentially lucrative arbitrage opportunities have been taken advantage of. A spatial price difference minus transfer cost is consistent with market efficiency in the absence of trade. However, if the spatial price difference is greater that the transfer cost, the market would be considered inefficient with or without trade, (Negassa *et al,* 2003).

2.2.3 Spatial Arbitrage

Spatial Arbitrage, according to FAO (1997), is the method of exchanging goods with the goal of profiting from price differences greater than transaction costs. The spatial arbitrage conditions allow for price differences between regions in a competitive market that trade with each other to equal the transaction cost for a homogeneous commodity, whereas price differences between two regions in an autarky market are less than or equal to the transaction cost (Tomek & Robinson, 2003).

According to Katengeza (2009), if price differences exceed the transfer cost, arbitrage is created, and profit-seeking merchants will purchase commodities from markets with low price surpluses and later sell them in markets with high price deficits. Market integration is also dictated by oligopolistic behaviour and complicity among local traders, according to Rapsomanikis *et al* (2004), because sellers can hold on to price differences between markets at levels higher than those determined by transaction costs.

2.2.4 The Law of One Price (LOP)

The Law of One Price (LOP) follows directly from the spatial arbitrage condition: prices expressed in the same currently, net of transportation costs, will be equalised in markets connected by exchange and arbitrage. The LOP is focused on international commodity arbitrage, which states that “perfect commodity arbitrage ensures that each good is uniformly priced (in common currency units) across the world” in the absence of transportation costs and trade restrictions (Isard, 1977). The respective contemporaneous prices of a homogeneous commodity traded between an exporting market j and an importing market i are an example.

The LOP demands that the price differences between i and j for a homogeneous commodity be equal to the transfer costs incurred in transferring the commodity from market j and i (in its poor form). It states that if the price difference exceeds the transfer costs, arbitrage mechanism (such as transferring the product from the low to the high price market) are used to ensure that the price difference and transfer costs are identical. Later research, however, showed that price series are largely non-stationary as a result of transfer costs, market control, and imperfect competition, implying that the LOP is not strictly fulfilled. This led to a change in the definition of the LOP in cointegration and regime-switching models that specifically account for nonlinearities in price series.

2.3 Models for price transmission and spatial market integration estimation

To infer demand and supply processes, it is also preferable to use all available information, such as prices and quantities produced and traded, data on costs or transaction costs, in the study of market integration. Due to lack of data, researchers must rely on assumptions based on economic theory in order to use price-based techniques like price transmission econometrics or parity bound models, which use more than price data in equilibrium representation (Ayeduvor, 2014). The following sections go into some of the techniques that are applicable to the wheat price transmission analysis.

2.3.1 The Ravallion Dynamic Model

After adjusting for seasonality, common trend, and autocorrelation, the Ravallion (1986) method became the most popular technique for measuring spatial market integration. It differentiated between short-run and long-run market integration and segmentation (Negassa *et al.,* 2003). The inspiration for this model stems from the sluggish nature of agricultural markets, which can take a long time to react to a shock. The inclusion of dynamic considerations in this model helps to avoid the inferential danger described in section 2.3.3 of the static model.

Inter-seasonal flow reversals are ruled out by the Ravallion model, which assumes a constant inter-market transfer cost. Inference would be skewed in favour of failing to refute the hypothesis of segmented markets if the transfer costs are variable or time varying (Cirera & Arndt, 2006). This approach assumes a radial spatial market structure between a group of local markets and a single central market, with trade with the central market dominating local price development.

2.3.2 Delgado Variance Decomposition Approach

Delgado (1996) created an alternative model to account for some of the many flaws in the bivariate correlation approach to evaluating market integration. According to Negassa *et al*. (2003), the Delgado method is a variance decomposition method that measures market integration for the entire marketing environment rather than a pair-wise test. Popular patterns and seasonality in price series are eliminated prior to the market integration evaluation, and transportation and transaction costs are presumed to be constant. Then, for a given season, the equality of spatial price spreads between pairs of markets indicates spatial integration. The issue with this strategy is that it is dependent on current price relationships and does not allow for complex relationships between markets.

2.3.3 Static Price Correlation and Regression Model

The use of static price correlations to monitor for spatial market integration in agricultural markets formed the basis for market integration research. The measurement of bivariate correlation and regression coefficients of homogeneous products in different markets is part of this process (Hossain & Verbeke, 2010). This concept is based on the assumption that prices in integrated markets move in lockstep.

Even though static models are simple to estimate using only price data, Barrett, (1996) and Baulch, (1997) claim that their assumption of stationary price behaviour and fixed transaction costs causes them to underestimate the degree of market integration. Recent advances in time series econometrics have allowed economists to test a broader notion of spatial market integration by examining long-run price co-movement, making the LOP a testable hypothesis.

Although simple, the static approach has significant flaws and thus poses inferential risks when drawing conclusions from parameter estimates. The main flaw is that correlation does not always mean causation (Cirera & Arndt, 2006). Since price spreads differ seasonally, Timmer (1974) recognise that inter-seasonal flow reversals, which are typical in areas with weak infrastructure, make price spread observations inaccurate measures of market integration or competition. The existence of such variables such as government policy effects and general inflation is also hidden by bivariate correlation analysis (Golleti *et al*., 1995).

Since the method assumes instantaneous price change, it is unable to capture the complex essence of prices. Even in the absence of market integration, prices can appear to move in lockstep, resulting in spurious market integration (Ravallion, 1986), which can be affected by general inflation, seasonality, or autocorrelation. The existence of heteroscedasticity, which is normal in price data, is also missed by this simple correlation study. Also, if the lag in price response is caused by lags in market knowledge, the correlation test can overestimate the lack of market integration (Barrett, 1996). It can only be used to test a pairwise market study and not the entire marketing system.

2.3.4 Cointegration Models

Price series used for measuring market integration with traditional measures are often nonstationary, making tests invalid. As a result of this problem, Engle and Granger (1987), and Engle and Yoo (1987) developed the concept of co-integration, which they define as the existence of a long-run relationship between two or more series. Market segmentation is indicated by the absence of co-integration between two market price series, otherwise, market interdependence is indicated.

The order of integration is determined using the required unit root test, the co-integration regression is constructed if price series are combined in the same order, and the residuals from the co-integration regression are tested for stationarity. The lack of a stochastic pattern in the residuals means that the two series have a long-term relationship (Negassa *et al.,* 2003). Since the Engle and Granger approach does not allow for testing all possible cointegrating vectors in a multivariate method, the Johansen (1988) cointegration approach was developed.

Maximum probability is used in the Johansen method to look for cointegrating relationships between many economic series. Engle and Granger (1987) recommend using error correction models to evaluate short-run dynamics if there is a cointegration relationship between the variables under consideration. The error correction representation clarifies the adjustment mechanism in both short and long-run price responsiveness, which typically represents arbitrage and market performance (Abunyuwah, 2007). Cointegration and error correction models are useful for delving deeper into concepts like completeness, speed, asymmetry of price relationships as well as the path of causality between two markets.

According to Barrett (1996), price series co-integration is neither necessary nor appropriate for market integration. If transaction costs are nonstationary, failure to find cointegration between two markets' price series may be fully compatible with market integration, according to Negassa *et al.* (2003) and Barrett (1996). Since a negative coefficient of the central market price indicates separation rather than co-movement, as shown by the principle of market integration, co-integration is inadequate. The magnitude of the cointegration coefficient can be implausibly small, which goes against market integration's intuition. Furthermore, market segmentation may occur when market margins are greater than or less than transfer costs, implying the absence of efficient arbitrage in both cases; however, co-integration tests only recognise the former (Barett 1996; Goletti *et.al.,* 1995).

It is worth noting that none of the above market integration models take into account the importance of transaction costs. The recognition of transaction costs data allows market integration modelling techniques to be significantly improved. As a result, models known as switching regime models have been used in recent market integration research.

2.3.5 Switching Regime Models (SRM)

According to Ayeduvor (2014), prices are usually nonlinearly connected, contrary to most of the leading price transmission literature's belief that linear price relationships exist. The realisation that price relationships could be nonlinear due to transactions costs led to the creation of a class of models known as switching regime models (SRM). For price transmission analysis, four types of SRM are commonly used in the literature: error correction models (ECM), threshold autoregressive (TAR) models, parity bound models (PBM), and Markov-Switching Models (MSM).

2.3.5.1 Parity Bound Models (PBM)

Spiller and Haung (1986) and other writers were among the first to develop the PBM. Other scholars, including Sexton *et al.* (1991), Barrett and Li (2002), and Baulch (1997), further developed and applied this concept. The creation of the Parity Bound Model, according to Abunyuwah (2007), represents an effort to use all available market data (prices, transfer costs, trade flows, and volumes) to characterise markets in their long-run conceptual settings. Transaction costs, according to the model, decide the price efficiency band (parity bounds) within which the prices of a homogenous good can differ independently in two spatially distinct markets (Baulch, 1997; Barrett & Li, 2002).

The PBM determines the degree of market integration by comparing three different trade regimes. At the parity bound, where the inter-market price difference equals transfer costs, Regime I emerges. If there are no impediments to exchange between the two markets, trade would cause rates between the two markets to change one-for-one, and spatial arbitrage conditions are binding. Regime II is located under the parity bound, where the price difference between markets is less than the transfer costs. This means that no trade will take place, and the spatial arbitrage conditions will not be met. Regime III occurs when the inter-market price gap exceeds the transfer costs; spatial arbitrage conditions are violated whether or not trade occurs (Baulch 1997; Sanogo, 2008).

Since the model specifies the likelihood that an observation would fall into one of the three regimes, the upper and lower parity bounds for spatial arbitrage conditions between the specified markets must be established. The model uses exogenous transaction cost data to estimate the likelihood of achieving inter-market arbitrage conditions, and the maximum likelihood estimator handles trade discontinuities and time varying transaction costs well (Barrett, 1996). Despite the fact that the PBM model aims to boost market integration estimation by integrating exogenous transaction costs, it still has flaws. Transaction costs, according to Barrett (1996), can be difficult to quantify. Trading margins have substantial unobservable components, and transaction costs may be underestimated in the presence of nontrivial risk premia or positive income, which biases the PMB results away from market segmentation. Since only contemporaneous spreads are used in estimation, Baulch (1997) recognises that accounting for the lagged price change predicted by causality and Ravallion models is difficult. The breach of the spatial arbitrage condition often suggests a lack of market integration, but it does not provide reasons.

2.3.5.2 Threshold Autoregressive Models (TAR)

The assumption that threshold autoregressive models consider thresholds induced by transaction costs that deviations must cross before provoking equilibrating price changes that lead to market integration is also used in the analysis of price transmission mechanism (Goodwin & Piggot, 1999). The dynamic responses resulting from threshold effects may be nonlinear in nature, unlike the Eagle and Granger (1987) and Johansen (1988) approaches, which assume a linear adjustment relationship between variables. When shocks above a critical threshold produce a different response than shocks below the threshold, this is known as the threshold effect. The thresholds are typically thought of as a feature of transaction and adjustment costs, as well as economic risks, which prevent agents from constantly adapting to market changes (Rapsomanikis & Karfakis, 2007).

According to Goodwin and Piggot (1999) and Hassouneh *et al.* (2012), Tong (1987) introduced the concept of nonlinear threshold time series. Tsay (1989) introduced a method for detecting and modelling threshold autoregressive processes, while Balke and Fomby (1997) expanded threshold autoregressive models to a cointegration system. Goodwin and Holt (1999), suggested the use of a threshold vector error correction model. Enders and Granger (1998), and Enders and Siklos (2001) are two examples of threshold models that have been used in empirical studies. The Enders and Siklos' method is based on a single threshold, two regime model, while other studies use a multiple threshold model. Although this method of determining market integration by identifying transaction cost constraints is an improvement over previous methods, is still has some flaws.

The presumption of constant transaction costs, which implies a fixed neutral band over the study period, is a constraint (Abdulai, 2007). In order to fix this flaw, time trend is included in both the threshold and adjustment parameter, and the threshold is then modelled as a simple linear function of time (Van Campenhout, 2007). Otherwise, different sub-samples to reflect the evolving policy and economic climate to capture possible variance in transaction costs as a result of different policy regimes could be introduced (Abdulai, 2007).

As previously discussed, threshold autoregressive models account for possible nonlinearities and asymmetries in the price adjustment phase and provide additional details about data dynamics (Abdulai, 2007). They also provide a measure of the market's breach of the spatial arbitrage condition, as well as a measure of how quickly it corrects these variations (Fackler & Goodwin, 2001).

Asymmetries in price change have sparked the interest of a variety of people. Consumers, for instance, are curious about why traders react differently to positive and negative market price shocks (downstream and upstream prices). Economic theory, according to Manera and Frey (2005), only provides a small range of justifications for market disparities. All of the methods addressed have one flaw in common: they measure the essence and degree of price transmission without discussing the underlying causes of the degree of transmission.

2.4 Price Transmission Asymmetry: Evolution, Types and Causes

Asymmetry exists when the market at one level reacts differently to a decrease and increase in price at a different level. Asymmetry in the degree or speed of change, or both, can occur. Short-run elasticities of price transmission vary depending on the sign of the initial shift in the former, whereas long-run elasticity differs in the latter (von Cramon-Taubadel, 1998).

Asymmetry may also be defined as positive (when one price responds fully or quickly to an increase in another price as it does to a decrease, implying that price movement that squeezes the margin is transmitted more quickly and/or absolutely than price movement that stretches the margin). Otherwise, it is negative (when one price reacts more completely or rapidly to a decrease in another price than to an increase; hence, total and/or fast transmission to price movements that stretch the margin). This decides the welfare transfer's course (Meyer & von Cramon-Taubadel, 2004). Asymmetry may also be vertical or spatial, depending on where it occurs in the food supply chain (e.g., from farm level to wholesale) or between two geographically divided markets.

Asymmetric price transmission has long been linked to agricultural prices, with Tweenten and Quance (1969) being the first to use a dummy variable to divide input prices into rising and declining input prices. Following this, studies like Wolfram (1971), Houck (1977) and Ward (1982) used variations of the variable splitting technique to capture price transmission asymmetry. These studies, on the other hand, anticipated the formation of cointegration and did not take into account the difficulties associated with nonstationary sequences (Hassouneh *et al,* 2012). To account for non-stationary, Granger and Lee (1989) introduced the variable splitting technique into the error correction representation. Variations of this method have been widely used in applied work since then (Von Cramon-Taubadel & Fahbusch, 1994; von Cramon-Taubadel & Loy, 1996).

Other studies, Engle and Granger, (1998); Enders and Siklos, (2001) and Abdulai, (2000) have used threshold models to capture asymmetry, in which price fluctuations above or below such thresholds elicit different responses. Asymmetries in price transmission have been attributed to a variety of possible causes, but their impact has been minimal. Meyer and von Cramon-Taubadel (2004), Frey and Manera (2005), and Abdulai (2000) are among the studies that address this subject. Market strength is one of the possible causes of asymmetry discussed in the literature. The capacity of an enterprise or a group of enterprises to increase and sustain prices above or below a competitive level is referred to as market power (Amonde *et al.,* 2009).

Adjustment/menu costs are another source of asymmetry. When a firm adjusts the quantities and/or price of its inputs and/or outputs, it incurs adjustment costs. The costs are referred to as menu costs if they are combined with price increase (Meyer & von Cramon-Taubadel, 2004). The cost of adjusting nominal rates, printing catalogues, inflation, and disseminating knowledge about price adjustments are all included in the menu cost. Such costs may be asymmetric in terms of rising and falling prices. Traders, for example, may not alter prices when input costs fall due to menu costs, particularly if the increase in input costs are thought to be temporary (Kovenock & Widdows, 1998).

When there is inflation, the cost of the menu will trigger asymmetry (Ball & Mankiw, 1994). According to Abdulai (2000), shocks that increase a firm's desired price results in greater response than shocks that decrease it, because firms can use optimistic shocks to correct accumulated and expected inflation. In many markets, asymmetry in price transmission can be caused by inventory management or trader's stock behaviour. In periods of low demand, firms typically increase inventory rather than reduced prices, whereas in periods of high demand, prices are typically increased. Positive asymmetry can result from asymmetry in costs related to high and low inventory stocks, as well as the fear of stock out (Reagan & Weitzman, 1982).

Perishability of a commodity plays a role in creating asymmetry in price transmission, according to Meyer and von Cramon-Taubadel (2004). According to Ward (1982), traders may be hesitant to lift prices for perishable products for fear of spoilage, resulting in negative asymmetry. Another counterargument offered by Heien (1980) is that price changes are more of an issue for products with long shelf-life than for perishables. This is because adjusting prices with the former incurs as higher time cost and a lack of goodwill.

The government's interventionist position is another factor that causes asymmetry in price transmission. This is exemplified by political interference in the form of price support in the agricultural sector, which is typically implemented as a floor price (Kinnukan & Forker, 1987). If retailers or wholesalers are led to believe that the intervention will last a long time, downstream price rises will be passed on quickly and entirely, while price cuts will be passed on slowly (Uchezuba *et al.,* 2010).

2.5 Market Integration and Price Transmission Asymmetry: Empirical Evidence

The price behaviour and responses of the South African agricultural markets, especially the grain and vegetable markets, have been extensively studied. Price transmission has been studied by a number of authors both inside and outside South Africa. In order to determine the effect of infrastructure on agricultural marketing in Rwanda, Loveridge (1991) uses a correlation coefficient approach. The study's findings show that market integration before and after road paving differs. The strength of linkages between major central markets has improved as a result of the development of new roads, however, farm level price data still indicates a high cost of transporting food between rural and urban markets. Loveridge (1991) indicates that investing in the transportation sector could help to reduce these costs. Badiane *et al.* (2010) investigated how local markets will respond to groundnut market liberalisation in Senegal.

The authors use a dynamic model of price formation that measures the response of local markets to policy changes by using estimates of spatial market integration across local markets. The impact of liberalising groundnut prices to enable domestic prices to reflect international levels was then simulated using this model. They discovered that this will affect prices in Dakar's central market, which influences prices in Kaolack and Fatick's output regions. Also, if the market had been completely liberalised in January 2007, when the groundnut parastatal agency (SANACOS) was privatised, groundnut prices would have been higher and passed on entirely to Kaolack and to a lesser degree to Fatick.

Muyatwa (2001) investigates whether regional markets have been spatially integrated as a results of Zambia's maize market liberalisation. Using monthly wholesale price data from 1993 to 1997, the study uses cointegration analysis and an error correction model. The results of the test show that the extent of market integration and the quickness of price transmission between regional markets are both very slow. Furthermore, despite the rapid emergence of private traders, the pace of filling in the gap left by the state has been slow, owing to a lack of capital, storage facilities, and access to market information, as well as old vehicles and weak transportation infrastructure. The government must therefore provide an enabling atmosphere for trading in order for the maize market to function efficiently.

Falsafian and Moghaddasi (2008) use the threshold cointegration method to analyse the trends of price change in selected spatially divided chicken markets in Iran, using weekly price data from 1998 to 2006. In every case, their findings show a different rate of change in response to positive and negative shocks. As a result, Qom-Tehran markets say that negative shocks are adjusted much faster than positive shocks, whereas positive shocks are adjusted much faster than negative shocks in Ghazvin-Tehran markets.

To investigate the dynamic adjustments to shocks, Goodwin and Piggot (2001) use threshold cointegration and nonlinear impulse response functions to evaluate regular price linkages among four corn and four soybean markets in North Carolina. Even though changes can take several days to complete after a price shock, the results show strong support for market integration. As compared to the model that ignores threshold behaviour, adjustments are quicker in response to deviations from equilibrium. Tostao and Brorsen (2005) use a parity bound model to assess the efficiency of spatial maize price arbitrage in Mozambique's post-reform era. The findings show that 90-100 percent of the time, spatial arbitrage between central and southern Mozambique is successful. Price differentials between northern and central/southern Mozambique, on the other hand, almost always fall below transportation costs.

According to these figures, shipping surplus maize from northern surplus maize region to southern surplus maize regions is not worthwhile. Food shortages and price volatility are likely to persist, according to the authors, because while market liberalisation appears to have improved spatial performance, high transfer costs appear to be limiting trade and potential benefits from market liberalisation, and thus improvements in transportation networks may help mitigate the costs involved.

Negassa and Myers (2007) investigated the maize and wheat markets in Ethiopia using an extension of the parity bound model that allows for complex shifts in regime probabilities in response to changes in marketing policy. There is evidence of a complex adjustment course, and grain marketing changes have improved efficiency in some markets while worsening efficiency in others. They attribute the inefficiency to resource misallocation in the two markets and propose different policy responses for the two commodities to boost efficiency, because maize traders experienced some losses the majority of the time while wheat traders made excess profit.

From 1995 to 2013, Selorm (2014) investigated the spatial price transmission and market integration of major maize markets in Chana. All five market pairs were found to be cointegrated. Inter-market prices change to achieve long-run, market equilibrium in a common domestic maize market in Ghana, demonstrating cointegration. In this case, the vector error correction model's speed of adjustment and half-lives indicate that producer markets corrected 8.2% of any disequilibrium within a month on average, while consumer markets corrected 12.4 percent of such shocks within a month. After a shock, net producer markets will return to equilibrium in 10 months, while net consumer markets will do so in 5 months. This means that consumer markets fix shocks faster than producer markets.

Abidoye and Labuschagne (2012) investigated the transmission of world maize prices to South African maize markets using a Bayesian approach and discovered that a threshold effect exists, implying that minor changes in world prices are not transmitted to domestic South African maize markets. However, the study found that massive long-run price variances are propagated, with approximately 98 percent of global price variance being transmitted at the end. Vertical price transmission and its inflationary effects in South African food chains were studied by Louw *et al*. (2017). To assess how underlying product prices manifest in final retail prices, the authors used time series econometric techniques. Due to their significance as staple foods in South Africa, the study focused on two value chains: wheat to bread and maize to maize meal. The findings also show that the wheat to bread chain has total price transmission, but the maize to maize meal chain has partial price transmission.

The price linkage block, according to Meyer and Kirsten (2005), formalises the relationship between the supply and demand blocks and also ties the world price and exchange rate to the local market. In the case of the wheat sector in South Africa, world prices strongly influence local wheat prices, but local prices have no effect on world prices. The explanation for this is that in the global wheat market, South Africa is a price taker. The local wheat producer price was calculated as a function of the Kansas City price of hard red winter wheat no. 2 plus the tariff and a ration of local wheat production over consumption, according to the writers. According to the findings, a 10% rise in the world wheat price results in a 4.6 percent increase in the local wheat producer price.

Kilima (2006) investigated the degree to which changes in world market prices are transmitted through changes in border prices through local producer prices for four agricultural product markets in Tanzania: sugar, cotton, wheat and rice. According to the statistical review, Tanzanian border and world market prices for these goods do not shift in lockstep, though there is evidence that border prices are affected by world market price levels but not the other way around.

Mokumako and Baliyan (2016) looked into the transmission of South African maize prices into Botswana markets and discovered that the two countries' maize prices were in a long-run steady state of equilibrium. According to the report, the elasticity of price transmission from South Africa to Botswana is 0.86, implying that in the long-run, approximately 86 percent of maize price shifts in the South African market are transmitted to the Botswana market.

CHAPTER 3 : OVERVIEW OF THE WHEAT INDUSTRY

3.1 Introduction

The wheat industry is briefly discussed in this chapter. The chapter begins with an overview of the global wheat market before focusing on the South African wheat industry. The chapter provides insights on the description of the South African wheat industry, production and area of production of wheat in South Africa, including wheat consumption, imports and exports, as well as wheat tariff, wheat prices, grading and value chain analysis.

3.2 The Global Wheat Market

3.2.1 Introduction

Since the latter half of the twentieth century, the agricultural sector has seen significant progress. The world's population has more than doubled since 1960, while real per capita income has nearly doubled (Pardey, 2010). The total production of cereals has expanded faster than the population over the same period, owing to remarkable gains in crop yields. According to Pardey (2010), increased agricultural output is the primary reason why the world has not yet encountered a catastrophic food crisis.

However, in the worldwide wheat market a distinct picture emerges, with wheat output generally failing to keep pace with worldwide population increase (Pardey, 2010). A drop in the rate of increase in agricultural research and development investment in many nations, as well as a change away from farm productivity-oriented research and development in at least several of the world's largest research systems, has preceded this productivity slowdown (Pardey, 2010). According to Aleksiev (2011), these trends have been accompanied by institutional actions from the grain trade's large players.

It is vital to understand who the primary role players in the global wheat market are, as well as what factors could influence their performance and competitiveness, in order to acquire grasp of this continuously changing global environment, which plays a significant role in the South African wheat business. This chapter, will identify the top players in the global wheat market and present an overview of their performance in terms of production, utilisation, stockpiles, and trade.

3.2.2 World cereal demand and supply overview

According to FAO (2019), cereal supply will be higher than expected in the 2019/20 season. Following an upward revision to world cereal production figures, global cereal suppliers are expected to be higher in 2019/20. FAO's predictions for global cereal production in 2019/20 is 2 708 million tonnes, up 23 million tonnes from its previous predictions and currently 55.4 million tonnes (2.1 percent) higher than the previous year's output. However, these positive adjustments overshadowed an expected decline in worldwide wheat production in 2019/20. The FAO predicts worldwide wheat production to be around 767 million tonnes, down approximately 4 million tonnes from their previous estimates. Table 3.1 below provide some basic information on the global cereal market.

Table 3.1: World cereal situation

	2017/18	**2018/19 estim.**	**2019/20 f'cast**	**Change: 2019/20 over 2018/19**
	million tonnes			%
WORLD BALANCE				
Production	2 702.7	2 653.1	2 708.5	2.1
Developing countries	1 641.3	1 621.9	1 655.4	2.1
Developed countries	1 061.4	1 031.2	1 053.1	2.1
Trade	421.9	414.2	414.8	0.1
Developing countries	154.3	149.0	162.0	8.8
Developed countries	267.6	265.2	252.7	-4.7
Total Utilisation	2 657.3	2 681.5	2 722.4	1.5
Developing countries	1 795.1	1 820.4	1 845.5	1.4

Developed countries	859.6	857.9	869.9	1.4
Per caput cereal food use (kg/yr)	*149.3*	*149.5*	*149.4*	*-0.1*
Ending stocks	873.7	852.9	847.2	-0.7
Developing countries	681.8	674.8	663.1	-1.7
Developed countries	196.0	188.3	184.3	-2.1
World stock-to-use ratio (%)	32.8	31.8	30.3	-4.7

Source: FAO, 2019

These lower worldwide wheat production volumes, according to FAO (2019), are the results of lower crop productivity in the Russian Federation and the European Union, which was largely offset by rising trends in production estimates for China (Mainland) and positive yields revisions in the United States of America. Despite the downward revisions made during the year, worldwide wheat output for 2019/20 is expected to exceed that of the previous marketing season by 36 million tonnes, or around 5.0 percent.

3.2.3 Wheat Production, Utilisation and Stocks

Following modest tightness in 2018/19 season, global wheat markets are expected to benefit from a considerable rebound in supplies `for the 2019/20 season that is according to FAO (2019). This is attributed to numerous wheat-producing countries' much anticipated production recovery. The total output of wheat in 2019/20 is 767 million tonnes, which is 5.0 percent increase over the previous year. The majority of the rise came from increased output in the European Union (EU), Russian Federation, and Australia, according to FAO (2019). The world wheat production, utilisation and stocks are depicted in Figure 3.1.

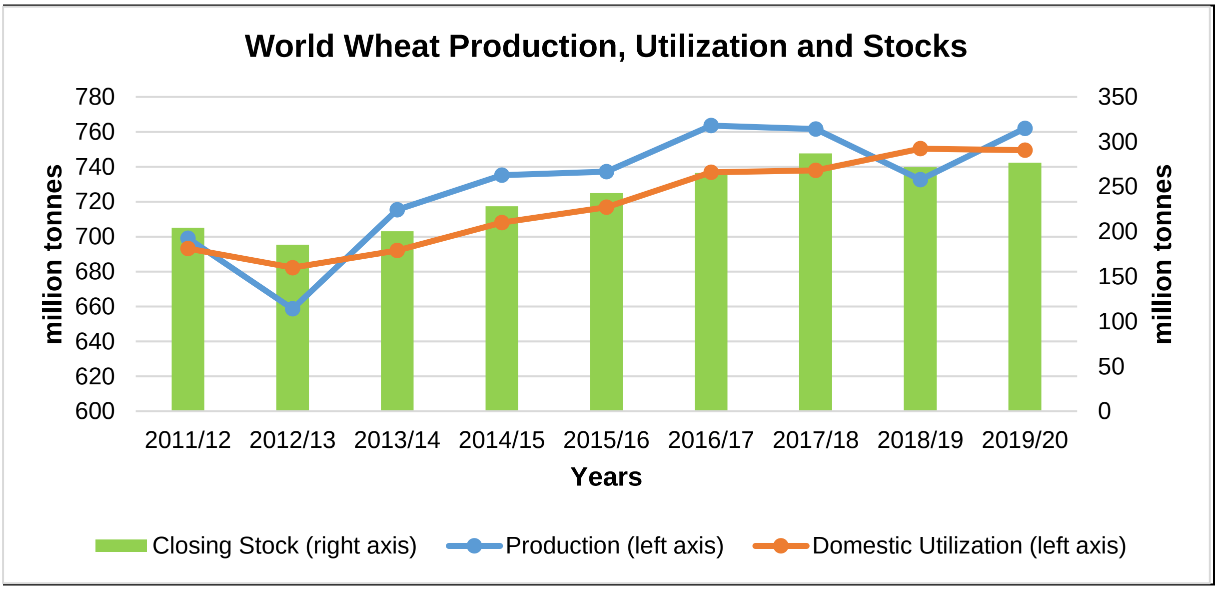

Figure 3.1: World wheat production, utilisation and stocks
Source: FAO, 2019

During the marketing year 2019/20 global wheat utilisation grew by 1.3 percent to 757 million tonnes as compared to the previous season. Despite the rise, FAO (2019) predicts that total utilisation will fall short of the 10-year trend value for the third consecutive season. According to FAO (2019), human consumption of wheat is expected to keep pace with population growth, reaching 519 million tonnes in 2019/20, while wheat consumption for animal feed is expected to reach roughly 144 million tonnes. This represents a 1.5 percent rise over the previous year's figures. This is because the majority of the grains were projected from China, the European Union and the Russian Federation, the world's largest wheat producers.

In the end of the season in 2020, world wheat stocks are expected to rise by 3.7 percent to 278 million tonnes, which is still less than the record stock of 282 million tonnes recorded in 2017/18 marketing season. The predicted increase in global wheat stocks is due to expected increases in stockpiles from China and restocking inventories in several wheat exporting countries, according to FAO (2019). Table 3.2 below shows the world wheat market at a glance.

Table 3.2: World wheat market at a glance

	2017/18	2018/19 estima.	2019/20 f'cast	Change: 2019/20 over 2018/19
million tonnes				%
WORLD BALANCE				
Production	759.9	730.2	767.0	5.0
Trade	176.7	170.7	173.5	1.6
Total utilisation	738.9	747.3	756.9	1.3
Food	*508.9*	*514.2*	*519.4*	*1.0*
Feed	*136.1*	*141.4*	*143.6*	*1.5*
Other uses	*94.0*	*91.7*	*94.0*	*2.5*
Ending stocks	282.3	268.2	278.0	3.7

Source: FAO, 2019

According to the FAO (2019), the world trade in wheat, which includes wheat flour, is expected to reach 173.5 million tonnes in 2019/20, up by 1.6 percent from 2018/19 levels. The change in trade is primarily due to greater wheat purchases projected in numerous Asian and North African countries. FAO (2019) also predicted an increase in global wheat import demand for the 2019/20 season, which will be readily fulfilled by higher surpluses in major exporting countries including Russia, the United States, and the European Union.

3.2.4 Major role players in global wheat industry

World wheat production is expected to set a new high in 2019/20, according to FAO (2019). In 2019, worldwide wheat production is expected to be over 767 million tonnes, up about 37 million tonnes or 5% from the previous year's output. As mentioned earlier in the chapter, most of this growth is as a result of increased production in the EU, Russia Federation and Australia. The overall increase in wheat output in the EU is primarily owing to a favourable weather outlook, which is aided by improved yields and a two percent estimated increase in total wheat plantings.

Wheat production in the Russian Federation is expected to rise to at least 82 million tonnes, an increase of about 14 percent year on year. This is due to larger plantings and improved yields expectations as a result of favourable weather conditions, according to FAO (2019). Table 3.3 below indicates the world leading producers of wheat between 2017 and 2019 production seasons.

Table 3.3: World leading producers of wheat between 2017 and 2019

	2017	2018	2019	Change: 2019 over 2018
		million tonnes		
European Union	152.0	137.5	149.5	8.7
China (Mainland)	134.3	131.4	132.0	0.4
India	98.5	99.7	99.6	-0.1
Russian Federation	85.9	72.1	82.0	13.7
United States of America	47.4	51.3	51.0	-0.6
Canada	30.0	31.8	33.1	4.2
Pakistan	26.7	25.5	26.2	2.8
Ukraine	26.2	24.6	26.5	7.7
Turkey	21.5	20.0	21.0	5.0
Australia	21.2	17.3	23.9	38.3
Argentina	18.5	19.5	19.8	1.7
Kazakhstan	14.8	13.9	14.0	0.4
Iran Islamic Rep. of	12.5	13.4	13.4	0.0
Other countries	70.5	72.2	75.0	3.9
World	759.9	730.2	767.0	5.0

Source: FAO, 2019

It can be observed from Table 3.3 above that the European Union (combined) has been the major producer of wheat in the world between the years 2017 and 2019, followed by China (Mainland), India, the Russian Federation and the United States of America. It must also be noted that South Africa falls on the 28th position in terms of the contribution to the total wheat production in the world with an average production of 1.8 million tonnes per annum, FAO (2019).

3.2.5 Top 10 wheat exporters in the world

Table 3.4 below shows the top ten leading exporters of wheat in the world between the marketing years 2016/17 and 2019/20. The exports are based on a typical marketing season of July/June.

Table 3.4: Top ten exporters of wheat in the world

	2016/17-2018/19 Average	2019/20 f'cast	Change
	million tonnes		%
Russian Federation	34.5	35.0	0.5
United States of America	26.6	27.0	0.4
European Union	23.7	23.5	-0.2
Canada	21.8	23.0	1.2
Ukraine	17.3	17.0	-0.3
Australia	16.0	14.0	-2.0
Argentina	13.1	13.6	0.5
Kazakhstan	8.0	8.0	0.0
Turkey	4.8	4.0	-0.8
Mexico	1.0	1.3	0.3

Source: FAO, 2019

The global supply of wheat in 2019/20 is anticipated to be higher than the previous season, with most major suppliers of wheat expecting larger production outputs. The above table, Table 3.4, shows that the Russian Federation maintained its spot as the global leader in terms of wheat exports for the third consecutive season. The United States of America ranks next, having maintained its position as the world's second largest wheat exporter in 2019/20.

3.2.6 Top 10 wheat importers in the world

The top 10 wheat importers in the world are listed in Table 3.5 below. Imports are based on the usual marketing season of July/June.

Table 3.5: Top ten wheat importers in the world

2016/17-2018/19 Average		2019/20 f'cast	Change
million tonnes			%
Egypt	12.0	12.6	0.6
Indonesia	10.4	10.7	0.3
Algeria	7.9	7.7	-0.2
Brazil	7.2	7.5	0.3
Philippines	5.8	6.3	0.5
Bangladesh	5.9	6.1	0.2
European Union	5.5	6.0	0.5
Japan	5.7	5.8	0.1
China	5.6	5.4	-0.2
Turkey	5.5	5.3	-0.2
SOUTH AFRICA (*No 24 in the world)	1.8	1.8	-0.7

Source: FAO, 2019

Table 3.5 demonstrates that several imports from Asia and North Africa have a significant impact on global wheat commerce. In Asia, total wheat imports are estimated to reach just over 86 million tonnes in the 2019/20 marketing season. This is owing to increased demand from a number of Asian countries, including China, Indonesia, the Republic of Korea, the Philippines, and Thailand FAO (2019). Table 3.5 shows that Egypt remained the world's biggest wheat importer during the time under consideration, followed by Indonesia, Algeria and Philippines. South Africa, which is likewise a net wheat importer, is ranked 24th among the world's top wheat importers for the period under consideration, according to FAO (2019).

3.3 The South African Wheat Industry

3.3.1 The wheat industry's description

Wheat is the second most important grain crop in South Africa after maize, contributing almost 5 billion Rand to the overall gross value of agricultural production between 2009 and 2018 (DAFF, 2019). Wheat is produced in all the provinces in both summer wheat areas and winter wheat areas. The majority of wheat produced is for bread, although there are other small volumes of durum wheat produced in other parts of the country and used mainly for pasta. In South Africa, wheat is mostly utilised for human consumption (biscuits, bread, rusks, breakfast cereals, and so on), with less than 2% of the remaining wheat being used for animal feed and seed. Other non-food uses for wheat include ethanol manufacturing, adhesives, absorbing materials for disposable diapers, and industrial applications such as starch on coatings (DAFF, 2019). According to DAFF (2019), the producers of wheat in South Africa are estimated to be between 3 800 to 4 000.

As previously said, bread is the most important product of the baking business, accounting for 70 to 80 percent of all wheat flour produced in South Africa. After maize meal, wheat is the second largest source of energy in the country's diet. According to DAFF (2019), yearly consumer expenditure on bread was projected to be R6 700 million in the year 2000, compared to R6 200 million for maize goods during the same year.

3.3.2 The Gross Value of Wheat Production

During 2009 and 2018, the wheat industry contributed more over 5 billion Rand to the gross value of agricultural production, as shown in Figure 3.2 below. The contribution of the wheat industry to the gross value of agricultural production was lower in 2009, but climbed slightly in 2010 and 2011, owing to an increase in producer prices at that time. From 2012 through 2016, the gross value of wheat production grew to its greatest level, before declining somewhat in 2017. At the end of the marketing year in 2018, the gross value of agricultural production continued to show increasing trends.

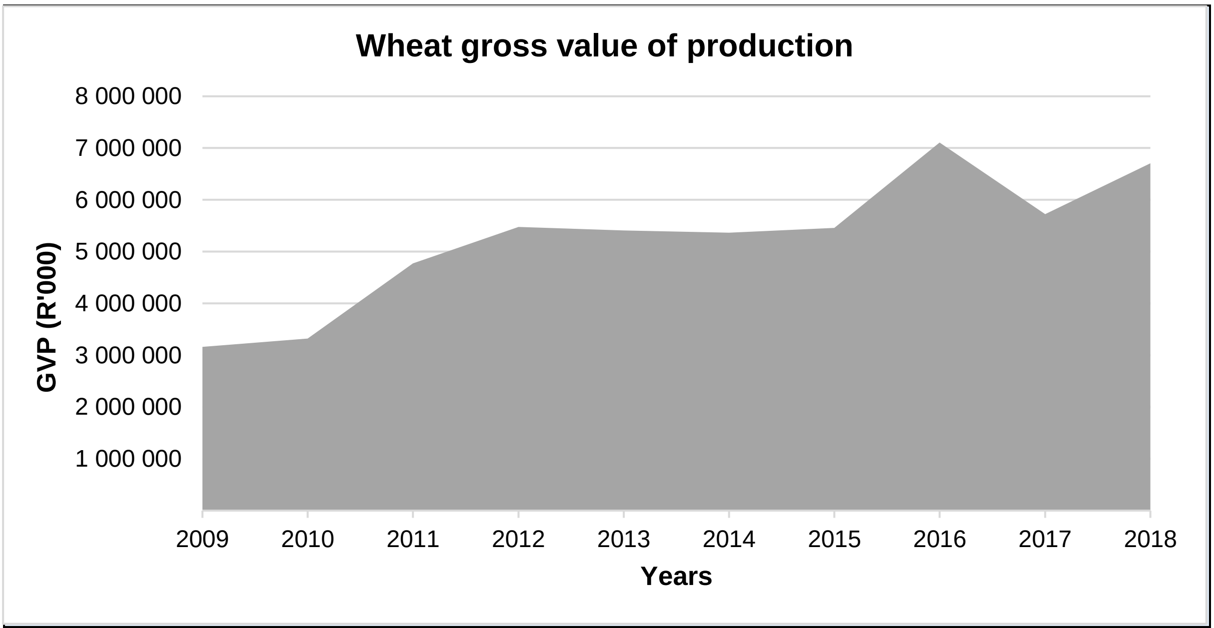

Figure 3.2: Gross Value of agricultural production
Source: DAFF, 2019

3.3.3 South African wheat production per province

Wheat is planted in South Africa between April and June in the winter rainfall areas and between May and the end of July in the summer rainfall areas, according to DAFF (2019). Wheat is grown throughout the country, with the Western Cape, Free State, and Northern Cape producing the majority of the country's wheat, accounting for around 84 percent of total production in 2018. Wheat is grown in other provinces as well, although its combined production accounts for just about 16 percent to 20% of overall wheat production. Nearly 19 percent of the entire area planted to wheat is irrigated, and more than 80 percent is grown on dry soil.

Figure 3.3 depicts wheat production in South Africa by province during the last ten years, as well as each province's contribution to overall South African wheat production in 2018. Figures 3.3 and 3.4 demonstrate that the Western Cape Province was the largest wheat producer in South Africa in 2018, accounting for nearly half of the country's total wheat production. This can be ascribed to the use of new technology, improved farming methods, increased yields, and favourable weather conditions in the Western Cape, which resulted in a strong crop.

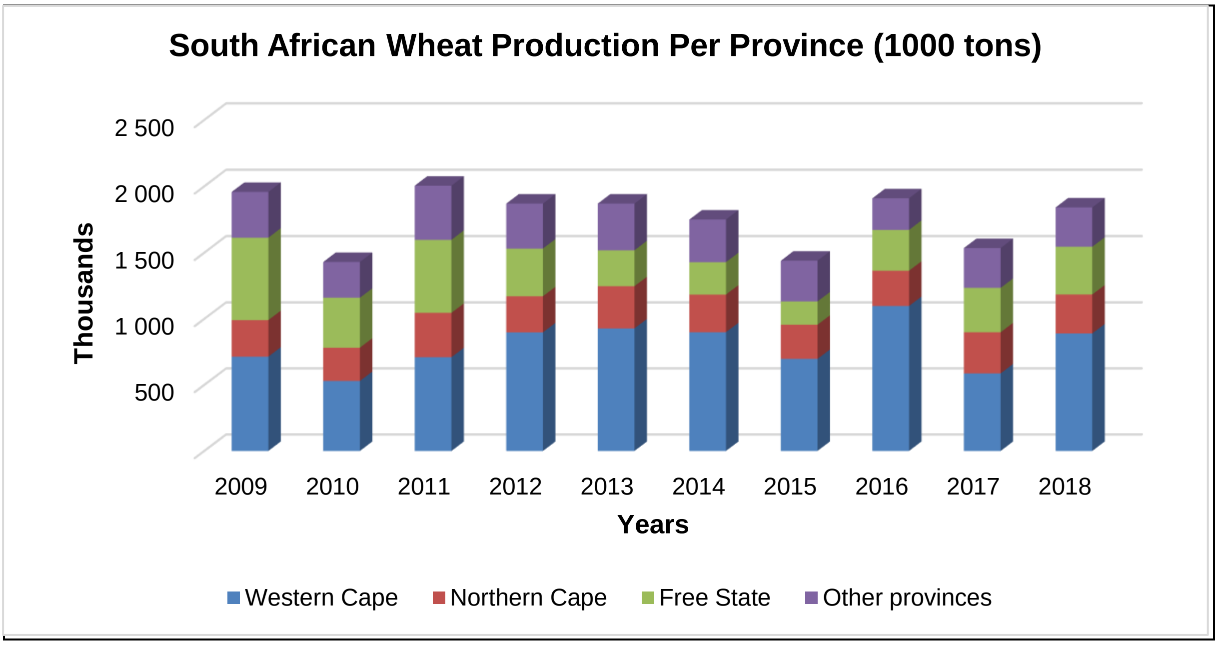

Figure 3.3: South African wheat production per province
Source: DAFF, 2019

Figure 3.4 depicts the contribution of each province for the 2018 season.

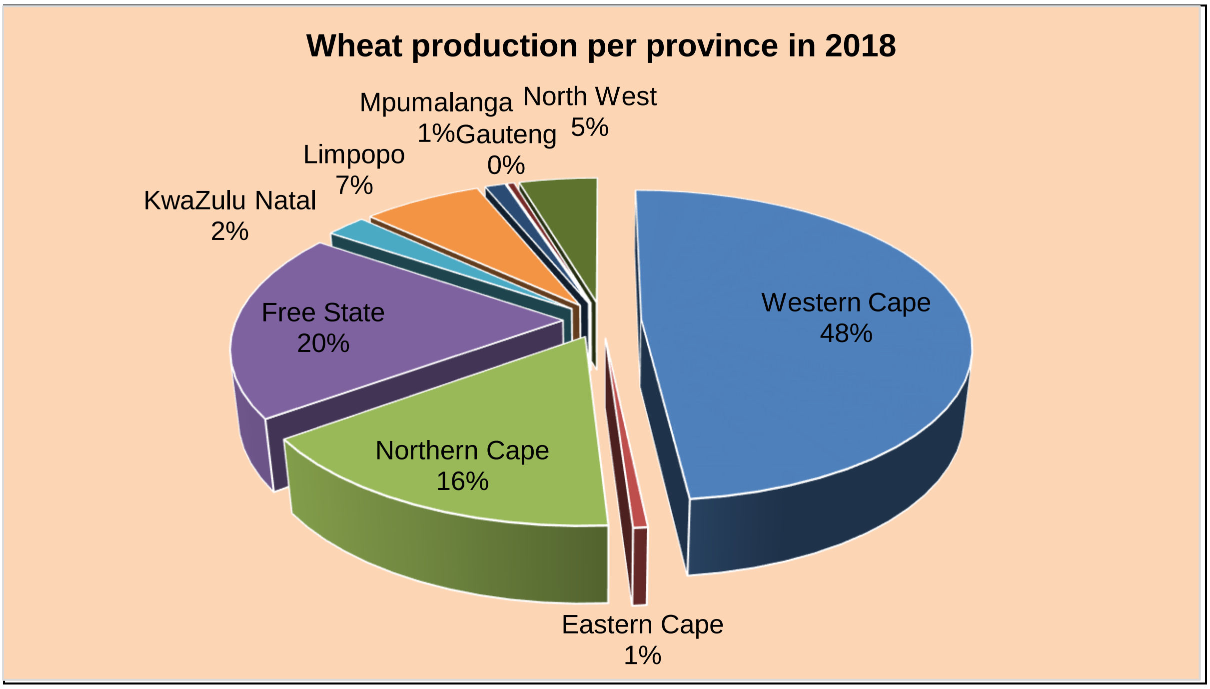

Figure 3.4: Wheat production per province in 2018.
Source: DAFF, 2019

Figure 3.4 shows that the Western Cape produced 48 percent of all wheat produced in South Africa in 2018, followed by the Free State (20%) and the Northern Cape (16%) (DAFF, 2019). The remaining provinces produced a total of 16 percent of the total, with Limpopo province accounting for 7% of the total.

3.3.4 South African wheat production volumes and hectares

According to CEC (2019), the total production for wheat was around 1 807 000 tons during the marketing year 2018, with an area planted of 503 000 hectares. According to DAFF (2019), South Africa has between 3 800 and 4 000 commercial wheat farms. Furthermore, as shown in figure 3.4, the Western Cape plays a critical role in the South African wheat sector, accounting for nearly 48 percent of total wheat produced in South Africa in 2018. Figure 3.5 and table 3.1 demonstrate that the area planted to wheat in South Africa has been declining for the previous ten years, with an average of 528 000 hectares per year between 2009 and 2018, despite increased yields keeping output neutral. This has resulted in an annual wheat harvest of around 1.8 million tons on average.

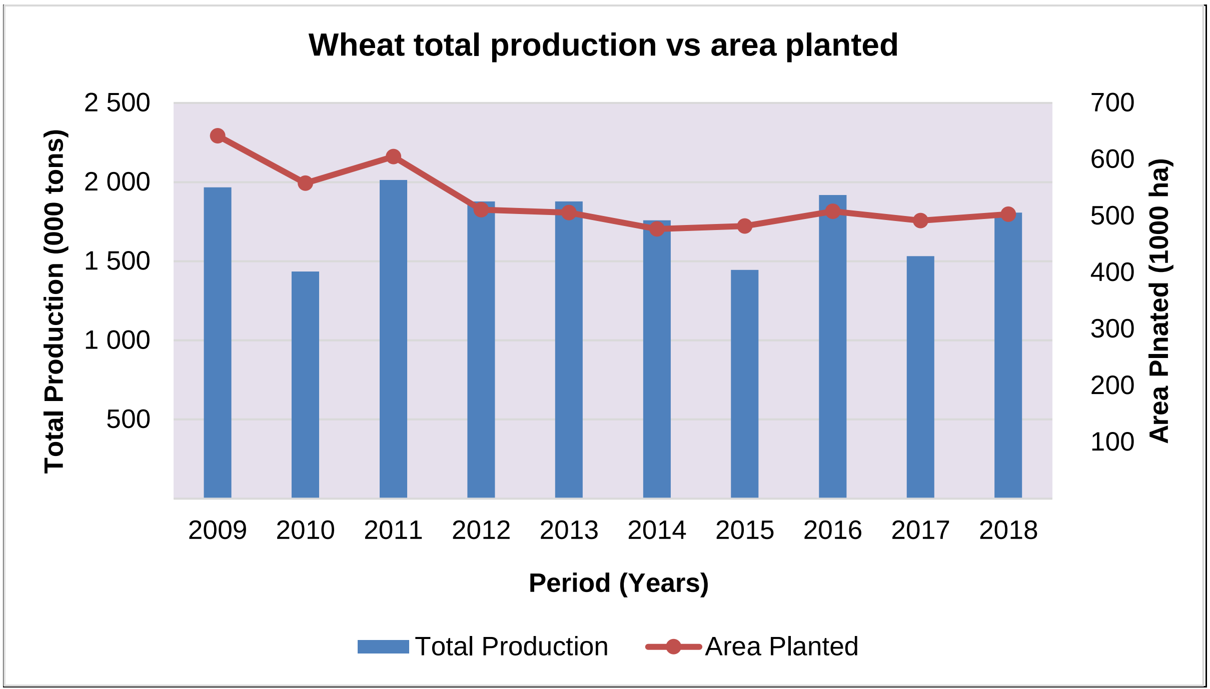

Figure 3.5: Total wheat output quantities and planted area in South Africa.
Source: DAFF, 2019

Table 3.6 below shows South Africa's total wheat production versus the area planted for the past ten years.

Table 3.6: Total wheat output quantities and planted area in South Africa

Period	Wheat Production (tons)	Area Planted (ha)
2009	1 967 000	642 000
2010	1 436 000	558 000
2011	2 014 000	605 000
2012	1 878 000	511 000
2013	1 878 000	506 000
2014	1 758 000	477 000
2015	1 446 000	482 000
2016	1 918 000	508 000
2017	1 532 000	492 000
2018	1 807 000	503 000
Average	**1 763 000**	**528 000**

Source: DALRDD, 2019

3.3.5 Wheat consumption in South Africa

Wheat is grown primarily for human consumption in South Africa. As noted in the previous section, only a tiny amount of low-quality tons is used for animal consumption. As illustrated in Figure 3.6, wheat consumption in South Africa has steadily increased over the last 10 years (from 2009 to 2018). In general, consumption of wheat has been above 3 million tons per annum except for the year 2010 where the total consumption was recorded at 2.9 million tons. According to BFAP (2012), it is expected that wheat consumption in South Africa will increase steadily by 2% per annum over the next decade.

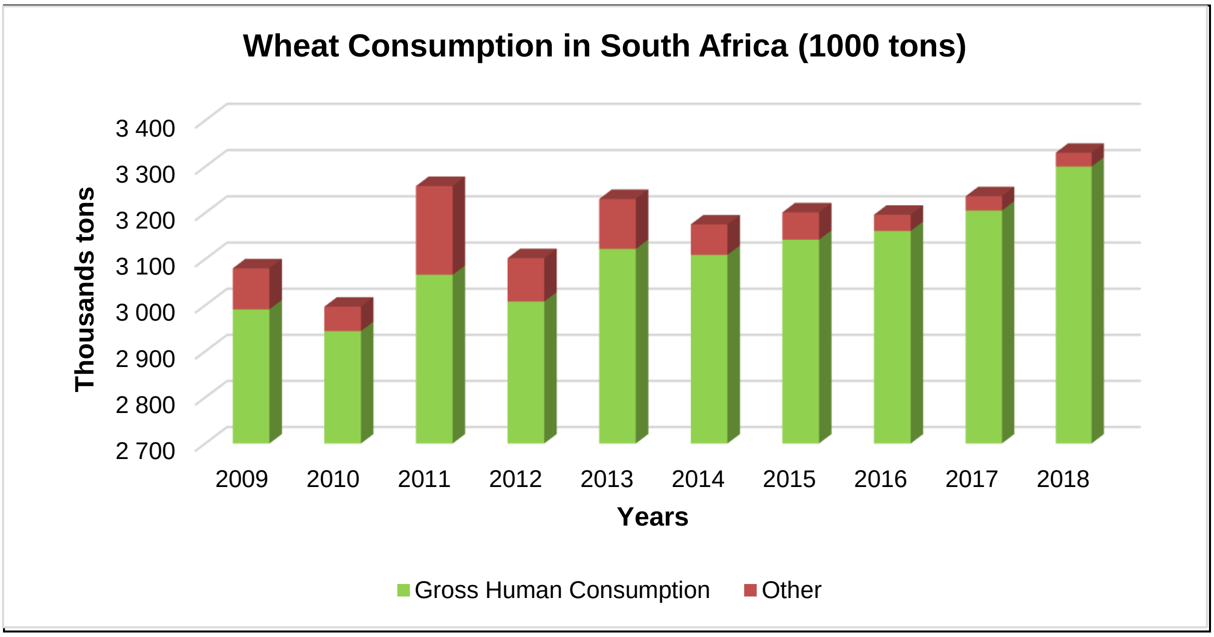

Figure 3.6: South African Wheat Consumption
Source: DAFF, 2019

3.3.6 South African Wheat Production versus Consumption

The majority of wheat produced in South Africa is utilised for the production of bread in the baking industry. The national consumption of bread is estimated around 2.8 billion loaves per annum or approximately 62 loaves per person per annum (DAFF, 2019). Figure 3.7 below provide a picture of the South African wheat production against the total domestic consumption from the year 2009 to 2018. Wheat production levels in South Africa are often lower, whereas consumption is always increasing, as seen in Figure 3.7 below.

Wheat output was at 1.80 million tonnes during the 2018 marketing season, while total domestic consumption was at 3.23 million tonnes (DAFF, 2019). This resulted in a wheat deficit of around 1.43 million tonnes, which was eventually filled by imports. Over the last ten years, South Africa has generated roughly 56 percent of its wheat consumption requirements, with the remainder coming from imports. In the local market, around 99.71 percent of the total wheat processed is used for human consumption, while the remaining 0.29 percent is used for animal feed.

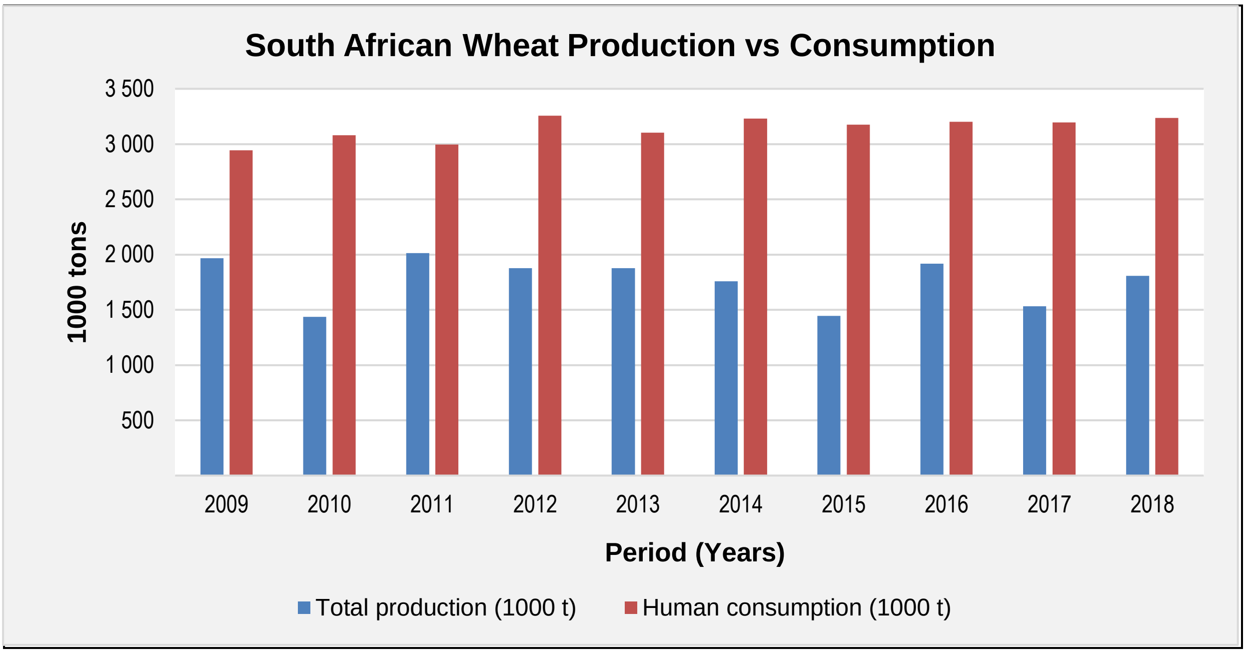

Figure 3.7: Wheat production vs. Consumption in South Africa
Source: DAFF, 2019

3.3.7 Wheat Imports and Exports

South Africa is not a large producer of wheat, according to DAFF (2019), and as a result, it relies on wheat imports from other regions to satisfy its ever-increasing domestic demand. Furthermore, domestically grown wheat must compete at international pricing with imported wheat. According to Hartwigsen (2013), the Western Cape Province of South Africa is in charge of producing local surplus wheat, which is then distributed to inland deficiency areas. In principle, the Western Cape Province should be well positioned for worldwide wheat exportation, however due to poor yields and high production costs, this is not the case. As a result of high deficit within the wheat industry, South African wheat prices are generally higher as they are based on the import parity prices (Hartwigsen, 2013).

Local wheat prices are frequently insufficient as a result of low yields and production costs, as well as the low productivity of the South African wheat industry in general. South African wheat growers are always competing with cheaper imports from other places, necessitating local prices to remain low in order to remain competitive. If not, millers will utilise imported wheat, which is less expensive than local wheat, making it difficult for local farmers to remain profitable (Hartwigsen, 2013). As with maize, local wheat prices are set by import parity prices rather than export parity pricing. This means that since the wheat market is already trading at import parity prices, the local supply and demand factors do not necessarily have the same price impact as in maize.

Given the foregoing, government intervention can only provide limited protection against cheaper imports in the form of a levy that will be activated once the price hits US $215 per ton. Although most industry stakeholders believe that this is insufficient to safeguard local wheat farmers from cheaper imports, the South African government is wary of supporting any extra import protection because it might easily raise food prices, affecting poor customers.

Figure 3.8 below illustrates the annual balances for South African wheat in million tons. As indicated by Hartwigsen (2013), there are many dynamics involved in the production and trade of wheat locally. To begin with, the fundamental production conditions are far from optimal, and as a result, wheat is less profitable than alternative staple crops such as maize. This, however, only applies to inland locations. It should be noted that some of South Africa's locally produced and imported wheat and wheaten products are headed for further export markets, mostly in the SADC region.

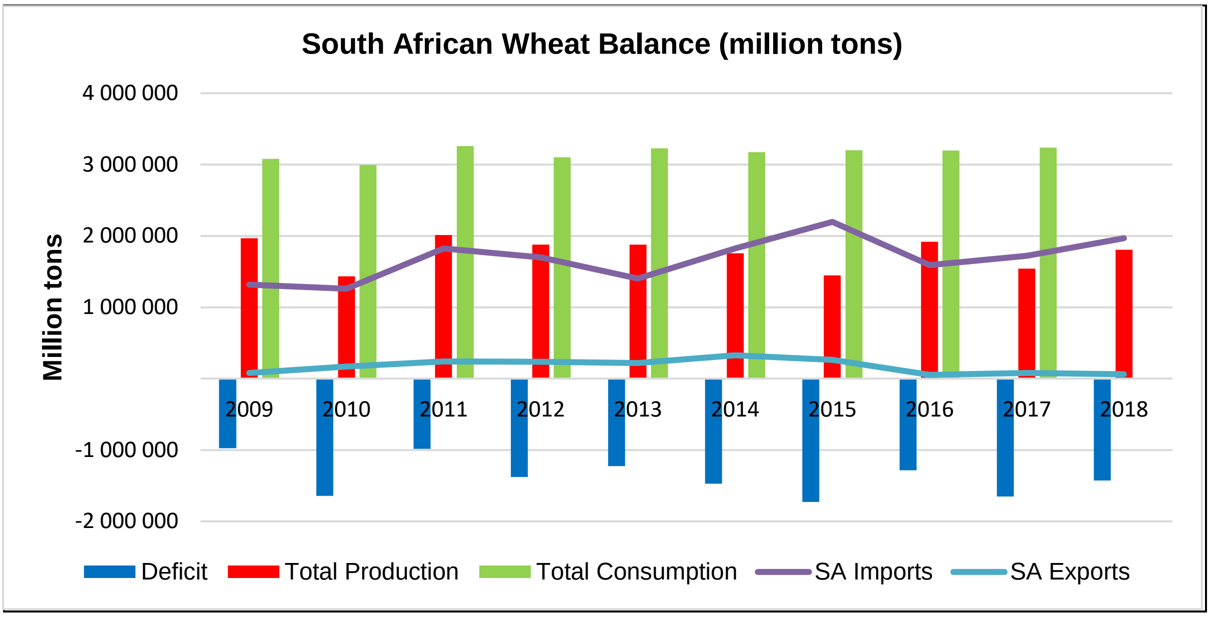

Figure 3.8: South African Wheat Balances
Source: DAFF, 2019

3.3.8 Dollar-Based Reference Price and Variable Tariff Formula for wheat

In South Africa the current tariff dispensation for wheat, termed the variable tariff formula was introduced in 1999 based on the recommendation provided by the then Board on Tariff and Trade (BTT). The domestic Dollar-based reference price (DBRP) for wheat was set at a level of US$157/ton equal to the average long-term international price for wheat (using the then latest 10year average US No.2 Hard Red Winter Gulf wheat prices as a benchmark for world wheat prices. Various adjustments to the degree of protection have been made since then, based on changes in global wheat prices (ITAC, 2016).

The then-Minister of Economic Development, aimed at ITAC, issued an order in 2016 to study and examine a revision of the Dollar-Based Reference Price (DBRP) and variable tariff formula for wheat. According to ITAC (2016), this directive was made in view of the fact that wheat, together with other staple crops such as maize and sugar are basic necessities used on a daily basis by the South Africans. This was also based on the fact that the country was still in the grip of a drought that was coupled with large exchange rate fluctuations during that particular period.

In its investigation and after thorough consultations with various stakeholders affected by the review, ITAC (2016), decided that the domestic DBRP for wheat be reduced from US$294/ton to US$279/ton based on the 5-year average USA Hard Red Wheat No.2 settlement price of wheat of US$295/ton, with additional adjustment for the distortion factor evident in the international wheat market of US$22/ton, minus the average ocean transport cost of wheat to a South African port of US$38/ton. According to ITAC (2016), this review meant that, the initial duty on wheat would be calculated as the difference between US$279/ton and the price of wheat as on the 9th of August 2016, which amounted to US$189/ton at an exchange rate of R13.43 to the US$ adjusted for price differentials between South Africa and its most important trading partners, using the published Real Effective Rand Exchange Rate Index.

According to ITAC (2016), adjustments to the degree of protection will be based on changes in the world reference price, which implies the difference between the three-week moving average of the US No. 2 Hard Red Winter Gulf settlement price (global reference price) and the domestic Dollar-based reference price for wheat will be computed weekly. If the three-week moving average of the US No. 2 HRW Gulf settlement price differs by more than US$10/ton from the preceding three-week trigger level, a tariff adjustment is triggered, and a new duty is determined.

The resulting Dollar particular tariff is converted to Rand at the current Rand/Dollar exchange rate on the day the adjustment is triggered, and then updated using the most recent real effective exchange rate reported by the South African Reserve Bank (SARB). The levels of duty should not exceed the bound rates of 72 percent ad valorem for wheat and 99 percent ad valorem for wheat flour. After every three years, the dollar-based reference price should be reassessed. This is done to guarantee that the DBRP is updated to reflect recent changes in the domestic and global wheat markets.

3.3.9 South Africa’s supplying markets for wheat imported in 2018

Russian Federation, Germany, Latvia, Argentina, Canada, and Lithuania were the top countries from which South Africa purchased wheat in 2018. Table 3.7 shows that the Russian Federation is the most important wheat exporter to South Africa, accounting for 42 percent of South African wheat imports in 2018, followed by Germany (17 percent) and Latvia (8 percent).

Table 3.7: List of South Africa's supplying markets for wheat imported in 2018

Exporters	Imported value 2018 (USD thousand)	Share in South Africa's imports (%)	Imported quantity 2018 (Tons)	Unit value (USD/unit)	Imported growth in value between 2014-2018 (%, p.a.)	Imported growth in quantity between 2014-2018 (%, p.a.)	Imported growth in value between 2017-2018 (%, p.a.)
World	414985	100	1983829	209	-7	-1	27
Russian Federation	174721	42.1	840371	208	-15	-10	82
Germany	70225	16.9	337720	208	-2	5	24
Latvia	33446	8.1	162908	205	158	18	539
Argentina	32459	7.8	166657	195	131	154	165
Canada	30873	7.4	131841	234	-23	-19	1086
Lithuania	24865	6	117779	211	46	52	44
Romania	10586	2.6	51863	204	0	0	-68
Ukraine	10422	2.5	46745	223	-35	-31	-58
United States of America	8568	2.1	42461	202	-3	5	-59
Poland	7182	1.7	30639	234	-7	12	-62

Source: ITC, Trade Map

According to BFAP (2012), wheat imports are predicted to rise consistently over the next decade, owing to a lack of predicted increases in wheat planted area and rising demand.

Table 3.8 shows the list of importing markets for wheat exported by South Africa in 2018. With the exception of exports to Madagascar, South Africa currently exports the majority of its wheat to other African countries by road transport. However, compared to the amount of wheat consumed locally, wheat exports are quite modest, and wheat is primarily exported from agricultural areas with summer rainfall. In 2018, the majority of South Africa's wheat was shipped to countries such as Namibia, Botswana, Eswatini, Lesotho, Zimbabwe, Mozambique, Canada, Zambia, and Malawi, as shown in Table 3.8 (ITC, 2018).

Table 3.8: List of South Africa's importing markets for wheat exported in 2018

Importers	**Exported value 2018 (USD thousand)**	**Share in South Africa's exports (%)**	**Exported quantity 2018 (Tons)**	**Unit value (USD/unit)**	**Exported growth in value between 2014-2018 (%, p.a.)**	**Exported growth in quantity between 2014-2018 (%, p.a.)**	**Exported growth in value between 2017-2018 (%, p.a.)**
World	19624	100	61326	320	-37	-37	-36
Namibia	4604	23.5	12608	365	-21	-19	94
Botswana	4481	22.8	14465	310	-40	-39	-40
Eswatini	4233	21.6	14584	290	-34	-32	491
Lesotho	3532	18	11374	311	-31	-35	-44
Zimbabwe	1872	9.5	5851	320	-46	-44	-84
Mozambique	535	2.7	2001	267	9	11	73
Canada	302	1.5	378	799	0	55	-4
Zambia	54	0.3	60	900	0	-77	-97

Source: ITC, Trade Map.

In 2018, Namibia alone absorbed 23.5 percent of South Africa's total wheat exports, followed by Botswana and Eswatini with 22.8 percent and 21.6 percent, respectively, according to Table 3.8. However, Table 3.8 shows that between 2014 and 2018, the volume of wheat exported from South Africa to the rest of the globe declined by 37%.

3.3.9 Producer Prices for Wheat

On SAFEX, the domestic prices for wheat for the near contract week are shown in the graph below. The spot price is the historic futures price quoted on the SAFEX in the week of delivery. SAGIS historic prices as supplied by SAFEX were used to calculate all import and export parity prices. In addition, Figure 3.9 shows that the domestic wheat price is closer to the import parity price. This is mostly owing to the fact that South Africa is a net wheat importer, and because wheat is an internationally traded commodity, domestic prices are highly influenced by global wheat prices.

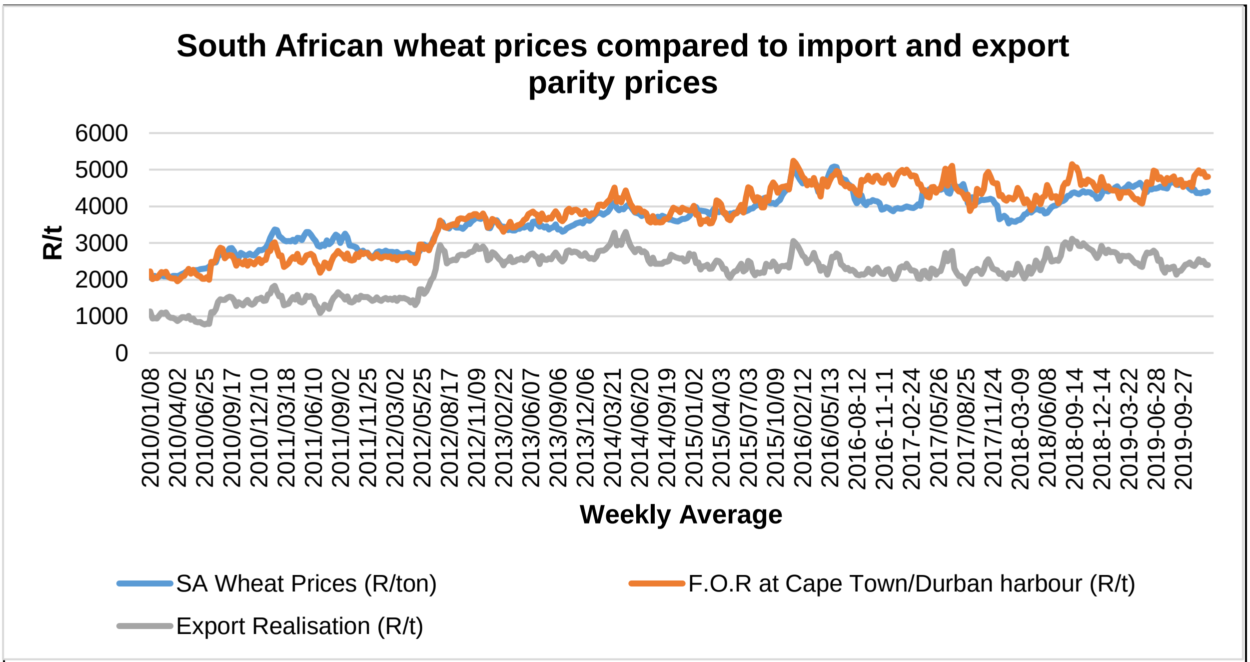

Figure 3.9: Wheat prices in South African versus import and export parity prices. SAGIS, 2020

Apart from high food price increase that took place in 2008 due to global inflation, more significant increases in wheat prices can also be observed during the marketing year 2012/2013. This is mainly due to drought that occurred in the United States during that particular period, heavily affecting the global commodity prices for staple crops such as maize and wheat. The analysis provided above also support the objectives of the study on the spatial price transmission and market integration for wheat, which aims to understand the significant impact of changes in international prices on the domestic prices for a homogenous commodity.

3.3.10 Wheat Grading in South Africa

South African wheat is thought to be of far higher quality than most imported wheat, according to Hartwigsen (213). However, there is still controversy about how the existing grading system affects the capture of wheat quality, which affects the predicted premium received by producers. Hartwigsen (2013) further argues that imported wheat may contain the required protein content to be categorised as South African B2 grade, despite the fact that it is of lower quality than what is required in the baking industry. South Africa currently has five wheat grades: B1, B2, B3, B4, and a Utility grade. Protein quality, hectolitre mass, kernel damage, and foreign contaminants are believed to be the key criteria for grading wheat. Table 3.9 summarises all of these values by grade level.

Table 3.9: South African wheat grading regulations

Grade	**Minimum Protein (12% moisture basis)**	**Minimum Hectolitre mass (Kg/ha)**	**Minimum falling number (Seconds)**
B1	12	77	33
B2	11	76	220
B3	10	74	220
B4	9	72	200
Utility	8	70	150

Source: DAFF, 2010

3.3.11 Wheat Market Value Chain

According to (DAFF, 2019), the milling industry, baking industry and retail sector make up the local market for wheat in South Africa. The wheat market value chain in South Africa is depicted in Figure 3.10.

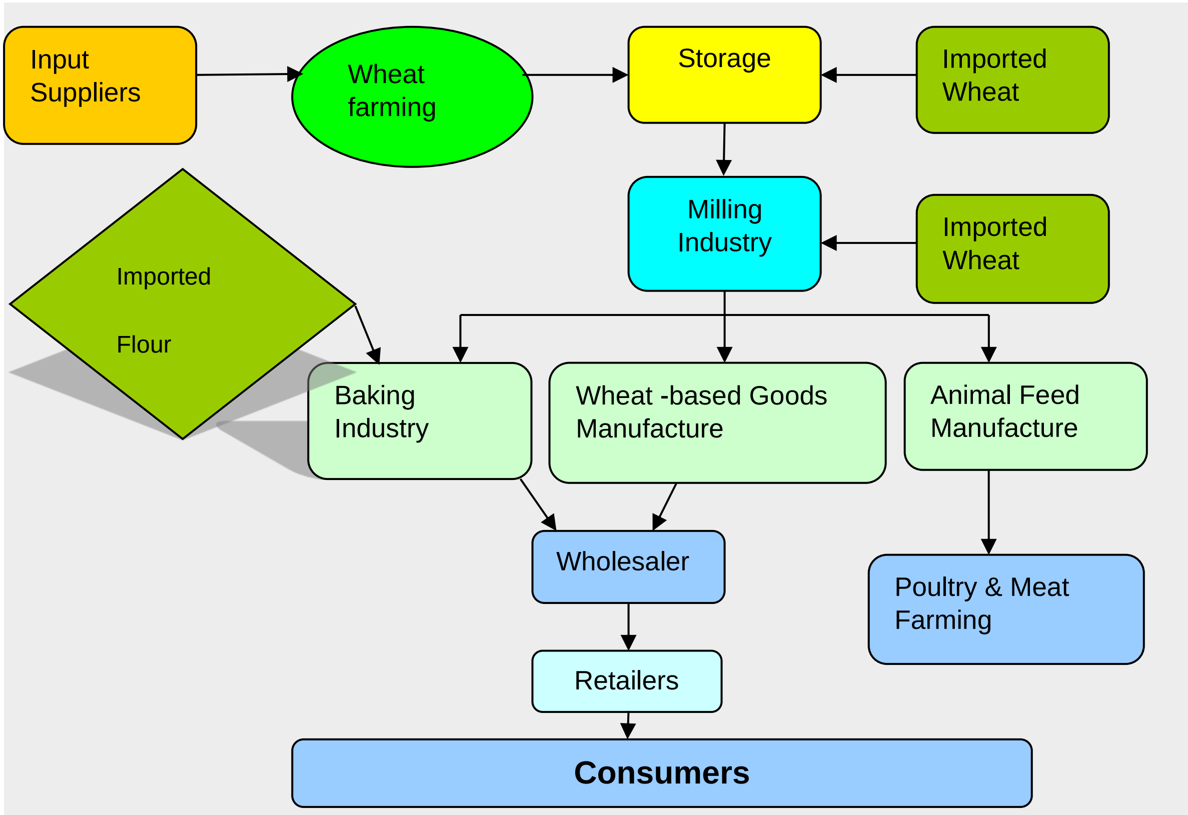

Figure 3.10: South Africa's Wheat Market Value Chain
Source: DAFF, 2019

Input suppliers offer seeds, fertilizer, insecticides, fuel and other items to farmers who then grow wheat, according to (DAFF, 2019). Wheat is held in a variety of storage facilities after harvesting, including imported wheat. The wheat is then sent to milling businesses, which mill it into wheat flour, meal, and bran, which are used in three ways. Wheat flour can be used to make perishable products including pan loaves, rolls, buns, confectionary, frozen dough and par-baked goods in the baking industry. Wheat flour can also be used to make wheat-based products including biscuits, pasta/spaghetti, crackers, and breakfast cereals. Wheat meal and bran are also used in the animal feed industry to produce agricultural feeds and pet foods (DAFF, 2019).

3.3.12 The South African baking industry

According to the South African Chamber of Baking, there are five major types of baking units: plant, wholesale, industrial, in-store, and other bakeries (DAFF, 2019). There are a lot of informal bakeries. Bakers mostly make bread and other baked goods such as biscuits, pies and pizzas. Plant bakeries remain popular, despite the fact that there is a substantial amount of retail baking, which may have a negative impact on the plant bakeries.

According to the HSRC report (2002), there are 7 905 baking units in South Africa, with roughly 45 500 job prospects. According to the Food Price Monitoring Committee research of 2003, there are around 52 200 unlicensed bakers who operate in non-licensed premises. The creation of franchises and in-store bakeries aided in the growth of this industry. Albany, Blue Ribbon, Sasko, Sunbake and BB Cereals are the leading companies in the baking industry.

3.3.13 Wheat Value Chain Tree

Figure 3.11 below illustrates the wheat value chain tree. As explained in the milling process structure for wheat provided earlier on, wheat is also suitable for other products.

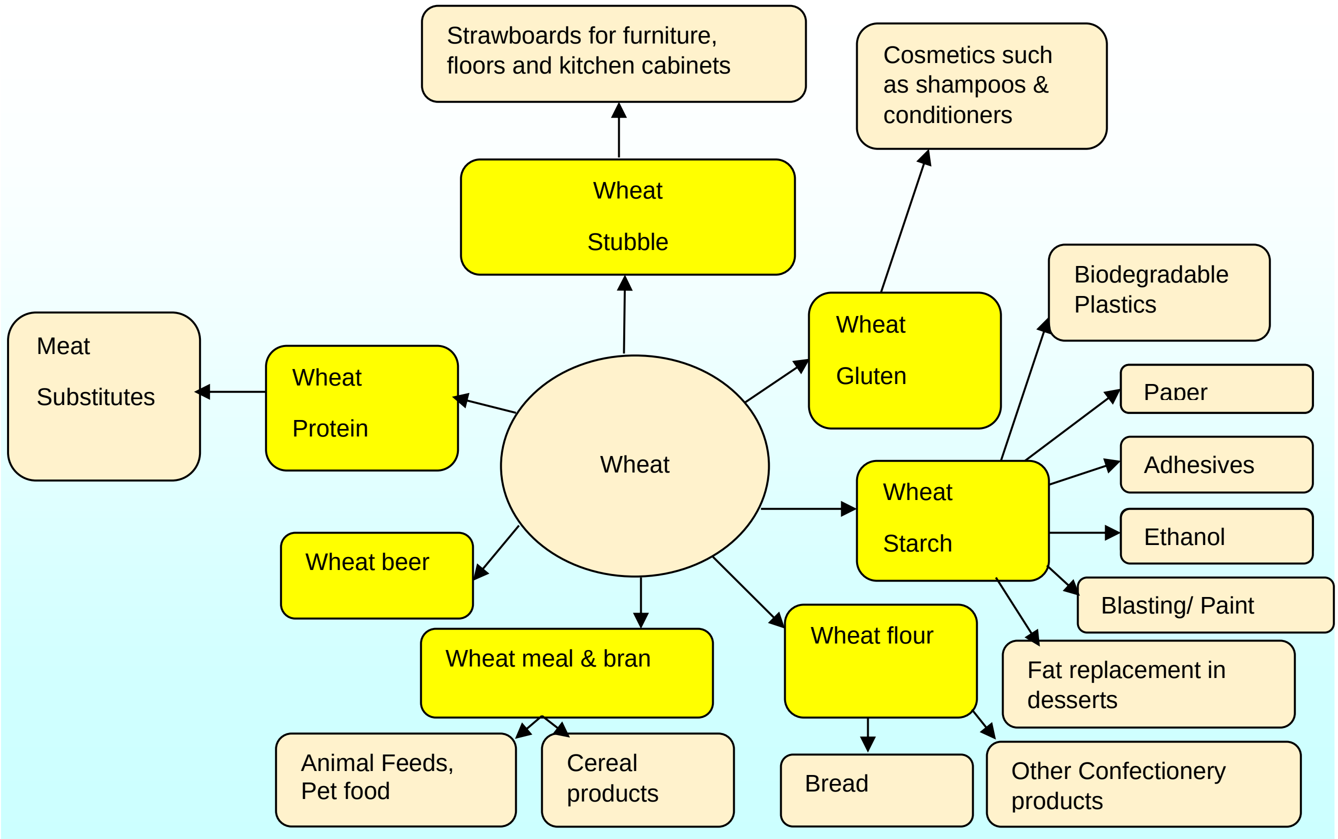

Figure 3.11: The Value Chain Tree for Wheat
Source: DAFF, 2019

The fact that it contains gluten (protein) and starch, according to DAFF (2019), makes it useful in non-food and industrial applications. Wheat gluten has the ability to be elastic, to bind water, and to produce heat-stable films. Wheat can be used to make adhesives, coatings, polymers and resins because of these qualities. Wheat is used in a variety of other goods, as indicated in Figure 3.11.

3.4 Summary

According to DAFF (2019), the contribution of the primary agriculture to the South African annual gross value added by industries was at R106 Billion in 2018, which is about 2.4% contribution to the national GDP. Field crops generated 18.96 percent of the overall gross value of agricultural production during the same time, in addition to the aforementioned. In 2018, the wheat industry accounted for roughly 9.32 percent of total gross value of field crops output, ranking fourth behind maize, sugar cane, and wattle bark. This shows that the wheat industry is very important as it contributes immensely to the South African economy.

This chapter looked at the industry as a whole to highlight how important the wheat industry is in South Africa. Numerous international and local market trends, as well as impressions of the institutional environment in which the South African wheat sector currently operates were revealed as a result of the aforementioned investigation. The wheat industry remains one of the critical industries within the agriculture space and the South African economy as it contributes largely to the eradication of poverty though the production of bread, which forms part of the national food basket. However, various concerns surfaced, particularly with reference to the country's continued decrease in wheat-planting area and a huge production shortfall, implying that the country will remain a net importer of wheat.

CHAPTER 4 : METHODOLOGY

4.1 Description of study area

The study focused on spatial price transmission and market integration of wheat prices from the global wheat market to the domestic wheat market in South Africa. The area allocated to wheat production in South Africa has been deteriorating over years while local consumption of wheat continues to increase in parallel with population growth. According to StatsSA (2018), South Africa has a population of 57.73 million and as reported in the abstract for agricultural statistics by DAFF (2019), the per capita consumption for wheat on average is around 48.6 kg per annum. Despite the fact that the South African wheat industry contributes more than 5 billion Rand per annum to the total Gross Value of Agricultural Production, the industry was mainly chosen for the study because of its enormous contribution to the South African food security.

In short, the wheat sector in South Africa contributes to the agricultural economy because wheat is the country's second most consumed field crop after maize (StatsSA, 2014), and primary production, together with domestic wheat processing, provides a bigger number of job possibilities. Furthermore, wheat flour, which is used in bread baking, is considered the second most important source of food in South Africa, and thus plays a critical part in the country's struggle against poverty and food insecurity. Bread, particularly brown bread, is regarded as an integral part of the National School Nutrition Programme across the country, according to NAMC (2005), and is increasingly becoming a staple food in South Africa.

4.2 The data set

This study used weekly average price data focusing on two variables, namely world wheat prices and domestic wheat prices in South Africa. The data covers 468 observations ranging from January 2010 until December 2019. The data on the world producer prices for wheat was obtained from the International Grain Council (IGC) and as reported on its grain market report, prices for US Hard Red winter wheat No.2 were used as the benchmark for world prices. On the other hand, the data for domestic wheat prices was obtained from the South African Futures Exchange (SAFEX) as reported by the South African Grain Information Services (SAGIS). The average of the daily prices for a certain week is used to compute weekly pricing. This is done to guarantee that South African prices are in line with the International Grain Council's weekly world pricing. International Grain Council prices are reported in $/ton and were converted to ZAR/ton by multiplying the stated world price for a given week by the current average exchange rate for that week. The exchange rate utilised in the above-mentioned calculation is the ZAR/USD average weekly nominal exchange rate as reported by the SAFEX.

4.3 Research design

The time series analysis was the adopted research design where various data analysis techniques were applied to test and analyse time series data on world and domestic prices for wheat in South Africa. This was done to assess the nature of the South African wheat market's spatial price transmission. Therefore, this design was considered relevant for the study, especially based on the time series properties of the data in order to understand how prices of wheat are transmitted from the international wheat markets to local wheat markets in South Africa.

4.4 Data analysis technique

This section focuses on the data analytic approaches that were used to measure the long and short run dynamics in the study on spatial price transmission and market integration of wheat in South Africa. Time series analysis, particularly cointegration models, are commonly utilised for price transmission analysis (Davids *et al*, 2016). This is due to a multitude of factors that contribute to their popularity: To begin with, cointegration models can be used to analyse both short and long-run price trends. Second, they can produce reliable results even when the only data given is based on prices. The interpretation of their findings, however, must be predicated on the assumption that continuous and unidirectional trade links exist between the markets under consideration. These data analysis approaches include, for example, checking the data series for stationarity using the Augmented Dickey-Fuller test and Johansen's Co-integration test used to check for the presence of a long-run co-integration relationship in the data series. After that, the Error Correction Model is estimated.

4.4.1 Conceptual framework

In general, price transmission research is based on the Law of One Price (LOP), which states that the price of a homogenous commodity in one market can only differ by the costs π^{XY} of moving them from point *X* to point *Y.* This condition is known as the spatial arbitrage condition or the weak form of LOP, according to Barrett (2001), and if this connection holds as equality, it is known as the strong form of LOP that is:

$$P_t^Y - P_t^X = \pi^{XY} \tag{4.1}$$

where P_t^Y and P_t^X denotes prices of a homogenous commodity in markets *X* and *Y* in time *t*. For the existence of a strong form of LOP, an equilibrium condition is achieved where price differences among markets evolve over time toward the transaction costs π_t^{XY} (Barrett, 2001). This notion is a long-run concept; prices can deviate from equality in the short-run due to various shocks. During the time when such disequilibrium occurs, price signals will stimulate the movement of products between surplus and deficit markets, thus restoring the long-run equilibrium.

The scenario of complete market integration, the intrinsic dynamic market relationship that develops as a result of inertia or trade discontinuities, as well as non-linearity that may develop from policies and other distortions in arbitrage, are all examples of price transmission as outlined in chapter two. Most crucially, it generates hypotheses that may be tested within a cointegration error correction model framework through its components.

In light of the foregoing, a variety of time series techniques or procedures can be utilised to evaluate each of the price transmission components as well as quantify the degree of price transmission and integration between different markets. Following many other time series analysis, the first step is to evaluate the time series properties of the data. This process is done through the application of Augmented Dickey-Fuller test to test for unit root, while the Johansen co-integration test is employed to evaluate the time series properties of the data. According to Vavra and Goodwin (2005), these tests are critical mainly for putting the results into the context of the larger body of research and to help consider the appropriate model for price transmission.

This process as specified by Eagle and Granger (1987), follows a two-step approach whereby a co-integration relationship amongst the two variables was estimated by the application of Ordinary Least Squares (OLS) methods, this was then followed by the estimation of Error Correction Model (ECM) through the use of lagged residuals from the co-integration regression as error correction terms. The following section provides detailed analytical procedures applied in the study.

4.4.2 Augmented Dickey-Fuller (ADF) unit root test

If the mean and variance of a time series data set remain constant, it is said to be stationery. This means that the series varies within a restricted range around its mean value and does not display any discernible pattern over time. As a result, a stationery series is one in which the mean, variance, and covariance do not change over time. As a result, a non-stationary series is defined as one in which the mean, variance, and covariance all shift with time (Mohammed, 2005). When time series are non-stationary, a regression analysis will almost always produce false findings. Even when there is no statistically significant relationship, a regression analysis of non-stationery time series data may suggest the existence of one. The Augmented Dickey-Fuller (ADF) test, which was employed in this study to check for stationarity of price variables, is shown in equation 4.2 below and can be written as,

$$\Delta P_t = \alpha + \boldsymbol{\beta} t + \varnothing P_{t-1} + \sum_{i=1}^{K} \theta_i \Delta P_{t-1} + \varepsilon_t \qquad (4.2)$$

Where, P_t stands for domestic wheat price at time t, and $\Delta P_t = P_t - P_{t-1}$;

α = an intercept term,

β, $\varnothing$, θ are coefficients

t = a term trend,

k = maximum lag order to be determined, and

ε_t = a stochastic non-auto correlated error term with zero mean and a constant variance.

To test for stationarity in time series data, the null hypothesis of unit root (i.e. non-stationarity) should be evaluated first, followed by the alternative hypotheses of stationarity. A variable is said to be non-stationary if the absolute value of its ADF statistics is smaller than its critical value, meaning that the null hypothesis will be accepted. The model will reject the null hypothesis only if the absolute value of ADF test statistics is more that its critical value.

4.4.3 Johansen's Co-integration test

The concept of cointegration is based on discovering a long-term relationship between variables. When two data series have a long-run equilibrium relationship, divergence from the equilibrium is restricted, which implies they move in lockstep and are cointegrated. In general, two conditions must be met for two or more series to be integrated: first, they must all be integrated to the same order, and secondly, a linear combination of the variables must exist that is integrated to a lower order than the individual series (Hansen & Juselius, 1995).

The study opted for the application of Johansen's co-integration test to identify the existence of long-run relationship or co-integrating relationship among the variables. The test is based on the notion that economic variables are much more likely to be endogenously interdependent. According to Du Preez, (2011), the presence of at least one co-integration relationship is necessary for the analysis of long-run relationship to be credible.

Two test statistics, namely the Eigen statistic and Trace statistic are used for Johansen cointegration test. This maximum likelihood ratio test involves a reduced rank regression between two variables, say I(1) or I(0), providing n Eigen values $\hat{\lambda}_1 > \hat{\lambda}_2 > \cdots > \hat{\lambda}_n$ and corresponding eigenvectors $\hat{v} = (\hat{v}_1 \ldots \hat{v}_2)$, where the r elements of $\hat{v}$ are the co-integration vectors. The magnitude of λ_i is a measure of the strength of correlation between the co-integrating relations for i =1 … r. The test of the null hypothesis that there are r co-integrating vectors present can be stated as:

H_0: $\lambda_i = 0$ $\quad\quad$ $i = r + 1 \ldots \ldots n$

The Maximal-Eigen Statistics is given by:

$$\lambda_{max} = -T \log(1-\hat{\lambda}_{r+1}) \qquad r = 0, 1, 2, \ldots \ldots, n-1 \qquad (4.3)$$

Where T is the sample size and $(1-\hat{\lambda}_{r+1})$ is the Max-Eigen Statistic estimate.

The trace statistic is given by:

$$\lambda_{trace} = -T \sum_{i=r+1}^{n} \log(1-\hat{\lambda}_i) \quad r = 0, 1, 2, \ldots \ldots, n-1 \qquad (4.4)$$

Testing the null hypothesis of r co-integrating vectors against the alternative of r+1. The Johansen co-integration test was crucial for this research since the results would indicate which sort of econometric model to use in estimating price transmission between international and domestic wheat prices in South Africa.

4.4.4 The Model

An application of Error Correction Model (ECM) was adopted for this study in order to determine how prices are transmitted from world wheat markets to the domestic wheat market in South Africa. In order to estimate the error correction model, the Engle and Granger (1987) two step procedure was followed. The long term relationship or cointegration between the pairs of log-prices is first approximated using equation 4.5, which shows an example of the relationship between world wheat prices and domestic wheat prices in South Africa According to Minot,(2011), since the prices are expressed in logarithms, the cointegration factor (β) is the long-run elasticity of the domestic price with respect to the world price. Thus, β is the long-run elasticity of price transmission. The expected value for imported commodities is 1> β>0, but for exports, it may be greater than 1. Thus, if for example, β=0.5, this means that 50 percent of the proportional change in the international price will be transmitted to the domestic price in the long-run. See equation 4.5 below:

$$lnP_t^{dwp} = \alpha_0 + \beta_1 lnP_t^{wwp} + \varepsilon_t \qquad (4.5)$$

Where:

P_t^{dwp} domestic wheat price

P_t^{wwp} world wheat price

β_1 long-run price transmission elasticity

ε_t shows the error term

Secondly, the ADF unit test is used to evaluate the residual (εt) for stationarity using the unit root test. Two non-stationary series of the same order I(1) are co-integrated if they have a long-run relationship and a linear combination of the series is stationary, even if they diverge in the short-run (Davids *et al*, 2016). Thus, if the residuals are I(1) we accept the null hypothesis of non-cointegration, but if the residuals are I(0) then we reject the null and accept that y and x are cointegrated.

When two price series are co-integrated, their short-run dynamics can be studied using an error correction model (ECM), which has the form shown in equation 4.6:

$$\Delta \ln P_t^{DWP} = \alpha_0 + \sum_{i=1}^{n} \beta_i \Delta ln P_{t-i}^{WWP} + \sum_{j=1}^{n} \Theta_j \Delta ln P_{t-j}^{DWP} + \alpha_1 \varepsilon_{t-1} + \mu_t \quad (4.6)$$

Where;

P_t^{DWP} price of domestic wheat in first difference form

P_t^{WWP} world wheat price in first difference form

ε_{t-1} lagged residual from (1), representing the error correction term

μ_t associated error term

The coefficient of the error correction term (α_1), which measures the speed of adjustments, indicates how long a shock that creates disequilibrium should flow through the system. Furthermore, the negative coefficient indicates that after a shock from world prices, the system converges back to equilibrium mode, while the magnitude of the coefficient reflects the time necessary for the model to return to equilibrium. According to Minot (2011), the coefficient value is expected to be in the range of $-1< \alpha_1<0$. The term in parentheses denotes the difference or "error" between the preceding period's prices and the long-term relationship between them. If the error is positive (the domestic price is too high given the long-term relationship), the negative value of α_1 helps correct the error by increasing the likelihood of a negative shift in domestic wheat price.

The greater the absolute value of α_1 (i.e., the closer it is to -1), the faster the domestic price returns to equilibrium. The following formula is used to generate the number of weeks required for the South African domestic wheat prices to adjust back to equilibrium after a change in the world wheat price, according to the approach used by Ghoshray (2002):

$$n = \frac{\log(1-p)}{\log(1-\alpha_1)} \quad (4.7)$$

where:

p denotes the fraction of the disequilibrium that needs to be adjusted, and

α_1 indicate the short-run adjustment speed coefficient from equation (4.6).

Testing for Granger causality is critical in many vector error correction models, according to Minot (2011), although it is less important when looking at the transmission of world prices to domestic prices. This is mostly due to the impossibility of causality from domestic to global or international prices. Therefore, the results for Granger causality test will not be considered for this study. Discussions of empirical results originating from the analytical procedures provided above are presented in Chapter 5 below.

4.5 Diagnostic Tests

After establishing the short-run relationship, the study will run numerous diagnostic tests on the error correction model to see whether any of the traditional normal linear regression models are violated (Wooldridge, 2013) and (Enders, 2010). The study included the following tests, referred to as the "battery" of diagnostic tests:

- **Normality test:** It's used to see if the residuals have a normal distribution with a mean and variance of zero. As a result, OLS estimators will be normally distributed as well. The Jarque-Bera test was used to determine whether the mistakes were typical.
- **Heteroscedasticity:** This happens when the variance of the residual term varies depending on the explanatory factors' values. The ARCH LM test was employed to check for heteroscedasticity in this example.
- **Serial Correlation:** It's used to see if the error term has anything to do with any observations. The Breusch-Godfrey LM Test is used to test for serial correlation in this investigation.
- **Misspecification:** In most circumstances, misspecification happens when an irrelevant variable is included or when a relevant variable is excluded. In this work, the Ramsey Reset test was utilized to check for misspecification.

4.6 Summary

This chapter provided a detailed overview of the research methodology used in this study. The chapter started with a quick overview of the study area, then moved on to the data set, and finally to the conceptual framework for data analysis on geographical price transmission and market integration for wheat in South Africa. The study further notes that it is crucial to test time series properties of the data before undertaking the price transmission analysis. This is also previously applied by a number of researchers. The Error Correction Model was chosen to be the most appropriate model for the study after proven existence of long-run relationship between the price pairs. Furthermore, a battery test is then performed on the error terms of the error correction model to validate the results and guarantee that the Classical Linear Regression Model is not violated. For this study, the main objectives will be met once the methods for cointegration and error correction have been completed.

CHAPTER 5 : RESULTS

5.1 Introduction

This chapter presents the detailed results and their interpretation emanating from this study based on the sample of 468 observations from the weekly data on world wheat and domestic wheat prices from January 2010 to December 2019. The chapter begins with the examination of time series properties of the data by testing the presence of unit root before presenting the outcomes of Johansen cointegration test. This is followed by the results of estimates of the long-run regression equations (cointegration regression equations) and the error correction model, followed by the results of the diagnostic tests performed on the residuals of the model.

5.2 Data properties

5.2.1 Stationarity test

In order to avoid erroneous findings based on spurious regression analysis, testing for unit root is a critical initial step in time series analysis. Before conducting any analysis on the data, it is necessary to test the data generation process of the price series. This is mainly done so that the presence of unit root in the price data could be probed and if found, the necessary steps be taken to turn the series into a stationary form. The study employed the Augmented Dickey Fuller tests to check the availability of unit root in the times series properties and the results are thus presented in Table 5.1 below.

Table 5.1: Augmented Dickey Fuller Unit root tests results

Variables	**ADF test**	**Critical value (95%)**	**Prob.**	**Coefficient of ADF test model**
	At levels			
DWP	-2.155	-2.867	0.223	
WWP	-2.748	-2.867	0.066	
	At first difference			
Variables	**ADF test**	**Critical value (95%)**	**Prob.**	
DWP	-18.358	-2.867	0.00	-0.841
WWP	-20.931	-2.867	0.00	-0.970

The ADF unit root tests were undertaken for all the data series at a 95% significance level. As illustrated in Table 5.1, the test results indicate that both WWP and DWP are non-stationery at level. This is ascribed to the fact that the absolute values of the ADF test statistics associated with these series are less than their respective absolute critical values, and the probability (i.e. Prob.) is insignificant at 5% level. Moreover, all series proved to be stationary at first difference given that their absolute values for

ADF test statistics are greater than the associated absolute critical values, with each indicating a significant probability value of less than 5%.

The null hypothesis of unit root, Ho: p = 0, that the price series is non-stationary or has a unit root, cannot be rejected for all two price series at level, based on the results reported in Table 5.1. After taking a first difference of all series and testing for stationarity, the null hypothesis is rejected. This means that the data series are stationery at first difference or integrated of order one, I(1). Furthermore, the coefficient of the ADF test model is negative for both data series at first differencing, which indicates that the model is viable and the first difference data is suitable for use in any type of econometric model. This discovery implies that all price series were formed by similar stochastic processes and can show a tendency toward long-run equilibrium. The outcome of these results support the findings by Alexander and Wyeth (1994) and Ogundare (1999) that food commodity price series are in most cases stationery after first differencing.

5.2.2 Co-integration testing

Given the empirical evidence that the time series are found to be integrated of any order, the next step in the process of analysis is to undertake cointegration tests in order to determine the existence of long-run equilibrium relationship amongst the variables. The cointegration process was done through the application of Johansen cointegration test in order to test for existence of long-run relationship between the world wheat prices and domestic wheat prices in South Africa. The results of the cointegration test are presented below in Table 5.2.

Table 5.2: Johansen Cointegration Testing Results

Variables	Hypothesized No. of CE (s)	Max-Eigen Statistic	Trace Statistic	0.05 critical value	Prob.**
DWP and WWP	None	8.165	13.166	15.494	0.108
	At most 1*	5.001	5.001	3.841	0.025
Normalized co-integrating coefficients					
D(DWP)= 1.00000				WWP= -2.344 (0.547)	
* denotes rejection of the hypothesis at the 5% significance level ** Mackinnon-Haug Michelis (1999) p-values.					

Table 5.2 above illustrates the results for cointegration tests. The results show that the hypothesis of no cointegration relationship between the prices pairs utilised in this investigation was rejected at the 0.05 level. This is because the probability value for at most 1 is less than 5%, which is further supported by the fact that both Trace and Max-Eigen Statistic values are greater than their critical values.

This finding shows that there is a single cointegration relationship between world wheat prices and South African wheat prices, which can be regarded as a long-run cointegration relationship estimate. Furthermore, the negative value of normalised cointegration coefficients suggests that world wheat prices have a beneficial impact on South Africa's domestic wheat prices. Therefore, it can be concluded that world wheat prices are well linked with the domestic wheat prices in South Africa. As a result of South Africa being a net importer of wheat and its local producer prices trade closer to import parity prices, the presence of a long-term relationship or cointegration between world wheat prices and the domestic wheat prices in SA was expected.

According to Engle and Granger (1987), if two variables X and Y are cointegrated, the Error Correction Model (ECM) can be utilised to analyse the relationship between the two variables. Therefore, taking Granger's representation Theorem into account, and based on the results in Table 5.2, there are sufficient grounds to express the relationship between world wheat prices and domestic wheat prices in South Africa in the Error Correction Model format.

5.3 Estimation of long-run relation regression

After assessing the long-run relationship between the price pairs, the next step is to estimate the long-run equilibrium relationship using the Ordinary Least Squares Estimates (OLS) method. The OLS estimates of the co-integrating price pairs are presented in Table 5.3 below. The findings aim to determine the extent to which world wheat prices influence domestic wheat prices in the South African wheat market. Since the Johansen Cointegration test results indicate the existence of long-run relationship between world wheat prices and the domestic wheat prices in South Africa, the OLS results below provide an assessment on the amount of impact which the world wheat price has on domestic wheat prices in South Africa.

Table 5.3: Estimation of long-run equilibrium relationship.

Least Squares Method (OLS): Dependent variable: LDWP				
Variable	**β_1 (elasticity)**	**Std. Error**	**t-Statistic**	**Prob.**
LWWP	0.817	0.025	31.671	0.000
C (intercept)	1.719	0.204	8.411	0.000
R-squared	0.68			
Durbin Watson Stat.	0.07			

The results for the estimation of long-run equilibrium relationship are presented in Table 5.3 above. The long run elasticity of price transmission is 0.817, this implies that in the long-run, about 82% of the proportional change in world price will be transmitted to the domestic wheat price in South Africa. However, the regression equation estimated in Table 5.3 seems to be spurious as the value of R^2 is more than the value for Durbin Watson statistics. This resulted in a test for unit root on the residual of the OLS equation.

The results of the unit root test on residuals, as illustrated in Table 5.4 below, indicate that the residuals are stationary. This shows that the estimated equation for OLS is reputable enough to assess the existence of long-run equilibrium relationship between the world wheat prices and the South African prices for wheat. Generally, the results confirm that in a long-run, the world wheat price does have a significant impact on the domestic prices for wheat in South Africa.

The results presented above further support the revelation of Johnsen's cointegration test results as shown in section 5.2.2, that there is at least one cointegration relationship between world wheat price and the domestic wheat price in South Africa. After determining the long-term relationship between the price pairings, the next step, as indicated by the Granger representation theorem, is to build an error correction model for the cointegrated series that quantifies the short-term dynamics surrounding the long-term relationship.

Table 5.4: Unit root test on residuals of OLS equations

Equation	ADF test statistic	Critical value at 5%	Prob.
OLS	-3.13	-2.86	0.024
R-squared	0.020		
Durbin Watson stat.	2.205		

5.4 Error Correction Model Parameter Estimates

According to Minot (2011), once a long-run relationship between price variables has been established, price transmission may be approximated to determine the elasticity of transmission and the speed with which domestic prices adapt to equilibrium following a change in international prices. As indicated earlier, the results of Johansen cointegration tests as well as the estimation of long-run equilibrium relationship confirmed the existence of long-run relationship between world wheat prices and the South African domestic wheat prices.

As a result, the error correction model for the cointegrated series, which quantifies the short run dynamics surrounding the long-run relationship, was calculated to further explain the relationship between international wheat price and domestic wheat price in South Africa, taking into consideration the results of the long-run relationship or cointegration. The model converges back to equilibrium following an external shock, as indicated by ect (-1), while the magnitude of the coefficient indicates the share or speed of the disequilibrium that will be corrected per unit time and can be used to compute the time required for the system to return to equilibrium. The results for error correction model parameter estimates are presented in Table 5.5 below.

Table 5.5: Error Correction Model Parameter Estimates

Dependant variable: ∆LDWP					
Independent Variables	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**	**Weeks to correct 90% of disequilibrium**
C (intercept)	0.001378	0.000916	1.504098	0.1332	96 weeks
∆LWWP	0.173592	0.023395	7.419926	0.0000	
α_1 (ect (-1)	-0.02366	0.00784	-3.01707	0.0027	
R-squared	0.116				
Durbin Watson stat.	1.866				

The error correction term is significant for the tested price pair at the 5% level, according to the results of the error correction model shown in Table 5.5. This suggests that a global wheat price shock is likely to generate price corrections in South African wheat prices, but not the other way around, demonstrating that global wheat prices lead in this case. In addition, the negative error correction term also indicates that the long-run adjustment towards equilibrium is possible.

In this instance, the error correction coefficient which reflects the speed of adjustment towards equilibrium is 0.02366, which indicates that the domestic wheat prices adjust by 2.4% per week towards equilibrium when given a shock in the world wheat prices. Since the coefficient of the lagged ect of the long-run equation is far from (-1), this means that the rate or the speed of adjustments towards equilibrium is slow. Following on the procedure applied by Ghoshray (2002), as explained in section 4.4, the results indicate that the adjustment to correct 90 percent proportion of disequilibrium after a positive or negative shock would take approximately 96 weeks for the domestic wheat price in South Africa.

This result is consistent with the findings of Abidoye and Labuschagne (2012). The authors conducted a study on the transmission of global maize prices to South African maize markets and discovered that large long-run price variances are transmitted, with roughly 98 percent of global price variances eventually reaching the domestic maize market in South Africa. Kilima (2006) investigated the degree to which changes in world market prices are transmitted through changes in border prices and through local producer prices for four agricultural product markets in Tanzania: sugar, cotton, wheat, and rice. According to the statistical review, Tanzanian border and world market prices for these goods do not shift in lockstep, though there is evidence that border prices are affected by world market price levels but not the other way round.

Furthermore, Mokumako and Baliyan (2016) investigated the transmission of South African maize prices into Botswana markets and discovered that the South African and Botswana maize prices were in a long-run steady state of equilibrium. According to the report, the elasticity of price transmission from South Africa to Botswana is 0.86, implying that in the long-run, approximately 86 percent of maize price shifts in the South African market are transmitted to the Botswana market. Other researchers' findings such as Tostao and Brorsen (2005), indicate that transportation networks could be improved, which could help offset the transfer costs associated with producer prices.

According to Ghoshray (2002), the slow speed of adjustment towards equilibrium could be associated with various factors such as lags due to contracts, imperfect information, sticky prices, long-term buyer-seller relationships and other reasons such as inertia in consumer habits which may cause prices to deviate from equilibrium in a short-run. Most fluctuations in food costs in Sub-Saharan Africa, according to Benson *et al*. (2008), may be explained by domestic causes rather than changes in global food prices. This includes factors such as higher transportation costs due to poor infrastructure and lack of storage facilities. Davids *et al*. (2016) also signal out the issue of inefficient trade, distance between markets and non-tariff barriers that may contribute to the slow speed of adjustments towards equilibrium.

The length of time it takes for domestic wheat prices to return to equilibrium could also be explained by government policies. The South African government's introduction of the Dollar-Based Domestic Reference Price (DBRP) and Variable Tariff Formula for wheat, as discussed in Chapter 3, may contribute to the long-term slowness of changes toward equilibrium. The current DBRP and variable tariff formula for wheat is established to set a fair level of protection that would encourage farmers to plant wheat which is able to compete with low priced imported wheat, without having undue adverse price raising effect downstream.

The DBRP adjusts its level of protection in response to quantum fluctuations in the world reference price. On a weekly basis, the difference between the 3 weeks moving average of the US No. 2 HRW (ord) Gulf settlement price (global reference price) and the domestic DBRP for wheat is computed. According to ITAC (2016), if the three-week moving average of the US No. 2 HRW (ord) Gulf settlement price differs by more than US$10/ton from the preceding trigger level for three weeks in a row, an adjustment to the tariff is triggered and a new duty is determined. The resulting Dollar particular duty is converted to Rand using the Rand/Dollar exchange rate on the day the adjustment is triggered, and then modified using the South African Reserve Bank's most recent published real effective exchange rate index.

Given the results above, if the South African government, through the International Trade Administration Commission (ITAC) fails to implement the new tariff once the adjustments to the new tariff is triggered, this may result in a longer period for the domestic prices for wheat to cover back to equilibrium after a shock in world wheat prices. The effective response in calculating and implementing the new duty by the government could assist in shortening the period of price adjustments towards equilibrium in a short-run.

The level of duty should not exceed the bound rates of 72 percent *ad valorem* for wheat and 99 percent *ad valorem* for wheat flour. The DBRP should be reviewed periodically after every three years. This would ensure that the DBRP is adapted to the most recent developments in the domestic and global markets for wheat.

5.5 The residual diagnostic tests

The residual from the short-run regression model was used in the diagnostic test. This was done to examine if any of the Classical Normal Linear Regression model's assumptions were incorrect. A series of experiments were carried out, with the results presented in Table 5.6.

The short-run model's residuals were tested using a Jarque Bera analysis to see if they were normally distributed with a zero mean and variance. We therefore fail to reject the null hypothesis that residuals are normally distributed with *p*-values of 0.23.

The ARCH LM and Harvey heteroscedasticity test was employed to see if the variance of the residual terms remained constant across varied explanatory variable values. We cannot reject the null hypothesis of no heteroscedasticity with *p*-values of 0.06 and 0.92.

A Breusch-Godfrey LM Serial Correlation test was used to see if the residuals were linked to any of the observations. We fail to reject the hypothesis of no 2nd order serial correlation in the residuals with a *p*-value of 0.16.

The Ramsey Reset test was used to determine whether an irrelevant or relevant variable was included or excluded from the model in the last misspecification test. We are unable to reject the null hypothesis of no misspecification due to the *p*-value of 0.19.

Table 5.6: Battery test results

Test	**H_0**	**Test Statistic**	**p-value**	**Conclusion**
Jarque-Bera	Residual are normally distributed	107.981	0.23	Normally Distributed
Ramsey RESET	No misspecification	1.287	0.198	No Misspecification
Breusch-Godfrey LM	No serial correlation up to second order	1.819	0.163	No Serial Correlation
ARCH LM	No ARCH (autoregressive conditional heteroscedasticity)	3.489	0.062	No Heteroscedasticity
Harvey test	No heteroscedasticity	0.069	0.932	No Heteroscedasticity

It is therefore evident from the Battery Tests results that the short-run model does not anyhow contradict the essential premise of Classical Normal Linear Regression.

CHAPTER 6 : SUMMARY, CONCLUSION AND RECOMMENDATIONS

This section summarizes the study's findings based on discussions from all of the previous chapters. Further discussions include concluding remarks, policy implications and recommendations, followed by the proposed areas for future research.

6.1 Summary

The aim of the study was to analyse the transmission of world wheat prices to the domestic wheat prices in South Africa, using the average weekly prices for the period between January 2010 and December 2019. The purpose of the study was to identify the degree of cointegration or long-run relationship between world wheat prices and domestic wheat prices in South Africa, as well as to analyse the degree of world wheat price transmission to domestic wheat prices in South Africa.

The analysis provided above generates a number of insights into the nature of price transmission from world wheat prices to domestic wheat prices in South Africa. The study used the Error Correction Model to conduct an econometric analysis on the degree to which world wheat prices are transferred to domestic wheat prices. The data for study consisted of 468 observations from the weekly averages for world wheat prices and domestic wheat prices in South Africa.

The study applied the use of Augmented Dickey Fuller test and Johansen cointegration test to test time series properties of the data. The results of the ADF test indicated that the data series used in the study were non-stationary at level and stationary after first differencing. The price series revealed the existence of a long-run relationship in which the domestic wheat price was influenced by the world wheat price, according to the Johansen cointegration test.

The study did not take into account the results of the Granger causality test because of the assumptions stated by Minot (2011), that it is less relevant to conduct a Granger causality test when analysing the transmission of world prices to domestic prices. This is due to the impossibility of causality from local to global or international prices, as in the case with South Africa. Given that South Africa is a net importer of wheat, domestic wheat prices are projected to be heavily influenced by global prices rather than vice versa. As a result, the Granger causality test results was not included in this study. This allowed the Error Correction Model to be estimated in order to determine the volume and nature of price transmission for South African wheat prices.

The results of Error Correction Model indicate that in a long-run a proportional change in world wheat price is transmitted to the domestic price in the South African wheat market. This suggests that a price shock in world wheat is likely to trigger price corrections in South African wheat prices, but not the other way round, demonstrating that world wheat prices lead in this case. Furthermore, the negative error correction term suggests that long-term revisions to domestic wheat price equilibrium are quite likely.

6.2 Conclusion

The study's findings suggest to a long-run price transmission elasticity of around 0.817 and an adjustment parameter of 0.0236. According to these findings, around 82 percent of the proportional shift in world price will be transferred to South Africa's domestic wheat market. The results further show that the domestic wheat price adjust by 2.4% per week towards equilibrium when given a shock in the international market, which indicates a fairly slow rate or speed of adjustments towards equilibrium. This is based on the fact that it takes around 96 weeks for domestic wheat prices to adjust to rectify 90% proportion of the disequilibrium.

However, previous studies indicate that the slow speed of adjustment towards equilibrium could be better explained through various factors in a domestic markets as compared to changes in world prices. It is further indicated that the slow speed of adjustment is associated with various factors such as lags due to contracts, imperfect information, sticky prices, fluctuating exchange rates, increase in oil prices, long-term buyer-seller relationships and other reasons such as inertia in consumer habits which may cause prices to deviate from equilibrium in a short-run.

Other factors relate to government interventions through the introduction of a tariff in order to protect the local market against cheaper imports. In this instance the South

African government introduced what is referred to as the Dollar-Based Reference Price and Variable Tariff Formula for wheat in order to set a fair level of protection for local wheat farmers against low priced imported wheat that put downward pressure on the domestic prices. A new tariff adjustment is triggered if the three-week moving average of the US No. 2 HRW (ord) Gulf settlement price differs by more than US$10/ton from the prior trigger level for three consecutive weeks. This necessitates recalculation and execution of a new duty.

Given the explanation above, if the South African government experiences delays in the implementation of the newly triggered tariff or duty, domestic wheat prices will continue to suffer from the shock originating from world wheat prices. This would in return contribute to the slow adjustments of domestic wheat prices towards equilibrium. However, if the newly triggered tariff is calculated and implemented earlier, it is assumed that the domestic wheat prices will quickly react to the activated shock and move towards equilibrium.

6.3 Limitations of the study

The research study focuses mainly on spatial price transmission and market integration of wheat in South Africa. This is to assess the level of cointegration between the two spatial markets and the magnitude and speed of price transmission between two geographically separated markets. The study acknowledges the exclusion of other critical variables that may be appropriate to the measure of price transmission such as transaction costs. This is mainly because transaction costs may be difficult or even impossible to measure due to lack of data. Therefore, the study is based solely on price data and intended to provide understanding of the structure and institutions underlying the results from the price data, also taking into account the assumptions and empirical methods followed to achieve the results.

6.4 Recommendations

Generally, the results show that the speed of adjustments towards equilibrium is fairly slow for domestic wheat prices when given a shock in international prices. The results pass a challenge to the wheat industry to increase investments into the sector in order to generate new technologies with improved yields, which will later increase domestic production for wheat. This will help reduce domestic consumption surplus and also block the flow of cheap imports into the country. This finding also shows that government actions, such as regulations aimed at improving the efficiency of cross-border trade and information, might help the wheat sector in South Africa. From a policy standpoint, the finding that world wheat prices and domestic wheat prices are cointegrated is critical. This means that any policy affecting wheat prices on the international market could have an impact on prices and consumer welfare in South Africa's local market.

In South Africa, government intervened in a form of Dollar-Based Reference Price and Variable Tariff Formula for wheat, which intends to protect the local wheat market against low priced wheat imports. It is therefore recommended that this intervention continue to be implemented and strengthened in order for it to respond quicker once there is a newly triggered tariff emanating from a consecutive increase in world wheat prices, to avoid disruptions in the domestic wheat market. The import duty is an automatic system that is triggered by the international prices, therefore, improving the speed and efficiency of the government administration responsible for amending the tariff will be beneficial to the domestic wheat sector and ultimately improve food security.

6.5 Suggestions for future research

Given that the study focused on spatial price transmission and market integration for wheat market in South Africa, it is necessary that more research be developed with particular focus on the analysis of vertical price transmission in the domestic wheat market with more updated data. Focus should be on the price transmission from wheat flour to bread and from wheat prices to price of cereals. This could be done to add to the existing literature with the use of more recent data and also building from the results of this study. This will help to further understand how world prices affect food security in the country, especially looking at the price and affordability of bread to the most vulnerable consumers.

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APPENDIX A: WEEKLY AVERAGE DATA FOR WORLD AND DOMESTIC WHEAT PRICES

week	SA Wheat Prices (R/ton)	US No.2 Hard Red Winter (FOB) Gulf (R/ton)	F.O.R at Cape Town/Durban harbour (R/t)	Export Realisation (R/t)
2010/01/08	2058	1672	2225	1130
2010/01/15	2075	1545	2014	942
2010/01/22	2103	1576	2052	953
2010/01/29	2059	1531	2038	942
2010/02/05	2086	1562	2131	1021
2010/02/12	2131	1588	2205	1096
2010/02/19	2097	1588	2177	1073
2010/02/26	2096	1621	2212	1105
2010/03/05	2074	1539	2077	990
2010/03/12	2065	1522	2043	962
2010/03/19	2098	1507	2036	957
2010/03/26	2105	1482	2031	922
2010/04/02	2092	1431	1956	873
2010/04/09	2119	1444	2005	917
2010/04/16	2155	1511	2081	976
2010/04/23	2182	1505	2101	979
2010/04/30	2222	1485	2201	947
2010/05/07	2244	1543	2293	1013
2010/05/14	2237	1444	2163	902
2010/05/21	2238	1500	2266	944
2010/05/28	2259	1408	2174	857
2010/06/04	2262	1392	2112	839
2010/06/11	2283	1351	2096	842
2010/06/18	2292	1403	2026	802
2010/06/25	2304	1381	2024	776
2010/07/02	2315	1467	2064	800

week	SA Wheat Prices (R/ton)	US No.2 Hard Red Winter (FOB) Gulf (R/ton)	F.O.R at Cape Town/Durban harbour (R/t)	Export Realisation (R/t)
2010/07/09	2352	1555	1999	790
2010/07/16	2418	1696	2485	1112
2010/07/23	2468	1688	2456	1101
2010/07/30	2469	1823	2546	1192
2010/08/06	2646	1942	2783	1397
2010/08/13	2680	2042	2867	1468
2010/08/20	2705	2078	2849	1445
2010/08/27	2729	2113	2587	1445
2010/09/03	2759	2234	2654	1510
2010/09/10	2855	2243	2669	1531
2010/09/17	2866	2225	2663	1516
2010/09/24	2775	2116	2569	1438
2010/10/01	2630	1920	2382	1282
2010/10/08	2590	2076	2500	1385
2010/10/15	2733	2031	2458	1343
2010/10/22	2693	2003	2418	1301
2010/10/29	2655	2129	2516	1386
2010/11/05	2669	2112	2382	1449
2010/11/12	2716	2010	2500	1351
2010/11/19	2672	1986	2458	1319
2010/11/26	2662	2045	2418	1352
2010/12/03	2736	2223	2516	1466
2010/12/10	2808	2240	2563	1473
2010/12/17	2805	2177	2452	1507
2011/01/07	2823	2254	2527	1424
2011/01/14	2871	2333	2541	1430
2011/01/21	2973	2490	2754	1600
2011/01/28	3142	2546	2780	1625
2011/02/04	3268	2650	2967	1787

week	SA Wheat Prices (R/ton)	US No.2 Hard Red Winter (FOB) Gulf (R/ton)	F.O.R at Cape Town/Durban harbour (R/t)	Export Realisation (R/t)
2011/02/11	3368	2763	3018	1836
2011/02/18	3352	2593	2831	1678
2011/02/25	3188	2443	2641	1541
2011/03/04	3138	2479	2657	1560
2011/03/11	3074	2209	2344	1302
2011/03/18	3045	2303	2387	1323
2011/03/25	3055	2293	2442	1341
2011/04/01	3050	2374	2559	1451
2011/04/08	3091	2420	2620	1525
2011/04/15	3039	2314	2568	1459
2011/04/22	3139	2471	2704	1584
2011/04/29	3134	2344	2495	1405
2011/05/06	3078	2304	2470	1380
2011/05/13	3202	2415	2534	1414
2011/05/20	3300	2583	2662	1563
2011/05/27	3299	2596	2681	1527
2011/06/03	3230	2465	2706	1550
2011/06/10	3124	2392	2651	1498
2011/06/17	3052	2226	2452	1317
2011/06/24	2926	2128	2379	1254
2011/07/01	2895	1977	2190	1093
2011/07/08	2959	1993	2284	1171
2011/07/15	2920	2136	2473	1313
2011/07/22	3074	2141	2430	1273
2011/07/29	2964	2093	2312	1202
2011/08/05	3018	2209	2497	1393
2011/08/12	3144	2363	2634	1505
2011/08/19	3233	2440	2695	1572
2011/08/26	3187	2546	2787	1655

week	SA Wheat Prices (R/ton)	US No.2 Hard Red Winter (FOB) Gulf (R/ton)	F.O.R at Cape Town/Durban harbour (R/t)	Export Realisation (R/t)
2011/09/02	3000	2540	2715	1594
2011/09/08	3157	2498	2667	1543
2011/09/16	3257	2387	2575	1455
2011/09/23	3160	2523	2715	1539
2011/09/30	2936	2366	2536	1391
2011/10/07	2927	2269	2522	1377
2011/10/14	2909	2344	2541	1410
2011/10/21	2877	2476	2697	1519
2011/10/28	2779	2416	2615	1459
2011/11/04	2759	2428	2750	1565
2011/11/11	2790	2387	2700	1528
2011/11/18	2726	2348	2733	1522
2011/11/25	2743	2357	2724	1523
2011/12/02	2618	2357	2646	1473
2011/12/09	2632	2316	2585	1423
2011/12/16	2663	2300	2619	1444
2012/01/06	2746	2378	2692	1517
2012/01/13	2778	2344	2618	1445
2012/01/20	2745	2270	2583	1422
2012/01/27	2762	2317	2629	1471
2012/02/03	2789	2303	2635	1503
2012/02/10	2754	2231	2619	1455
2012/02/17	2757	2295	2633	1481
2012/02/24	2755	2248	2563	1446
2012/03/02	2741	2313	2622	1500
2012/03/09	2755	2211	2530	1419
2012/03/16	2692	2285	2619	1509
2012/03/23	2697	2290	2608	1495
2012/03/30	2695	2290	2612	1500

week	SA Wheat Prices (R/ton)	US No.2 Hard Red Winter (FOB) Gulf (R/ton)	F.O.R at Cape Town/Durban harbour (R/t)	Export Realisation (R/t)
2012/04/06	2715	2225	2637	1476
2012/04/13	2729	2201	2607	1445
2012/04/20	2691	2107	2527	1379
2012/04/27	2671	2126	2590	1437
2012/05/04	2672	2026	2451	1308
2012/05/11	2715	2095	2570	1400
2012/05/18	2775	2494	2956	1732
2012/05/25	2904	2497	2961	1735
2012/06/01	2956	2345	2834	1615
2012/06/08	2893	2361	2900	1679
2012/06/15	2927	2293	2803	1835
2012/06/22	2940	2491	2968	1987
2012/06/29	3112	2575	3035	2071
2012/07/06	3219	2780	3247	2275
2012/07/13	3371	2888	3355	2680
2012/07/20	3508	3149	3618	2941
2012/07/27	3568	3011	3499	2828
2012/08/03	3430	2979	3441	2772
2012/08/10	3428	2952	3411	2447
2012/08/17	3399	3013	3473	2506
2012/08/24	3498	2999	3483	2517
2012/08/31	3476	3053	3516	2546
2012/09/07	3420	3035	3491	2529
2012/09/14	3423	3165	3645	2649
2012/09/21	3419	3198	3671	2681
2012/09/28	3388	3192	3668	2676
2012/10/05	3446	3179	3652	2662
2012/10/12	3530	3208	3681	2691
2012/10/19	3521	3268	3742	2751

week	SA Wheat Prices (R/ton)	US No.2 Hard Red Winter (FOB) Gulf (R/ton)	F.O.R at Cape Town/Durban harbour (R/t)	Export Realisation (R/t)
2012/10/26	3597	3274	3748	2757
2012/11/02	3638	3306	3784	2789
2012/11/09	3694	3320	3788	2923
2012/11/16	3679	3231	3722	2834
2012/11/23	3656	3239	3731	2843
2012/11/30	3709	3305	3806	2908
2012/12/07	3673	3203	3668	2807
2013/01/04	3416	2921	3419	2526
2013/01/11	3402	2968	3472	2573
2013/01/18	3539	3147	3659	2751
2013/01/25	3600	3109	3623	2713
2013/02/01	3625	3041	3576	2646
2013/02/08	3528	3028	3476	2562
2013/02/15	3441	2943	3425	2513
2013/02/22	3445	2841	3304	2395
2013/03/01	3429	2917	3415	2496
2013/03/08	3356	2887	3444	2511
2013/03/15	3371	3004	3582	2620
2013/04/05	3343	2912	3424	2481
2013/04/12	3342	2907	3426	2495
2013/04/19	3397	2941	3485	2547
2013/04/26	3387	3008	3500	2549
2013/05/03	3441	3048	3533	2590
2013/05/10	3419	3048	3634	2530
2013/05/17	3443	3078	3668	2551
2013/05/24	3485	3194	3786	2657
2013/06/07	3385	3174	3824	2694
2013/06/14	3579	3189	3854	2711
2013/06/21	3590	3232	3793	2645

week	SA Wheat Prices (R/ton)	US No.2 Hard Red Winter (FOB) Gulf (R/ton)	F.O.R at Cape Town/Durban harbour (R/t)	Export Realisation (R/t)
2013/06/28	3505	3023	3768	2606
2013/07/05	3447	2975	3581	2429
2013/07/12	3474	3200	3808	2642
2013/07/19	3419	3102	3657	2545
2013/07/26	3458	3045	3644	2537
2013/08/02	3371	3126	3690	2579
2013/08/09	3415	3096	3662	2559
2013/08/16	3428	3206	3775	2658
2013/08/23	3505	3259	3868	2742
2013/09/06	3368	3204	3775	2656
2013/09/13	3381	3036	3644	2559
2013/09/20	3309	3043	3596	2497
2013/09/27	3334	3203	3669	2567
2013/10/04	3401	3331	3885	2773
2013/10/11	3427	3322	3934	2803
2013/10/18	3466	3324	3842	2736
2013/10/25	3493	3288	3904	2769
2013/11/01	3533	3339	3911	2759
2013/11/08	3556	3291	3879	2722
2013/11/15	3571	3187	3785	2650
2013/11/22	3531	3180	3785	2652
2013/12/06	3624	3186	3872	2720
2013/12/13	3619	3131	3800	2635
2014/01/03	3607	3099	3738	2573
2014/01/10	3660	3127	3817	2590
2014/01/17	3731	3105	3786	2557
2014/01/24	3793	3173	3863	2624
2014/02/07	3820	3299	4046	2772
2014/02/14	3814	3367	4053	2794

week	SA Wheat Prices (R/ton)	US No.2 Hard Red Winter (FOB) Gulf (R/ton)	F.O.R at Cape Town/Durban harbour (R/t)	Export Realisation (R/t)
2014/02/21	3769	3341	4004	2791
2014/02/28	3817	3311	4070	2825
2014/03/07	3852	3502	4135	2896
2014/03/14	3940	3621	4186	2961
2014/03/21	4062	3747	4355	3119
2014/03/28	4105	3705	4510	3280
2014/04/04	3956	3442	4129	2933
2014/04/11	3896	3420	4228	3057
2014/04/18	3936	3556	4109	2952
2014/04/25	3919	3636	4282	3178
2014/05/02	3985	3834	4434	3301
2014/05/09	4041	3685	4255	3107
2014/05/16	3999	3498	4070	2921
2014/05/23	3912	3421	3983	2834
2014/06/06	3828	3433	3851	2750
2014/06/13	3815	3373	3943	2839
2014/06/20	3800	3431	3940	2832
2014/06/27	3739	3408	3846	2747
2014/07/04	3770	3327	3861	2771
2014/07/11	3796	3082	3815	2721
2014/07/18	3685	3064	3609	2521
2014/07/25	3634	3081	3559	2433
2014/08/01	3633	3121	3734	2598
2014/08/08	3683	3064	3564	2436
2014/08/15	3716	3012	3566	2437
2014/08/22	3693	3051	3564	2434
2014/09/05	3744	3007	3573	2432
2014/09/12	3720	2884	3646	2484
2014/09/19	3692	2953	3660	2487

week	SA Wheat Prices (R/ton)	US No.2 Hard Red Winter (FOB) Gulf (R/ton)	F.O.R at Cape Town/Durban harbour (R/t)	Export Realisation (R/t)
2014/09/26	3637	3129	3702	2509
2014/10/03	3639	3154	3842	2678
2014/10/10	3615	3157	3961	2646
2014/10/17	3599	3177	3924	2612
2014/10/24	3589	3122	3901	2590
2014/11/07	3624	3049	3842	2572
2014/11/14	3658	3201	3961	2580
2014/11/21	3655	3101	3924	2492
2014/11/28	3688	3161	3901	2520
2014/12/05	3731	3201	3886	2713
2014/12/12	3829	3266	3889	2655
2015/01/02	3940	3203	4012	2684
2015/01/09	3976	3072	3768	2450
2015/01/16	3860	3031	3778	2467
2015/01/23	3888	2944	3521	2278
2015/02/06	3880	2939	3611	2364
2015/02/13	3863	2962	3600	2364
2015/02/20	3850	2841	3644	2405
2015/02/27	3783	2870	3533	2295
2015/03/06	3851	2816	3540	2300
2015/03/13	3935	2992	3682	2416
2015/03/20	3874	3210	4163	2521
2015/03/27	3841	2994	4127	2501
2015/04/03	3873	3093	4055	2435
2015/04/10	3850	3012	3820	2293
2015/04/17	3762	2829	3822	2291
2015/04/25	3766	2717	3657	2119
2015/05/01	3808	2690	3624	2047
2015/05/08	3806	2778	3738	2159

week	SA Wheat Prices (R/ton)	US No.2 Hard Red Winter (FOB) Gulf (R/ton)	F.O.R at Cape Town/Durban harbour (R/t)	Export Realisation (R/t)
2015/05/15	3831	2829	3796	2221
2015/05/22	3810	2907	3817	2239
2015/06/05	3895	2924	3926	2339
2015/06/12	3878	2933	4044	2436
2015/06/19	3842	2817	3835	2224
2015/06/26	3864	3003	4244	2276
2015/07/03	3893	3148	4520	2516
2015/07/10	3941	3113	4487	2469
2015/07/17	3950	2960	4256	2218
2015/08/07	4008	2759	4149	2116
2015/08/14	4031	2807	4252	2201
2015/08/21	4042	2749	4225	2169
2015/08/28	4101	2761	3970	2194
2015/09/04	4221	2875	3969	2190
2015/09/11	4238	3057	4245	2436
2015/09/18	4113	2941	4151	2374
2015/09/25	4084	3017	4520	2356
2015/10/02	4096	3024	4655	2498
2015/10/09	4060	2970	4566	2416
2015/10/16	4131	2865	4373	2233
2015/10/23	4174	2909	4499	2343
2015/11/06	4304	2996	4535	2375
2015/11/13	4393	2998	4539	2363
2015/11/20	4448	2987	4560	2394
2015/11/27	4474	2913	4460	2334
2016/01/08	4832	3345	4822	2656
2016/01/15	4973	3614	5244	3051
2016/01/22	4929	3586	5181	2990
2016/01/29	4827	3495	5076	2916

week	SA Wheat Prices (R/ton)	US No.2 Hard Red Winter (FOB) Gulf (R/ton)	F.O.R at Cape Town/Durban harbour (R/t)	Export Realisation (R/t)
2016/02/05	4725	3349	4957	2802
2016/02/12	4631	3252	4804	2656
2016/02/19	4662	3238	4750	2611
2016/02/26	4622	3045	4572	2450
2016/03/04	4687	3286	4690	2533
2016/03/11	4612	3246	4593	2575
2016/03/18	4639	3171	4772	2730
2016/03/25	4610	3112	4565	2532
2016/04/01	4393	3091	4478	2450
2016/04/08	4507	2909	4272	2242
2016/04/15	4608	2852	4741	2343
2016/04/22	4597	2884	4717	2304
2016/05/06	4753	2756	4539	2135
2016/05/13	4920	2971	4689	2317
2016/05/20	5064	3005	4825	2628
2016/05/27	5087	3130	4861	2611
2016/06/03	5070	3075	4964	2713
2016/06/10	4833	3164	4929	2667
2016/06/17	4792	2982	4657	2415
2016/06/24	4730	2885	4627	2375
2016/07/01	4720	2686	4551	2283
2016-07-08	4617	2735	4588	2316
2016-07-15	4576	2690	4498	2243
2016-07-22	4510	2747	4543	2271
2016-08-05	4207	2685	4456	2225
2016-08-12	4088	2591	4347	2133
2016-08-19	4163	2602	4300	2117
2016-08-26	4300	2474	4719	2150
2016-09-02	4097	2583	4684	2137

week	SA Wheat Prices (R/ton)	US No.2 Hard Red Winter (FOB) Gulf (R/ton)	F.O.R at Cape Town/Durban harbour (R/t)	Export Realisation (R/t)
2016-09-09	4030	2613	4729	2181
2016-09-16	4131	2727	4836	2294
2016-09-23	4116	2645	4704	2199
2016-10-07	4173	2587	4674	2155
2016-10-14	4149	2773	4816	2284
2016-10-21	4139	2737	4835	2332
2016-10-28	4091	2661	4740	2229
2016-11-04	3914	2579	4650	2161
2016-11-11	3928	2549	4645	2158
2016-11-18	3979	2708	4809	2261
2016-11-25	3950	2687	4858	2282
2016-12-02	3905	2493	4710	2145
2016-12-09	3865	2574	4593	2021
2017-01-06	3938	2690	4725	2021
2017-01-13	3953	2781	4884	2145
2017-01-20	3935	2794	4948	2333
2017-01-27	3936	2760	4995	2367
2017-02-03	3975	2765	4904	2332
2017-02-10	4001	2844	5006	2437
2017-02-17	3983	2781	4912	2335
2017-02-24	3962	2785	4821	2248
2017-03-03	3957	2670	4848	2250
2017-03-10	3989	2725	4832	2227
2017-03-17	4061	2538	4616	2031
2017-03-24	4016	2466	4599	2023
2017-04-07	4372	2625	4427	2220
2017-04-14	4403	2665	4441	2246
2017/04/21	4393	2472	4272	2094
2017/04/28	4472	2560	4246	2038

week	SA Wheat Prices (R/ton)	US No.2 Hard Red Winter (FOB) Gulf (R/ton)	F.O.R at Cape Town/Durban harbour (R/t)	Export Realisation (R/t)
2017/05/05	4439	2670	4523	2303
2017/05/12	4414	2733	4532	2273
2017/05/19	4412	2661	4376	2138
2017/05/26	4456	2695	4468	2223
2017/06/02	4450	2566	4491	2236
2017/06/09	4475	2802	4679	2419
2017/06/16	4513	3171	5033	2734
2017/06/23	4376	3018	4565	2506
2017/07/07	4351	3282	5016	2702
2017/07/14	4535	3196	5111	2781
2017/07/21	4608	2961	4601	2305
2017/07/28	4489	2842	4482	2187
2017/08/04	4533	2744	4404	2103
2017/08/11	4538	2725	4400	2097
2017/08/18	4613	2651	4328	2024
2017/08/25	4389	2586	4204	1894
2017/09/01	4082	2645	4322	2018
2017/09/08	4164	2804	3874	2137
2017/09/15	4247	2919	4004	2237
2017/09/22	4216	2912	4024	2245
2017/10/06	4114	2921	4474	2293
2017/10/13	4146	2940	4427	2244
2017/10/20	4181	2798	4336	2157
2017/10/27	4172	2965	4464	2269
2017/11/03	4181	3147	4854	2477
2017/11/10	4194	3254	4944	2554
2017/11/17	4207	3102	4806	2433
2017/11/24	4184	2995	4655	2299
2017/12/01	4080	2974	4625	2279

week	SA Wheat Prices (R/ton)	US No.2 Hard Red Winter (FOB) Gulf (R/ton)	F.O.R at Cape Town/Durban harbour (R/t)	Export Realisation (R/t)
2017/12/08	4023	2954	4623	2259
2018/01/05	3646	2850	4290	2158
2018/01/12	3689	2795	4309	2178
2018/01/19	3741	2757	4188	2066
2018/01/26	3689	2798	4151	2036
2018/02/02	3539	2843	4245	2176
2018/02/09	3611	2791	4221	2159
2018/02/16	3583	2835	4187	2133
2018/02/23	3582	2778	4265	2204
2018/03/02	3621	3077	4507	2431
2018-03-09	3633	3007	4412	2338
2018-03-16	3682	2953	4231	2154
2018-03-23	3780	2764	4089	2029
2018-04-06	3793	2895	4190	2134
2018-04-13	3875	2918	4097	2347
2018-04-20	3834	2839	3904	2161
2018-04-27	3894	3014	4041	2285
2018-05-04	3929	3206	4297	2524
2018-05-11	3917	3031	4207	2438
2018-05-18	3880	3089	4058	2263
2018-05-25	3898	3287	4250	2446
2018/06/01	3808	3162	4280	2574
2018/06/08	3827	3335	4583	2848
2018/06/15	3902	3415	4455	2696
2018/06/22	3978	3207	4237	2495
2018-07-06	4018	3215	4264	2514
2018-07-13	4021	3094	4281	2543
2018-07-20	4065	3142	4089	2513
2018-07-27	4139	3301	4242	2655

week	SA Wheat Prices (R/ton)	US No.2 Hard Red Winter (FOB) Gulf (R/ton)	F.O.R at Cape Town/Durban harbour (R/t)	Export Realisation (R/t)
2018-08-03	4146	3441	4542	2954
2018-08-10	4194	3644	4644	3018
2018-08-17	4287	3697	4628	2984
2018-08-24	4291	3510	4834	2844
2018-09-07	4365	3552	5148	3117
2018-09-14	4383	3627	5072	3042
2018-09-21	4355	3637	5061	3037
2018-09-28	4329	3387	4917	2919
2018-10-05	4377	3465	4583	2912
2018-10-12	4414	3596	4691	2997
2018-10-19	4371	3446	4605	2935
2018-10-26	4391	3406	4731	2867
2018-11-02	4378	3369	4687	2830
2018-11-09	4331	3342	4653	2789
2018-11-16	4315	3251	4533	2685
2018-11-23	4210	3133	4435	2596
2018-12-07	4224	3329	4527	2695
2018-12-14	4323	3569	4797	2928
2019-01-04	4468	3339	4619	2799
2019-01-11	4430	3317	4508	2723
2019-01-18	4411	3354	4549	2815
2019-01-25	4442	3344	4449	2750
2019-02-01	4456	3299	4435	2759
2019-02-08	4517	3305	4439	2752
2019-02-15	4546	3330	4418	2706
2019-02-22	4439	3174	4224	2512
2019-03-01	4436	3164	4394	2655
2019-03-08	4490	3138	4385	2643
2019-03-15	4527	3215	4381	2635

week	SA Wheat Prices (R/ton)	US No.2 Hard Red Winter (FOB) Gulf (R/ton)	F.O.R at Cape Town/Durban harbour (R/t)	Export Realisation (R/t)
2019-03-22	4597	3222	4401	2655
2019-04-05	4550	3112	4342	2603
2019-04-12	4533	3093	4247	2514
2019-04-19	4571	2991	4186	2455
2019-04-26	4597	2929	4200	2449
2019-05-03	4642	2907	4114	2372
2019-05-10	4574	2794	4079	2344
2019-05-17	4461	3052	4334	2587
2019-05-24	4390	3192	4664	2741
2019-06-07	4501	3202	4611	2722
2019-06-14	4464	3421	4620	2736
2019-06-21	4484	3304	4975	2794
2019-06-28	4488	3246	4949	2728
2019-07-05	4504	3154	4738	2510
2019-07-12	4539	3225	4795	2552
2019-07-19	4510	2985	4727	2284
2019-07-26	4504	3001	4616	2190
2019-08-09	4489	3106	4779	2335
2019-08-16	4636	3132	4715	2284
2019-08-23	4655	3125	4771	2338
2019-08-30	4664	3003	4816	2354
2019-09-06	4594	3015	4593	2138
2019-09-13	4583	2974	4703	2234
2019-09-20	4726	3054	4725	2240
2019-09-27	4545	3090	4534	2319
2019-10-04	4590	3152	4621	2409
2019-10-11	4547	3166	4606	2426
2019-10-18	4477	3216	4644	2469
2019-10-25	4439	3224	4533	2398

week	SA Wheat Prices (R/ton)	US No.2 Hard Red Winter (FOB) Gulf (R/ton)	F.O.R at Cape Town/Durban harbour (R/t)	Export Realisation (R/t)
2019-11-01	4460	3302	4830	2372
2019-11-08	4365	3289	4907	2456
2019-11-15	4366	3226	4987	2560
2019-11-22	4352	3213	4896	2474
2019-11-29	4394	3245	4941	2517
2019-12-06	4385	3169	4805	2405
2019-12-13	4409	3273	4814	2396