Feed cost sensitivity and commodity risks in pork production in South Africa

by

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DECLARATION

I, Jacobus Johannes Schoeman, declare that the dissertation, which I hereby submit for the degree Magister Commercii (Agricultural Economics) at the University of Pretoria, is my own work and has not been submitted for a degree at any other tertiary institution.

SIGNATURE: ……………………..……………… DATE: January 2013

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Jacques Schoeman
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by

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EXECUTIVE SUMMARY

Risks and uncertainty of the future are two of numerous key drivers that decision makers need to take into account when considering opportunities and embarking on new business ventures. As with all agricultural industries, another few factors that need to be considered during decision-making are the pressure of food security, weather changes, input and output price volatility, changes in consumer preference and political instability. Farmers of the 21st century are becoming business executives of their farming enterprises.

The rules of the farming industry, and particularly the South African pork industry, are rapidly changing. Information on trends regarding future possibilities is changing the way that pork producers used to do business and view the industry. Economic analysis, animal health, production, genetics and feed utilisation are the standards to measure and evaluate performance for current pork producers and new entrants to the industry.

The objective of this study is based on the economic principles that examine feed price sensitivity and the associated commodity risks in a pork production unit. These principles are applied in the evaluation of possible risk aversion alternatives.

This was achieved by redesigning an out-dated pork price-sensitivity model to produce outputs that are of value to decision makers in the industry. These outputs assist in testing different risk aversion alternatives that are available to a pork producer to hedge input cost risks in order to achieve a sustainable profit margin and the ability to expand operations in a sustainable way.

The main objective of this study was to redesign a feed input price-sensitivity model for pork producers who mainly use home mixing of feeds. Risks directly affecting feed costs and thus profit margins, needed to be identified and different risk-minimising strategies and alternatives evaluated and tested on a farm level. Scenarios based on possible price ranges of commodities were calculated, as well as the impact and scale that fluctuations in these prices could possibly have on a pork producer's profit levels.

Redesigning the pork price-sensitivity model was achieved by using the principle of a dynamic approach to modelling, whereby all varying factors and inputs can be captured in an MS Excel setup according to changes in industry prices and dynamics. This application was a requirement because of the high volatility of the input commodity price for the major feed commodities such as maize, sunflower and soya oil cakes, and wheat bran.

As part of this study, the following economic applications were combined to answer the research questions. These applications included the market environment for South African pork production, strategic planning, scenario analysis and hedging feed commodity prices with options as well as alternative pricing contracts. Risks classified as priority and of highest concern in the pig industry in South Africa were price volatility in especially the grain market of feed commodities, financial and economic instability and the political [instability] risk. These risks needed to be factored into the decision-making and strategic planning process when the model outputs were evaluated.

The methodology applies was to measure the sensitivity that feed commodities have on the gross income (income minus feed cost at a predetermined price for commodities and quantity level), the principle of price elasticity was applied, by using the changes in commodity prices over the changes in gross income.

The sensitivity of yellow maize, soya (full fat and oil cake), and sunflower and wheat bran was tested to determine the impact that these commodities individually contribute to the overall feed cost in a pork unit.

From the price elasticity and sensitivity calculations and evaluations, it became clear that volume, in conjunction with commodity cost, are important considerations on which decisions from a managerial perspective can be based. A pork producer can choose to be price-elastic/-inelastic according to the levels of sensitivity towards price changes consistent with his/her preference to risk.

The scenarios illustrated the risk that a producer can face on an annual basis, and which commodities have the biggest impact on profit levels when prices fluctuate. Maize was seen as being the highest contributor and risk to upward/downward movements. Different alternatives to hedging price risks on the market were tested and the impact of making a decision in the market illustrated. From these calculations, it was clear that each alternative yielded its own risks and opportunities. The minimum price option posed the lowest risk, although a premium is paid, it still allows a pork producer to benefit from rising prices.

The recommendation to the pork industry is to expand the study of the industry on a financial basis. Due to recent changes to the National Credit Act (No. 34 of 2005) on the regulation of credit, credit management are becoming stricter from a financial institutional point of view. A producer must be able to prove that his/her farm is sustainable and does not pose a risk to the institution granting the loan. Loan grant decision makers are not always knowledgeable about the different farming industries and practices. It is therefore important that this model is used to identify risks and that the results, together with an indication of how these risks will be dealt with given different market scenarios, are included in pork producers business plans.

Other recommendations included the following:

- This study should be used by decision makers in SAPPO and the industry to base decisions regarding the economic value of production on;
- Home mixers should evaluate the financial impact if inputs in their existing feeding system change, as well as possible ways in which these changes might affect their cash flow;
- Producers should acquire a better understanding of SAFEX in the industry by obtaining more case study examples of how hedging risks could be applied to the advantage of a pork producer;
- Technology should be used more frequently to communicate relevant and updated market information to role players to equip them for decision-making processes on current and future market developments and scope;
- Opportunities to engage in pork meat price futures contracts (trades as pork bellies in the US) should be investigated to give open market producers a tool to contract their products in the future;
- Consumer trends needs to be analysed and constantly revised to ensure that producers will be able to deliver products in line with the needs of future consumers; and
- Interdisciplinary relationships with respect to animal science, animal health nutrition, agricultural economics, soil science, SAFEX and offset markets should be fully incorporated in the outputs. This will facilitate the true delivery of an exact research output that can be used by role players in the applicable industry to base good judgement decisions on in future.

UITVOERENDE OPSOMMING

Risiko's en onsekerheid is twee van vele sleutelareas wat besluitnemers in ag moet neem wanneer hulle geleenthede oorweeg en nuwe besigheidsgeleenthede ontgin. Soos met alle sektore in die landbou, is nog 'n faktore wat tydens besluitneming in gedagte gehou moet word onder andere die druk van voedselsekuriteit, weerveranderings, prysvolatiliteit van in- en uitsette, veranderings in verbruikersvoorkeure en politieke onstabiliteit. Boere van die 21ste eeu is besig om hoof uitvoerende beamptes van hulle eie boerdery-ondernemings te word.

Die spelreëls van boerdery, en spesifiek die Suid-Afrikaanse varkindustrie, is besig om vinnig te verander. Inligting oor huidige tendense, wat toekomstige moontlikhede inhou, verander die manier waarop varkprodusente besigheid doen en die industrie beskou. Ekonomiese analises, in kombinasie met dieregesondheid, produksiegenetika en voeding, word die winsdrywers en meet-instrumente waarteen huidige varkprodusente sowel as nuwe toetreders in die industrie hulself kan meet.

Die fokus van hierdie studie word gebaseer op die ekonomiese beginsels wat voedingspryssensitiwiteit en die gepaardgaande kommoditeitsrisiko's in 'n varkproduksie-eenheid ondersoek. Hierdie beginsels word aangewend in die evaluasie van moontlike risiko-vermydingsalternatiewe. Dit is bereik deur die herontwerp van 'n verouderde varkpryssensitiewe model om waardevolle uitsette vir die varkprodusente industrie te lewer. Hierdie uitsette help met die toetsing van verskeie risiko-bestuursalternatiewe wat vir die varkprodusent beskibaar is om insetkosterisiko's te verskans en sodoende 'n volhoubare winsgrens en die vermoë om werksaamhede op volhoubare wyse uit te brei, te bereik.

Die hoofdoelwit van die studie was om 'n voedingspryssensitiewe model vir varkprodusente wat voer hoofsaaklik tuis meng, te herontwerp. Risiko's wat voedingskostes en dus winsgrense direk affekteer, moet geïdentifiseer word en verskillende strategië en alternatiewe om risiko's te beperk moet op plaasvlak geëvalueer en getoets word.

Scenarios gebaseer op moontlike kommoditeitsprysreekse is bereken, sowel as die impak en skaal wat skommelings in hierdie pryse moontlik op ‘n varkprodusent se winsgrense tot gevolg kan hê.

Die herontwerp van die varkpryssensitiewe model is bereik deur die gebruik van die beginsel van ‘n dinamiese benadering van modellering, waarby alle wisselende faktore en insette in ‘n MS Excel-spreiblad ingevoer kan word, volgens veranderinge in industriepryse en -dinamika. Hierdie toepassing was ‘n vereiste as gevolg van die volatiele aard van insetkommoditeitspryse van die hoofvoedingskommoditeite soos mielies, sonneblom- en soja-oliekoeke en koringsemels.

As deel van hierdie studie, is die volgende elemente gekombineer: die markomgewing, strategiese beplanning, scenario-analise, verskansing met afgeleide instrumente (deur gebruik te maak van termyn- en opsiekontrakte) asook alternatiewe aankoopkontrakte. Prysvolatiliteit in veral die graanmark; finansiële en ekonomiese onstabiliteit; en die politieke [onstabiliteit] is geïdentifiseer as die hoogste risikofaktore in die vark-industrie. Daar moet rekening gehou word met hierdie risiko’s tydens die besluitnemings- en strategiese beplanningsproses.

Om die sensitiwiteit te meet wat voerkommoditeite op die bruto inkomste het, is die beginsel van pryselastisiteit toegepas deur die veranderinge in kommoditeitspryse oor die veranderinge in bruto inkomste te gebruik. Die sensitiwiteit van geelmielies, soja (volvet en oliekoek), sonneblom en koringsemels is getoets om die impak te bepaal wat hierdie kommoditeite individueel bydra tot die oorkoepelende voerkoste in ‘n varkeenheid. Uit die pryselastisiteits- en sensitiwiteitsberekenings en -evaluasies het dit duidelik geword dat volume, tesame met graanpryse, belangrike oorwegings is waarop besluite uit ‘n bestuursperspektief gebaseer moet word. ‘n Varkprodusent kan kies om pryselasties of -onelastis te wees volgens sy/haar vlakke van sensitiwiteit teenoor prysveranderinge in ooreenstemming met sy/haar risikovoorkeur.

Die scenario’s het die risiko geïllustreer wat ‘n produsent op jaarlikse basis kan trotseer en watter kommoditeite die grootste impak op wins het wanneer pryse wissel. Mielies blyk die grootste impak en dus ook risiko, met op- en afwaartse bewegings te wees.

Verskeie alternatiewe tot die inperking van prysrisiko's op die mark is getoets en die impak van besluitneming in die mark geïllustreer. Uit hierdie berekeninge was dit duidelik dat elke alternatief sy eie risikso's en geleenthede voortbring. Alhoewel 'n premie betaal is, hou die minimumprys-strategie die laagste risiko vir varkprodusente in deurdat dit steeds 'n produsent toelaat om voordeel uit wisselende pryse te trek.

Daar word aanbeveel dat die studie uitgebrei word om ook die finansiële posisie van 'n varkprodusent in die besluitnemingsmodel in te sluit. Na aanleiding aan die onlangse veranderings aan die Nasionale-kredietwet (Wet No.34 van 2005), word kredietbestuur strenger toegepas. 'n Produsent moet in staat wees om te kan bewys dat sy/haar besigheid volhoubaar is en nie 'n risiko inhou vir die instansie wat die lening toestaan nie. Besluitnemers wat lenings toeken is nie altyd ingelig oor die verskillende boerderyindustrië en -gebruike nie. Dit is daarom belangrik dat hierdie model gebruik word om risiko's te identifiseer en dat die resultate (produksie en finansies), tesame met 'n aanduiding van hoe hierdie risiko's hanteer moet word gegewe verskillende markscenario's, ingesluit moet word in varkprodusente se besigheidsplanne.

Ander aanbevelings sluit die volgende in:

- Hierdie studie behoort deur besluitnemers in SAPPO en die industrie gebruik te word om besluite met betrekking tot die ekonomiese waarde van produksie op te baseer;
- Tuismengers behoort die finansiële impak te evalueer indien insette in hulle huidige voedingstelsel verander, sowel as moontlike maniere waarop hierdie veranderinge hulle kontantvloei en winsgewendheid kan affekteer;
- Produsente behoort 'n beter begrip oor SAFEX in die industrie te verkry deur meer gevallestudies te bekom oor hoe om die inperking van risiko's toe te pas tot voordeel van 'n varkprodusent;
- Tegnologie behoort meer gereeld gebruik te word om toepaslike en die nuutste markinligting aan rolspelers te kommunikeer om hulle sodoende toe te rus vir besluitnemingsprosesse;

- Geleenthede om betrokke te raak by varkvleistermynkontrakte behoort ondersoek te word om varkprodusente in staat te stel om ook hul uitsette te verskans;
- Verbruikersneigings behoort ontleed en voortdurend hersien te word om te verseker dat produsente in staat sal wees om produkte te lewer ooreenkomstig die behoeftes van verbruikers; en
- Interdissiplinêre verhoudings met betrekking tot veekunde, diere-gesondheids-voeding, landbou-ekonomie, grondkunde, SAFEX en verskansing, behoort ten volle geïnkorporeer te word by die uitsette. In die toekoms sal dit die lewering van ‘n presiese navorsingsuitset kan fasiliteer wat deur rolspelers in die toepaslike industrie gebruik kan word om goeie oordeelkundige besluite op te baseer.

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

In 2009 (SAPPO (i), (2009), there were 103 000 production sows in South Africa that were managed by approximately 230 individual commercial pork producers. These pork producers produced more than 180 000 tons of pork per annum (BFAP, 2012). The farms ranged from a sizeable farm with 100 sows to larger commercial farms with 7 000 sows. The South African Pork Producers Organisation (SAPPO) reports that approximately 2.4 million pigs are slaughtered annually in South Africa (SAPPO, 2012).

For any industry or business to be successful in a dynamic environment, a number of elements need to be taken into account. What is especially important is how risks are managed to achieve these successes. In agriculture, continuously changing circumstances force industries to find new innovative methods to adjust their business models and characteristics to ensure that associated risks can be managed and that sustainable development in agriculture is possible. SAPPO supports this by stating that: "*The South African pork industry, however small, is [a] dynamic, well organised [agricultural industry that] compares favourably to the rest of the world in terms of production outputs*" (SAPPO (i), 2009).

During the Annual General Meeting in 2009, it was quoted that: "*The pig industry will have to think of creative ways to stimulate pig research ... currently there is not much interest among researchers and scientists to conduct pig research*" (Gous in SAPPO (ii), 2009). Continuous research is needed to address and replenish the knowledge gaps in the pork industry created by the continuously changing agricultural and consumer-driven and competitive markets. For an industry to remain sustainable and growing, economic and scientifically conducted research is imperative.

However, the lack of continuous research in South Africa is hampering the pork industry with respect to cost management, resulting in industry expansion restrictions. The costs of inputs and the associated risks of price structures are main drivers and a concern in any agricultural industry or business enterprise. How well operational costs and risks are managed determine the performance, survival and ultimately expansion of a farming business or industry. For the pork industry, feed cost accounts for more than 70 percent of pig production input costs (Streicher, 2010). Various feed commodities in feed mixes can be substituted with other feed components in the diet. Many smaller farmers tend to use substitutes as the price of feed commodities changes. However, this is not recommended in a larger scale operation.

In general, it can be stated that, if feed costs are managed more effectively in a pig unit, the result may be, *ceteris paribus,* that approximately 70 percent of the risks involved in feed costs can be quantified, managed and/or optimised from an economic point of view. However, this can only be achieved when decisions are made on a sound strategic plan basis with quality information and a well-studied understanding of all risks associated within the industry.

The aim of this study is to assist management and the South African pig industry at large to better plan for unforeseen changes in the macro environment in order to react proactively, given different scenario outcomes that can improve profit margins and ensure sustainable pork farming. In order to better manage associated risks with raw feed components, economic tools along with a strategic scenario analysis needs to be developed and continuously revised to aid as support at both farming and industry level.

This study is based on the significant improvement of an out-dated feed price-sensitivity model indicating the scale of impact in the rapid shifting of major commodity prices in pig feed rations. Certain risk mitigation strategies and alternatives from model outputs and the use of different price scenarios in a pork production unit can be tested to provide an output that can potentially assist the planning at a farm-level cash flow basis.

The aim is to enhance farming profitability through the development of a feed price-sensitivity model that will minimise the direct feed cost and assist farmers with feed planning.

Commodities such as maize, wheat and oilseeds can be traded and hedged on the Commodity Derivatives Market (CDM) of the Johannesburg Stock Exchange (JSE)[1]. Prices are determined by supply and demand through a virtual network of buyers and sellers. The advantages are that buyers know the price that they will pay at a certain time in future and sellers know the price that they will receive in future.

For pork producers not under contract for selling their produce, the risk associated with not knowing the possible realised profit margin at the end of a production cycle can cause investors and lenders of foreign capital (e.g. banks and financial institutions) to doubt the possible investment opportunity and withdraw from the arrangement because of a lack of managerial performance.

1.2 PROBLEM STATEMENT

Only limited published information and/or literature could be found on how the South African pork industry can manage, analyse or model the size and impact that rapid changing feed cost can potentially have on its farming business. There is a lack in modelling to evaluate or study the impact of a pork production unit's real-time risk levels regarding feed inputs. The purpose of such modelling is to determine the impact (or sensitivity) of raw feed component costs on a pork producer's profitability given the volatility in the grain and oil seed markets.

Specific risk mitigation scenarios and strategies which could provide farmers with a better perspective on how they could potentially hedge or mitigate their price fluctuation risks over time are either unavailable or unclear to them. Literature or data are sometimes written in a high academic level and producers have difficulty to relay the information back to a farm level.

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[1] The Commodity Derivatives Market was formerly known as SAFEX and will as such be used in the study. The majority of producers recognizes the use of the term SAFEX above CDM.

The outlay of tools available to assist farmers on the SAFEX market is also a grey area. Most of the current farming business models are based on how the farm was operated in the past decades and these methods and ways of thinking was passed on from generation to generation.

However, the changing agricultural environment requires larger farming units to be economically sustainable, thus forcing farming businesses to expand, produce more efficient and be more cost-efficient with current resources available.

The challenge is to adapt the business model in advance, or be forced to surrender the business to new entrants in the industry or larger more dominant established operations. At present, there are still pork producers that often do not know how they can adapt their way of doing business or how to become more efficient. A model indicating potential risks is also just as good as the understanding of the output or final outcome. Thus, without a strategic scenario analysis of possible ‘what if’ situations, the information of the outcome will be of little value.

1.3 PURPOSE STATEMENT

This study aims to simulate and test the viability of the problems discussed above. A study focusing on the macro-economic impact of feed production costs on feed input components is necessary. Feed inputs and other supplements are combined, analysed and justified to form the basis of a pork price-sensitivity model of an adjustable[2] pork farm size. The intended outputs of this model will give pork producers an indication of what outcome can be expected, given certain market price scenarios and other fundamental factors, and how these factors can potentially impact on their profit margins and cash flow.

The purpose of the model is to develop a financial decision-making tool to, as far as possible, optimally minimise production feed component input costs in the pork industry.

[2] The model can be adjusted to any pork unit size. For the purpose of this study a 500 sow unit was used for illustration.

This will enable pork producers to manage their costs and profit margins in a controlled method, given the volatile input market conditions. This model can then be used, in conjunction with different scenarios, to provide pork producers a broader financial and economical perspective of the sensitivity of inputs on their farming business's profit levels.

Risks have to be identified in the industry so risk mitigation strategies can be developed to aid in managing the short term production risks. The competition for supply of pork at profitable economical levels between South African pork producers and cheap, subsidised imports[3] from abroad means that, if too few regulations and the growing concern of food security continue, local producers will have to adapt their way of doing business to be able to continue producing competitively.

1.4 RESEARCH OBJECTIVES

1.4.1 Primary objectives

The primary research objectives for this study are as follows:

- To redesign a feed input price-sensitivity model for pork producers who mainly use home mixing;
- To identify risks directly affecting feed costs and thus profit margins;
- To identify and test risk management, hedging, and the use of alternatives available to a pork producer;
- To identify and test possible outcomes of risk minimising strategies to hedge short term raw feed input costs and associated risks; and
- To conduct scenario evaluations of different market conditions to determine the possible market scenarios that may have an effect on the financial position of a pork producer.

[3] South African imports are annually around 30 000 tons of pork (BFAP, 2012)

1.4.2 Secondary objectives

The supporting objectives for this study in conjunction with the primary objectives are:

- To change an existing out-dated pork production unit model to a feed-directed sensitivity model;
- To use standardised feed rations for generic scenario analysis;
- To use the Black and Scholes model to determine hedging premiums as a basis;
- To determine feed flow, storage capacity and current costs;
- To determine different plausible market scenarios, given the current industry-related economy; and
- To determine a cyclical profit margin, given the different risk mitigation strategies;
- To validate findings with industry role players and leaders.

1.5 IMPORTANCE AND BENEFITS OF THIS STUDY

After continuous evaluation of different commodities in the agricultural sector, the remark was made that there is a lack of current interdisciplinary research knowledge and business tools to assist decision-making in the South African pork industry.

According to Streicher (2010), numerous bursaries are presented to students on an annual basis to develop continuous research on the scientific aspects in the pork industry, but the interest in economic research is lacking. By using and maintaining the redesigned current price-sensitivity model, the benefits of this study are to aid the decision-making process of pork producers and policy-impact decision evaluators, given certain scenarios of possible market analyses, as well as to assist in risk management.

Hedging is also unfamiliar to many smaller producers who do not always see the existing 'tool' or benefits to manage their feed cost risks. By using hedging strategies and realising the financial impact it can bring about, pork producers should be more informed on what the benefits in their procurement strategies can be, given certain market conditions and changes.

1.6 OUTLINE OF THE STUDY

The outline of this study is as follows. Each chapter consists of an introduction and outline of the chapter, the content and a conclusion.

Chapter 1 gives the general introduction and background of the study and discusses the problem, purpose and objectives of the study.

Chapter 2 focuses on the literature review of the study. This chapter forms the basis of the study by identifying the research shortcomings and possible study focus areas that needs to be discussed and addressed in the study.

Chapter 3 debates the model redesigned for the purpose of this study as well as its intended use in the industry. The function, application, purpose and value of the model are discussed.

Chapter 4 focuses on the different risks associated with the pork and feed industry, with reference to the major commodity components in feed rations.

Chapter 5 is based on the price-sensitivity analysis of feed commodities. The purpose of this chapter is to determine the direct impact or scale that the daily price volatility of feed commodities brings about for a pork producer and the resulting risks they face. For the purpose of illustration, a representative medium-sized pork unit is used against a predetermined set of prices and operational criteria.

Chapter 6 focuses on hedging alternatives and how hedging can impact on a pork producer's financial position. Scenarios are tested based on historical price data, illustrating the different breakeven and profitability levels that pork producers can achieve when certain alternatives remain constant. Alternative procurement strategies that can be implemented by a pork producer are discussed, including resources and capacity required by the operational structure.

Chapter 7 completes the study with conclusions and recommendations as well as the validation of the study with industry role players and participants.

1.7 DELIMITATIONS AND ASSUMPTIONS

1.7.1 Delimitations

For the purpose of this study, a price-sensitivity model is revised, updated to new economical applications, and reconstructed to indicate the impact that changes in commodity prices of feed rations can possibly have on the profitability of a pork producer. However, as is the case with modelling, this price-sensitivity model cannot provide a 100 percent accurate output of future scenarios and market conditions. It is still bound by possible realistic assumptions and data and can therefore only show the scale of changes in profit, given certain changes in the variables of the model.

The basis for the scenario analysis is presented for three levels (average market conditions and high and low market price levels, according to the standard deviation over a five year period) on the assumption that prices of feed ingredients *ceteris paribus* stay constant (forming the basis), or increase or decrease to certain plausible levels.

It is not the intent of this study, with its individual components, to prescribe to producers what to do to eliminate all associated risks with feed, but to give an indication of the potential pitfalls that are associated with certain risky decisions.

This form of price-sensitivity modelling can also be used in the analysis of the impact that related governmental policy decisions may have on the pork industry with respect to, for example, the price of maize, wheat, soya and sunflower. The impact of new and revised feed acts (South African Department of Agriculture, Act No. 36 of 1947 as amended) can also be tested by using this model. Policy assumptions can be supported given the scenarios and outputs obtained from modelling.

1.7.2 Assumptions

The purpose of this study assumes that pork producers use the same set of basic raw feed ingredients but with different compositions, varying in the ration offered to pigs during the different stages of production. The production size of a pork producer is determined by considering the total number of production sows. The scenario analysis is a case study based on a medium-sized producer with 500 production sows, with a standard production cycle using feed rations as determined by a pig nutritionist. SAFEX prices are used to base hedging scenarios on.

For the purpose of this study, the producer price, received as a farming gate price, remains invariable but can be adjusted for the future intent of this model. A constant price over time is used, although provision is made in the model to vary pork prices in real life situations.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

The purpose of this study is to develop a framework for a business decision support system for the South African pork industry to aid strategic decision-making for improved feed commodity risk management and improved cash flow management for individual pork producers. This framework is dependent on the inputs sourced from the commodity market in which the pork industry operates. To better understand why this study is necessary, one requires a snapshot of the structure of the feed as well as the pork industry in South Africa, with respect to pork production and costs and the different phases of production. This snapshot creates the background and environment in which the price-sensitivity model is used and indicates the impact that can be associated with changes in feed commodity industries.

Literature and information to assist in the construction and setup of a price-sensitivity model are available on the global web, however, the combination between a farming level model and the collective use of pricing options of inputs, different scenario and risk assessments are limited. Studies found on the individual sections of this model are mentioned in this chapter.

2.1.1 Feed industry in South Africa

After the deregulation of agricultural marketing boards of South Africa in 1997 (Van Zyl, Vink & Kirsten, 2000), a free market system developed which lowered the entry barriers for new and smaller entrants into the industry and allowed for free market price determination. Prices could then be formed by means of true supply and demand and not regulated by marketing boards. However, it created the problem that the levels of exposure of domestic markets to larger international markets could have a negative impact on sustainable growth due to the possible dumping of subsidised commodities from abroad.

Although the marketing boards were abolished, industry-specific organisations, for example, GrainSA, SAPPO, the South African Poultry Association (SAPA) and many more were formed to gather information and lobby on behalf of the agricultural industries in an effort to offer a certain level of industry information and support systems. These organisations receive an income from statutory levies obtained from producers to assist in the organisational functionality within the industries.

These organisations are also responsible for the gathering of statistical data; the monitoring of issues on a farming as well as global industry level; the promotion of growth and expansion; lobbying on behalf of producers to government and creating opportunities for new entrants (especially BBEEE parties); and for sustainable growth. The feed industry is no exception. The Animal Feed Manufacturing Association (AFMA) is the organisational body responsible for assisting and lobbying on behalf of the South African feed industry.

AFMA plays a significant role in providing a link between the raw material suppliers, manufacturers, Government and the final consumer. The horizontal integration lies in the links between AFMA, the feed manufacturers, the final product and the offset in either the local supply to the South African animal industry or in exports.

AFMA’s vision is “[To] *strive* [ ] *for the development of a sustainable industry that acts responsible within the food chain by ensuring safe feed for safe food*” (AFMA, 2010). The mission of AFMA is as follows:

- “Lobbying and negotiating with Government as well as local [ ] and international agencies
- Influencing those factors that have a bearing on industry costs
- Creating awareness amongst industry role-players of threats and opportunities facing the industry, and formulating unified action plans with them
- Promoting AFMA's image
- Providing [ ] information service[s] to members and other role players” AFMA (2010).

The factors mentioned in the mission are all relevant to one of the main issues of the industry, namely the price of feed, and more specifically the increase of feed prices over time. Price formation by the free market system can result in uncontrollable price fluctuations. Industry-governing organisations can, by method of information, give the correct market information to role players to minimise uncertainty and in the process reduce uncontrolled price movements in input and product commodities.

Figure 2.1 shows the changes in raw feed material cost for animals from 2000 to 2008. From 2005 to 2008, the average raw feed cost increased by 57.7 percent from R1 308 per ton in 2005 to R2 063 per ton in 2008[4].

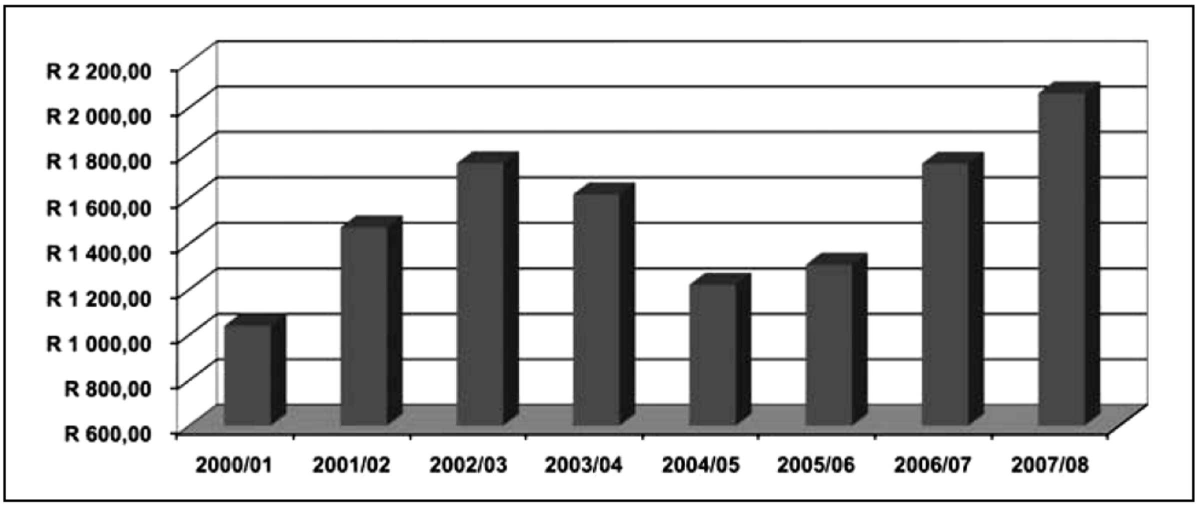

Figure 2.1: AFMA-weighted average raw material cost

Source: AFMA Chairman's Report (2009)

As explained by Dr Erhard Briedenhann, Chairman of AFMA (2009), the domestic prices of raw feed ingredients are mainly based on the following:

- **World population**

As the world population increases, so does the demand for more protein-based and staple foods. The higher demand causes an increase in the price of raw ingredients such as maize, wheat, soya and sunflower, the key raw ingredients in a balanced feed mixture.

[4] More recent data was not available at date of submission.

- **Ending stocks**

  The higher the ending stocks of, for example, grains for a given production year, the lower the price at which the available surpluses can be sold. However, if prices are on export parity levels, those surpluses can be exported to countries that do not have sufficient stock levels, thus keeping the price relatively stable. On the negative side, if ending stock reach very low levels or even in a shortage, the prices of feed ingredients may increase.

- **Currency fluctuations**

  In 2010, South Africa was a net exporter of maize, but a net importer of wheat, soya and sunflower (GrainSA, 2010). The changes in the exchange rate, especially the R/USD impacts on the price of commodities as follows: if the Rand is strong, imports become relatively cheaper whereas, if the Rand is weak, imports get more expensive and exports more profitable. The exchange rate has a direct correlation to the South African commodity prices, *ceteris paribus*.

- **Global growth**

  Global growth in agriculture, with increases in both yield and production, can cause the price of raw ingredients to decrease. This reduction can only be sustainable if the levels of increased growth are more than the reduced prices received for commodities.

- **Disposable income**

  The higher the levels of disposable income, the higher the spending power of people. The increased buying power puts consumers in the position to purchase animal proteins rather than plant-based proteins. Due to the higher number of animals being fed and slaughtered, the multiplier effect down the supply chain results in a higher demand in raw feed ingredients and thus a higher price for commodities.

- **Fund activity and speculation in the markets**
  A growing concern of especially grain farmers are on how the prices of, for example, maize are formed on grain markets. The issue relates to the role that speculators play in the market and how arbitrage opportunities are used in restoring market imbalances. The problem with this price formation is that the true cost of production is not fully accounted for. The result is that, if commodity prices fall to below production breakeven point, a situation arises that fewer farmers produce that specific commodity, thus a shortage is created in the market. In the long run, this can force the price of a commodity to increase to profitable price levels. For the feed industry market, these cyclical changes can be negative. Prices can be fixed on relative price levels but with the high volatility in the market, those prices can become expensive and would have to be factored down the supply chain to the end consumer.

The CDM on the JSE Ltd (previously SAFEX)[5] plays an intricate part in the feed industry and feed price formations are directly linked to changes in grain prices. For this reason, it is very important to have an adequate early warning system as well as an accompanying price risk aversion strategy to be able to compensate for price volatility that can impact on an agribusiness. For many feed rations grain prices contribute between 70 to 80 percent to cost. The sensitivity of these price changes must be measured to indicate the sensitivity and elasticity shifts in profit margins in order to give pork producers a competitive edge in sustainable and profitable farming. A shift in feed cost is expressed as a lagged change in the price of pork (per kg).

Figure 2.2 shows, for example, how volatile the white and yellow maize prices can be over a period of time. The shifts in prices can be as much and more as R500/ton downwards or upwards in a relatively short period of time, as seen in the period between November 2009 and January 2010. For own feed mixers, this is favourable, but if the opposite is true, the profit margins and cash flows on final pork production are much less over a time period.

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[5] Although the name of SAFEX has changed, this study still uses "SAFEX" when referring to the Commodity Derivatives Market (CDM).

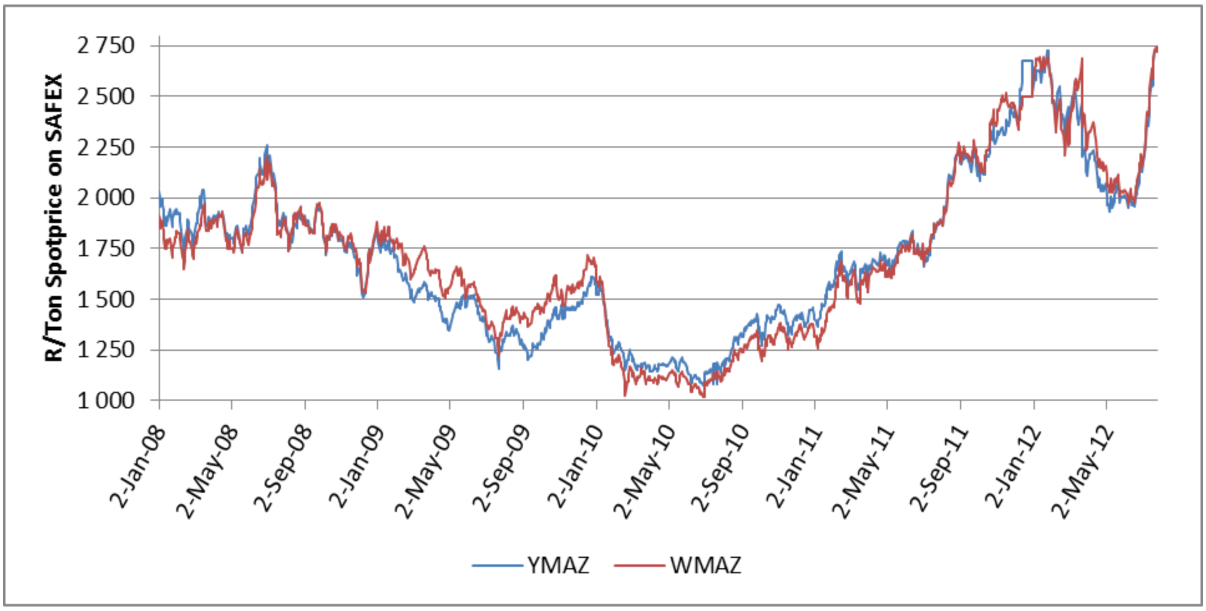

Figure 2.2: White and yellow maize spot prices (Jan 2008 to Jun 2012)

<u>Source:</u> Extracted from GrainSA (2012)

Table 2.1 shows the 2010/2011 figures of South African animal feed production. From the table, it is evident that AFMA members only produced 27.3 percent of the feed required for the domestic pork industry in 2010[6]. Thus more than 72 percent of all pork producers either managed their own feed manufacturing plant (not registered under the AFMA organisation) or mixed their own feed mixtures as prescribed by a feed nutritionist. SAPPO estimates that around 60 percent of the 400 registered pork producers manufactured their own feed and mixes. As will be discussed later in this study, the table shows that the pork feed industry accounted for only 7.6 percent of the total annual domestic feed requirements. However, the dynamics of this industry must not be underestimated with reference to governance and the impact of reviewed policies and Acts on animal feed.

[6] Updated figures will be made available by AFMA in late 2012.

Table 2.1: National animal feed production during 2010/11 (tonnes)

Feed type	AFMA-feeds plus feeds derived from concentrates	National feed production	AFMA feed as % of production
Dairy	1 024 495	1 880 000	54.49%
Beef and sheep	991 035	3 038 000	32.62%
Pigs	221 125	810 745	27.27%
Layers	812 743	1 130 755	71.88%
Broilers	3 175 991	3 194 130	99.46%
Dogs	14 430	297 000	4.86%
Horses	30 818	121 047	25.46%
Ostriches	17 473	180 450	9.68%
Aquaculture	2 860	2 900	98.62%
Total	**6 291 970**	**10 655 028**	**59.05%**

Source: Briedenhann & Griessel (2011) in [AFMA Chairman's report (2011)].

The study by Louw, Geyser & Schoeman (2010) focuses on how the supply chain of the feed industry operated, with direct reference to the pork and broiler industry. The aim of the study was to determine if the current supply chain still applies to the industry and how structural shifts have taken place during the past 10 years. Current issues and concerns were raised and operational risks quantified to assist the pork and broiler industries in strategically changing and adapting their business, given the factors identified and quantified in the study.

The benefit of this study by Louw *et al.* (2010) is that it provides current data analyses and resources to better understand how the critical links of the feed and pork industry interact and work with each other. This study made use of industry-related data on an international as well as on a domestic level. Structured questionnaires were used to obtain data and information that are not available through organisational bodies or industry leaders.

These questionnaires were then evaluated to show the impact that changes in the market environment have on feed and the pork industry. These changes need to be accounted for when developing assumptions on scenario and strategic planning. Furthermore, the study also looked at how business models should change and adapt in order to be prepared for the structural changes that will be taking place in the future. For management on all levels in the vertically integrated supply chains, it is crucial that changes in the business environment be taken into account and that strategies get revisited and updated on a regular basis.

2.1.2 Pork industry in South Africa

The cost of production in any industry contributes as one of the most important key driver towards decision-making. A second driver in this industry is risk management and risk mitigation strategies. The cash flow needed to run a successful pig farm is very high and extremely volatile, given the raw material content of the different feed mixtures. It is estimated that the average pork feed rations are a combination of 50-70 percent maize, 20 percent soya while the balance of 10 percent accounts for additional supplements On average, a sow is expected to wean 25 piglets per annum. On average, these piglets, together with the sow, consume 6 tons of feed per annum (Streicher, 2010). Pork production costs are composed of different cost items for activities from the time that the pigs are born until they are ready to be slaughtered.

Figure 2.3 is a generalised representation of the US hog production cost structure and shows the different farming types and stages in pork production. To calculate the production costs, specific activities' pro rata contributions are indicated for each stage. Feed make out between 33 to 42 percent of the total production cost in a pork production cycle. On average, the cost for a live animal adds up to about 32 percent of the total cost. Other costs include overheads, labour, marketing and veterinary costs.

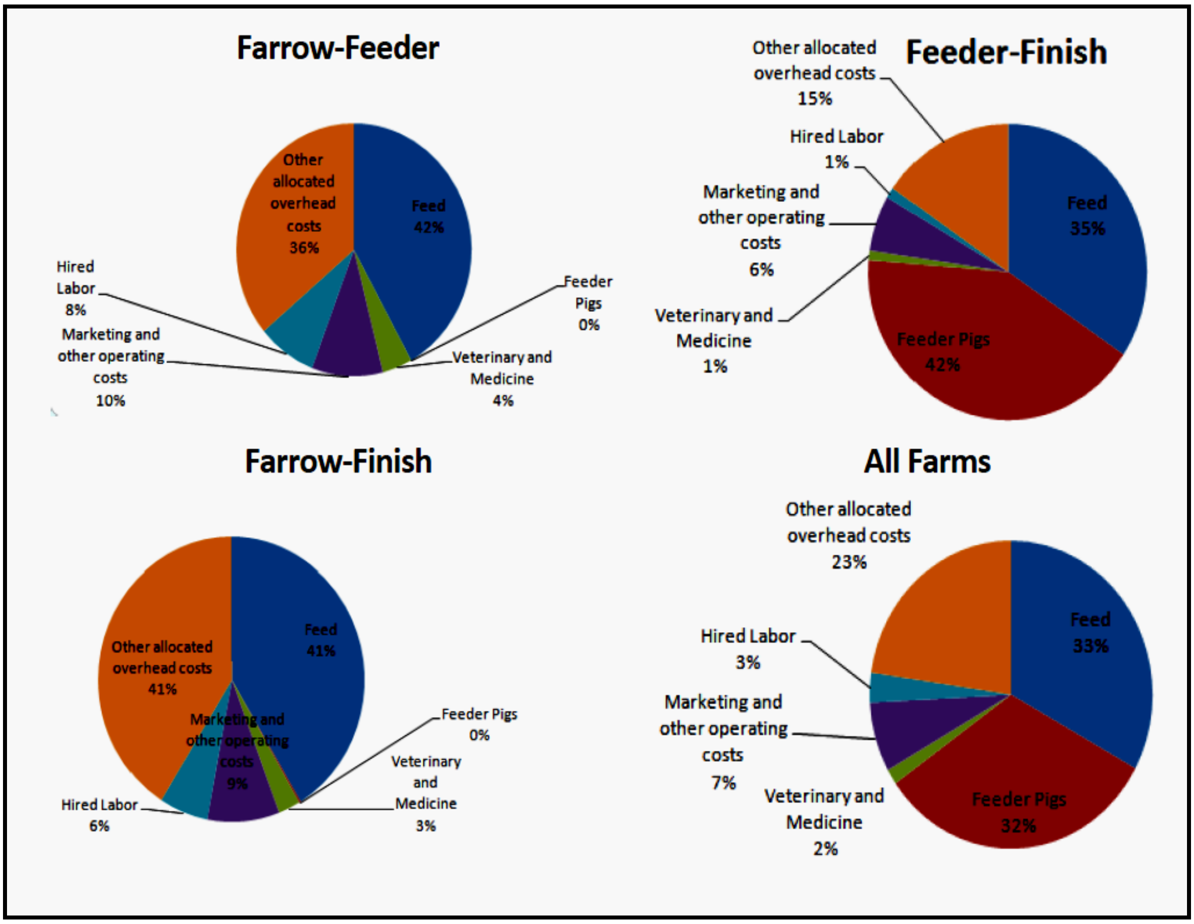

Figure 2.3: Comparison of US hog farm production cost by farming type

Source: USDA, ERS (2008) in [Lowe *et al.*, 2008]

The South African structure differs in the weight of a carcass' mass (preferred weight varies by country) and production costs due to 'smart' subsidies[7] that are paid to, for example, American producers. In South African pork production, the share of feed cost is almost 70 percent of the total production costs (Streicher, 2010). Listed below are eight classifications of feed mixtures that have a specific ratio of raw feed ingredient balance to the mixture to optimise growth and lower costs. The stages will be used as a basis in a case study, as supplied by Viljoen (2011).

[7] 'Smart' subsidies are not defined as subsidies but are government assistance in the production of feed inputs used in feed rations.

The feed rations are as follows:

- Creep feeders
- Weaners
- Growers
- Link-feeders
- Finishers
- Gilts
- Lactating sows
- Sow and boar mix

The raw ingredients incorporated into the formulation of the feed rations per stage are a calculated weight of the following main ingredients, depending on the availability and the quality of raw ingredients:

- Maize
- Soya oil cake
- Sunflower oil cake
- Wheat bran
- Fish meal
- Additives

To a major extent, the cost of maize, soya, sunflower and wheat (that accounts for more than 90 percent of the total feed cost, as previously mentioned) can be hedged on the SAFEX grain market in their original commodity form to evade the impact of sudden changes in prices due to the volatile nature of these commodities. In order to build a price-sensitivity model, the stages of production and growth must be taken into account. Although the stages of production vary from farmer to farmer and between feed formulations of different animal health nutritionists, the basis and level of impact observed from the short-term shifts in price trends remain the same.

The study by Visser (2004) focused on the pig supply chain in South Africa. In this study, the consumer was fundamental to the supply chain and an in-depth review of the meat market surveys for the period 1970 to 2000 was undertaken. The central theme is: "*How to reconcile meat quality, genetics and the consumer with bio-economic pig production in the South African pig supply chain*" (Visser, 2004).
The following issues were focused on in the feed analysis:

- The protein and animal feed dilemma
- Feed production levels
- Mineral and pre-mix market
- The Pharmaceutical Industry
- Vulnerabilities pertaining to the South African Pig Industry

The issue of information flow in the supply chain remains an important point of discussion. In a paper by Verbeke, Doyer and Visser (2002), the focus of the study was on how information can be managed and traceability aspects incorporated into the supply chain in order to be pro-active in an industry. Kirsten, Blignaut and Visser (2009) also conducted a study on the pork supply chain of South Africa. The different links between the role players were pointed out in this study and the feed usage indicated by pork producers were 791 265 tons per annum, of which 750 000 tons of feed were from own feed mixers.

Other studies that relate more to the supply chain of the pork industry were conducted by Bahlmann and Spiller (2009), with the focus on "*The effect of institutional innovations on food chain governance: a case study on the shifting role of German QS systems from certification to supply chain coordination*" (Bahlmann & Spiller, 2009). The issue that prices and price structuring remains important in the supply chain, was discussed on an international level. In order to be more price-competitive in markets, vertical integration and the coordination of the supply chain must be optimised (Bahlmann & Spiller, 2009).

Bahlmann and Spiller's study focused more on the optimisation, governance and management of an industry and therefore has relevance to this study. Before operational expansions can take place, it is a necessity for future growth and expansion in the pork industry that governing structures are in place.

From the study by Paarlberg *et al.* (1999), focusing on structural change in agriculture and emphasising issues and concerns about concentration in the pork industry, it became evident that information on the input and output part of the supply chain is of importance to policy-makers. The main issue was: Who carries the risk and who benefits from lower input costs? Two policy options discussed by Paarlberg *et al.* (1999) can be implemented due to the integrated and concentration of the pork markets, namely the 'anti-trust' activity and the granting of a market power increase to pork producers.

As is the case globally, also in South Africa, pork producers are mostly price-takers and can only rely on strategic intelligence for an advantage to conduct business in the current market environment. It is difficult to predict the future, however, a sound strategic and operational plan can assist in bridging market gaps and gaining an advantage.

2.2 LITERATURE ON THE PRICE-SENSITIVITY MODEL

The concept of a price-sensitivity model as a 'tool' is not new to the world of agriculture. Economists, business managements, industry leaders, farmers and producer organisations can all make use of such a modelling concept that can range between analyses to assist with impact assessment, risk management, strategic planning and assistance in policy statement debates and decisions.

A key issue in the context of the South African pork industry is that it is relatively small when compared to other production regions. In 2009, the three largest producers of pork was China with 48.5 million tons, EU-27 with 22 million tons and Brazil with 3.1 million tons per annum.

The top three global consumption regions for pork and pork-related products were China with a total annual pork consumption of 48.3 million tons domestic consumption, EU-27 with 20.8 million tons and Russia with an annual pork consumption of 2.9 million tons (USDA, 2009 in Louw *et al.*, 2010).

To give a better perspective, South Africa only produced 164 700 tons of pork in 2009 while the consumption for that year was 172 100 tons. The difference was imported from mainly Brazil, Canada and the United States of America (BFAP Baseline, 2009). In retrospect, these statistics emphasises the need for the South African pork industry to expand domestically and participate in sustainable growth.

Streicher (2010) indicated that little research on the economical aspect of pork farming is based on the South African context. Most research is done on the nutritional performance of the industry but little emphasis is placed on the management of farming costs and the impact that feed price fluctuations have on a producer. The only price-feed model that is known and available to SAPPO is a sensitivity-measuring model of a pork production unit built by Pieter Cornelius in 1995. However, this model was not maintained or updated to accommodate the changes in the industry since 1995 onwards.

The following section focuses on how the logic of this model was constructed and how it can assist in the development of a more advanced and research-specific outcome that can be of use to producers as well as to SAPPO. The price-sensitivity model, as set up by Cornelius (1995), was used to calculate the total impact on the profitability of a pork producer, considering change in all the inputs of the production process. The basis for the model was constructed from four production stages that require feed ration mixes. As previously mentioned, more pork feed production stages can be included in the pork production cycle. The production stages included in this model, that require different rations of feed mixtures, was the farrowing, lactating, growth, and sow and boar stages.

The model can adjust to the change in prices of commodities and the change in feed rations, as prescribed and developed by a feed health nutritionist for each specific farmer.

This characteristic, to indicate the impact levels of changes in the feed input costs, makes the model adjustable to use on different farms and for different purposes. Further assumptions included by Cornelius (1995) are to account for all costs included in the production cycle.

The following costs were included in the model as fixed variables but they can change according to different machinery types used in different farming practices. These costs are:

- **Transportation cost of feed products**
  This cost included the cost of the feed delivery wagon that delivered the raw feed ingredients to the mixing facility, the tractor that operated the wagon and the labour cost of the operator. The cost was then calculated at a R/ton-feed basis in order to get an accurate per ton cost of the feed needed for production.

- **Mixing cost of the feed raw ingredients**
  After the raw feed ingredients had been transported to the mixing facility, the feeds were mixed by the hammer mills and feed mixers. This cost included the operating costs and the fixed overheads and maintenance costs. Depending on the kilowatt (kW) output of the machinery used, the cost was calculated at a per-ton-of-feed basis.

Other variables that were included in the model are described below (note that these variables must be adapted according to the size of each individual pork producer's production unit in order to accurately calculate the feed requirements).These variables are:

- Size of production units and breeding stock
- Production statistics, including litter size, mortality, herd feed conversion ratio (FCR), marketable stock and breeding stock
- Marketable stock analysis
- Total sale analysis (slaughtered and live)
- Feed usage and costs
- Income and expenses analysis

- Capital outlay
- Diverse costs

The aim of the pork unit sensitivity model by Cornelius (1995) was to illustrate what the changes will be on the profit levels (Rand) if a change would occur in the following areas:

- Price of raw feed ingredients
- Feed conversion ratio (FCR)
- Mortality
- Price received for marketable live stocks
- Capital costs
- Variable overhead costs

The output of the model was the income less total expenditure (net income) that a pork producer can receive, given the current state and levels of production. However, the model did have its limitations. Although the model was used in this study as basis for the development of an improved feed price-sensitivity model, certain structural changes had to be incorporated. These changes included the size of the impact expected from the results in order to make the model more output-specific.

This model by Cornelius (1995) is the most relevant study in a South African pork industry context. There are, however, other price-sensitivity modelling methods that can be based on a Microsoft Excel spread sheet (Source: Unknown). The computer program Pig Pro also has certain latent possibilities that are not always explored. The methodology is founded on the same basis as with the model used by Cornelius. The fundamental factors that need to be considered in constructing these types of models are the assumptions used, as well as the standardisation of the model. Input data from, for example, the grain markets must be obtained from a reliable source and farming production data must be verifiable by statistics obtained from agribusinesses.

The shortcoming of the model by Cornelius (1995) is that the model does not give through the sensitivity or impact from a change in a commodity to the impact on the cash flow. The model only showed the long-term impact on profitability. Thus, the model has to be adjusted to include the sensitivity or elasticity of a change in prices on a market to market basis and then used in the development of hedging strategies to be able to assist pork producers to increase their overall farming profit levels.

2.3 LITERATURE ON PRICE-HEDGING ON THE SAFEX GRAIN MARKET

Numerous studies and publications have been done on the futures markets. However, for the purpose of this study, only a few key studies will be discussed to give a broader overview of the underlying issues at hand and show the important value that price-hedging have on risk management.

Before strategies and the benefit of different hedging techniques can be discussed, the fundamental workings must first be considered. SAFEX issued a handbook on its operations as well as the operations of contracts available to grain buyers, sellers and speculators. This handbook or guidelines contains the following information as set out by the JSE (2008):

- The fundamentals of the agricultural market in South Africa and the products traded
- The origin and development of Agricultural Derivative Markets
- Forwards in the agricultural commodities market
- The Agricultural Product Market (APM) – Futures
- The Agricultural Product Market (APM) – Options
- Trading on the Agricultural Product Market (APM)
- Commodity swaps
- The use of futures and options in the agricultural commodities markets
- Forecasting price movements

By understanding the abovementioned and combining it with the appropriate forecasting and sensitivity models in the grain markets, an output can be obtained to measure and adjust the core business and cash flow, thereby reacting to changes in the market. Early warning systems can thus be developed for management to use and incorporate into scenario and strategic planning. Before a risk strategy can be implemented, management must evaluate and analyse the core pros and cons of the underlying hedging, and the possible effect of a negative outcome due to unforeseen circumstances.

Boyle (2009) explained hedging and available derivatives as: *"... an investment to reduce the risk of adverse price movements in an asset. Derivative contracts, such as futures, forwards, puts and calls are now a part of everyday operations as lenders encourage producers to implement risk management strategies. A futures contract is a financial contract obligating the buyer to purchase an asset (or the seller to sell an asset), such as a physical commodity or a financial instrument, at a predetermined future date and price. Option contracts, such as puts and calls, give a buyer the right, but not the obligation, to purchase an asset (or the seller to sell an asset) at a predetermined future date and price*".

In the study by Kim, Brorsen and Anderson (2007), the focus was on how to hedge profit margins and find the optimal solutions for profit margin hedging. The purpose of this study was to determine "*What assumptions for producer's utility and price process can justify profit margin hedging?" (*Kim *et al.*, 2007). The study made use of statistical tests of mean reversing in agricultural futures prices processes.

The study also made use of simulation modelling to compare "... *the expected utility of profit margin hedging strategy with the expected utility of other strategies such as always hedging and selling at harvest*" (Kim *et al.*, 2007).

These profit levels were calculated on commodities that have to be delivered to the market directly after harvest. The strategies that are used and tested are based on four different cases, as explained by Kim *et al.* (2007), namely that there are no risks, basis risks, transaction costs and yield risks for three different hedging strategies.

The end result was that, given the tests and simulations, there was very little difference between the expected utilities and the hedging strategies that implied selling at harvest time. The only factor that plays an intricate role is the transaction costs for the different strategies. For this study, a hedging strategy must be in place to test the effect under certain market conditions.

Parcell and Pierce (2010) from the Department of Agricultural Economics at the University of Missouri posted numerous publications on risk management in a US context. Accompanying papers in a series of risk management studies included the following self-explanatory topics:

- An introduction to hedging agricultural commodities with options
- Agricultural commodity futures contracts specifications
- Using commodity futures as a price forecasting tool
- Interpreting commodity futures and options price quotes
- An introduction to basis
- Commodity futures terminology
- Long hedge examples with futures
- Long hedge examples with options
- Short hedge examples with futures
- Short hedge examples with options

The purpose of these studies was to educate and demonstrate the different available hedging derivatives which can be used when analysing the market to determine the optimal strategy that needs to be executed in order for a desired outcome to take place. Although these studies are mainly based on the US grain futures markets, the issues related to risks and risk management remain the same to some extent.

Another study conducted by Moschini and Lapan (1995), determined whether production risks could be hedged or whether they were an optimal solution. The assumptions of the study were that all firms that wanted to hedge their production risks were risk averters.

A model was developed to determine if an optimal hedging solution could be established in order for a firm to hedge the associated production risks. The results indicated that firms under the assumption as stated above and with a specific position in the market (hedging strategic position), was better off in limiting the associated risks.

As mentioned earlier in this section, there are numerous studies conducted with relation to hedging and risk management. However, it is the balance between early warning outputs (that can be obtained from price-forecasting models or price-sensitivity models), that needs to be used in conjunction with the strategic focus of a pork producer, which will eventually lead to a risk-optimised solution. Pork producers can choose between different numbers of hedging strategies to divert risks, depending on the risk strategy they choose.

By using options and futures contracts with respect to the risk and return as desired, an optimal solution can be created on the short to medium term. What needs to be taken into account is that cash flow needs to be managed in such a manner that short-term cost can still be covered and the profit margin can remain as large as possible.

Futures contracts, unlike options, require short-term funds to be available in a call account to adjust payment on a market to market (MTM) basis. On the other hand, options are a once-off payment, depending on the price at which the option was offered to the buyer or seller.

To determine if an option contract is priced correctly or if an arbitrary opportunity exists, the Black and Scholes model developed by Fischer Black and Myron Scholes in 1973 (JSE, 2008) can be used. In this study, the Black and Scholes model is used in the hedging strategy development to determine what the best possible strategy for a pork producer can be, considering his risk profile.

2.4 LITERATURE ON STRATEGIC AND SCENARIO PLANNING AND RISKS

Strategic and scenario planning go hand in hand when decisions determine either a desired outcome or a damage limitation result. Strategic management per definition is: "... *the process by which a firm manages the formulation and implementation of its strategy*" (Carpenter & Sanders, 2009), and "…*can be defined as the process whereby all the organisational functions and resources are integrated and coordinated to implement formulated strategies which are aligned with the environment, in order to achieve the long term goals of the organisation and therefore gain an competitive advantage through adding value for the stakeholders"* (Ehlers & Lazenby, 2009).

Scenario planning is defined by Borjesson (2007) as the understanding of different driving forces in industries and the extrapolation of different market possibilities to understand the global context in which business can be conducted in the future.

As earlier mentioned, management of firms, organisations and, for the purpose of this study, pork producers all have risks that needs to be managed proactively. To prevent these risks from becoming a long-term obstacle, certain strategic plans and scenario possibilities need to be set into motion. With strategic planning, management also have to assess the possible outcome under certain conditions. In two publications by Ilbury and Sunter (2001 & 2007), they focused on how people perceive to think and react to scenario and strategic planning.

The methodology in setting up different scenarios was by using a simple two-axes matrix. On the horizontal axis were the opposites, 'uncertainty' and 'certainty', and on the vertical axis the opposites 'control' and 'absence of control'. The logical framework used in analysing scenarios by virtue of this matrix can be described in four steps.

These steps were adapted from Ilbury and Sunter (2001):

- The rules of the game
- Key uncertainties and different scenario levels
- Options
- Decisions

Boehlje (2002) summarises the assessment of risks when addressing the issues affecting agriculture on a broader basis. Within a dynamic changing industry, rules also change. He indicates that, as the business climate changes, so do the risks and models associated with risk change. The following areas discussed by Boehlje (2002) from an American perspective have a direct link to the South African agricultural and pork industry:

- Time and risk – as time changes, so does the risk factor;
- Tactical or operational risk – associated with business and financial risk;
- Strategic risk – "… is the sensitivity of the strategic direction and the ultimate value of a company to uncertainties in the business climate" (Boehlje, 2002);
- Options thinking – seen as the pricing of financial risk;
- Scenario analysis and stress testing – by using the 'what if' analysis, the scale or impact of changing environments can be determined and evaluated;
- Strategic development and risk – development of new strategies to fit the risk profile;
- New business models and risk – how business should be conducted in future;
- Market risk and performance – changes in markets (inputs) have a significant effect on agriculture; and
- Integration of risks and financial markets – integration of insurance in agriculture.

2.5 CONCLUSION

To conclude, as indicated by the various modelling tools available, hedging techniques and strategic and scenario planning can be developed as risk management system for the pork industry to assist pork producers to better manage their feed cost risk in the production process. By incorporating an early warning system with an appropriate hedging strategy, the short-term cash flow as well as the long-term profit margins can be managed to lower producer risk.

With any protection method, a producer must bear in mind that the methods used and strategies implemented can limit risks but may also limit returns. Depending on the risk profile of an individual, the management of risks can be adjusted to allow for larger, though manageable risks and higher returns.

As part of this study, the following elements are combined, namely:

- Market environment
- Strategic planning
- Scenario analysis
- Hedging with options
- Risk analysis
- Business model analysis

These elements were used to base financial and operational decisions on.

CHAPTER 3

SYSTEMATIC APPROACH AND MODEL DESIGN

3.1 INTRODUCTION

The purpose of this chapter is to recognise and illustrate the design process of a systematic research approach in the development of a computer-based (for the purpose of this study MS Excel will be used) modelling structure. This model is used throughout this study to illustrate influential changes on a pork producer and to test certain research questions. This is done to bridge gaps that exist with respect to realistic simulations of changes in scenarios that may or may not affect the outcome of modelling outputs. The concept that will be applied to this model is illustrated in Figure 3.1 below.

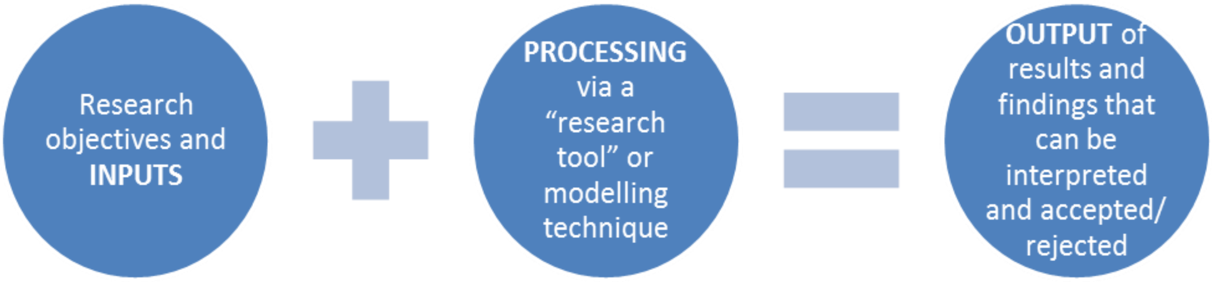

Figure 3.1: Systematic approach in research model design

Source: Authors interpretation as applied in many industries

Figure 3.1 illustrates how research and objectives, in combination with modelling, processing/computing and simulations, produce an output that can be analysed and interpreted. The processing and quality of the inputs given can be changed to result in different outputs, considering changes in variables used, and changes in scenarios according to different conditions. These outputs and findings can then either be accepted and applied, or rejected where the criteria are not met. When an outcome is rejected given the criteria tested beforehand, the findings can still be interpreted and an explanation provided for the outcome not being used or found to be unrelated in this research structure.

3.2 STRUCTURAL SIMULATIONS OF AGRICULTURAL MODELS

In agricultural economics, simulation models are, according to Strauss (2005), difficult to build for the purpose of experiments. Strauss also explained that the use of a physical model, as in various fields of science, is easier and better controlled as in the case of simulation modelling in agriculture. The difficulty is that there is no or little control over the numerous internal and external variables that need to be taken into account. As with any economic situation, the agricultural economic environment cannot be controlled or is even less controllable. However, solution-driven simulation modelling can produce outputs useful in decision-making as well as in scenario and strategic planning.

A logical structure is used for the development of this study's systematic farm level price-sensitivity model on a pork producing unit, which should produce an output that can be used in the field of agricultural economics. Csáki (1976) in Strauss (2005) explained the thought process behind the development of an experimental model as being one that can be used to determine a specific objective by using the correct inputs to produce a realistic output against which a specific research question or hypotheses can be tested.

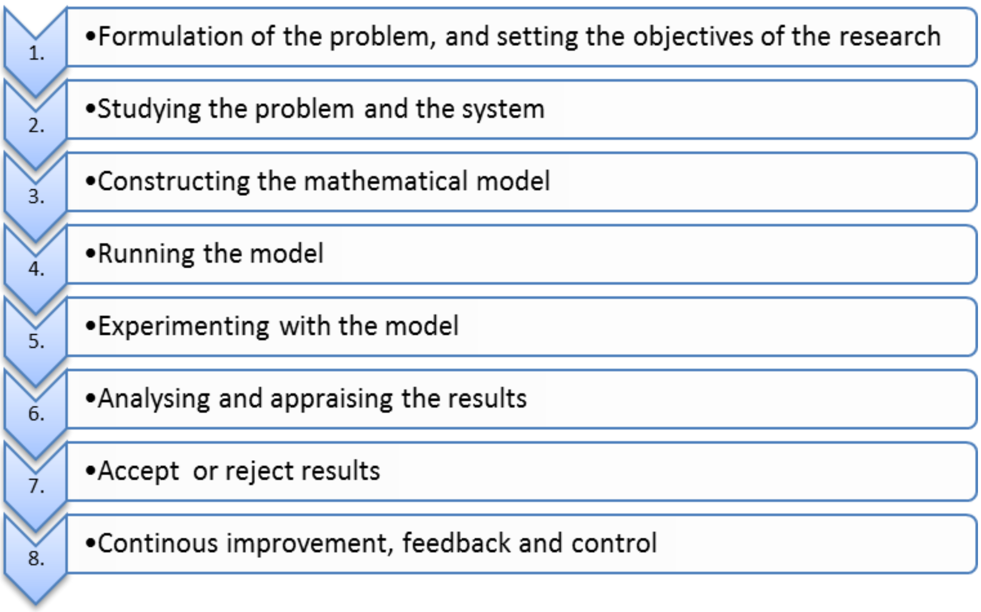

Figure 3.2: The order of implementation of simulating economic problems

Source: Csáki (1976) in Strauss (2005)

Figure 3.2, in conjunction with Figure 3.1, explain the implementation of a systematic approach towards problem-solving in the field of agricultural economics. The results obtained when these steps were followed can be used to explain and interpret the objectives as set out before.

In his study, Strauss (2005) also explained the different approaches to systematic modelling that can be used to obtain different results. He distinguishes between deterministic versus stochastic modelling as well as between the normative and positive approaches. Strauss (2005) described the deterministic models as "*… models in which the probabilities of the different model variables values are one, and in which the system relationships are constant. The output of a deterministic model is therefore definite"* (Strauss, 2005). In contrast to deterministic models, stochastic models have a random set of variables and relationships and, as Strauss (2005) indicated, the output of the models therefore has random elements or probability distributions.

As indicated by Csáki (1976) in Strauss (2005), the normative approach uses mathematical relationships and constraints to solve problems and give optimum solutions. Richardson (2003) in Strauss (2005) indicated that the positive approach uses statistical and historical data to find positive answers to a solution.

For the purpose of this study, a combination of the normative and positive approach is applied as a type of synthetic model, as explained by Brockington (1979) in Strauss (2005). Brockington (1979) indicates that two objectives can be tested simultaneously with this synthetic modelling approach. The approach represents the simulation and optimisation models. The re-engineering of the pork farm level model by Cornelius (1995) is based on this approach, whereby simulating of different conditions can result in the optimisation of the given constraints to obtain an optimal result.

The shortcoming of the model by Cornelius (1995) is that it does not extend the sensitivity or impact from a change in a commodity (or other critical inputs) to the impact on the bottom-line cash flow. The model only shows the long-term impact on profitability.

Thus, the model will have to be re-designed to include the sensitivity of a change in commodity prices on a market to market basis (simulation model).Only then can it be used in the development of possible applicable hedging strategies in order to assist pork producers to increase their overall farming profit levels and/or simultaneously lowering their producing risks (optimisation model). The model of Cornelius 17 years ago, addressed the most important needs which was then relevant.

3.3 PORK FEED PRICE-SENSITIVITY AND FARMING MODEL

By merging the different approaches in the development of a research model, as explained by Csáki (1976), Strauss (2005) and Brockington (1979), in combination with the existing model of Cornelius (1995), a new systematic approach model can be developed to simulate and optimise the current conditions faced by pork producers.

Figure 3.3 shows how the systematic approach is implemented in the synthetic input/output simulation model. This section explains how the model interlinks with the different input components on a pork production unit and how the assumptions were formed to base the farming level simulations on.

Figure 3.3: Outline of the re-designed feed sensitivity model

Source: Own interpretation

3.3.1 Farmer and operational information

The intension with this model development is to keep the simplicity with which the model is set up so that any person can use it to produce financial planning outputs, with the main purpose of using it to base management decisions on in order to maximise opportunity and minimise risk over time.

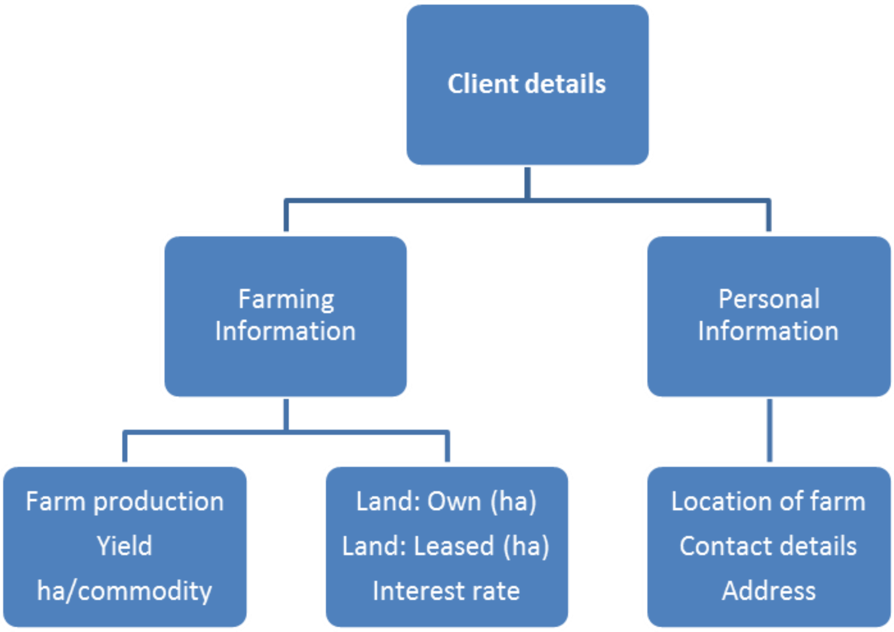

Figure 3.4: Client information
Source: Own interpretation

Figure 3.4 marks the beginning from where the simulation and systematic approach to this model starts, and forms part of the inputs. From the information provided by the farmer, certain assumptions can be made and conclusions drawn as part of the simulation. The client information parts into two sections namely *farming information* and *personal information.*

Farming information includes:

- Composition of farm land owned and leased (specifying the size of dry land, irrigation, grazing, natural/planted pastures and farm sheds/houses/stalls/pens per hectare;
- Owned land and leased land totals (ha);

- Farming production of commodities if applicable (maize, soya, wheat and sunflower);
- Yield per ha for planted feed commodities;
- Allocation (per ha) for each commodity; and
- Interest rates (debit and credit rates).

Personal information includes:

- Farm location (region and address);
- Contact information; and
- Date of initiation.

PORK PRODUCTION UNIT FEED SENSITIVITY ANALYSIS

CLIENT DETAIL

			Production:	Ha	Yield/ha	Total
Client:						
Address 1:			Maize	0.0	0.0	0
			Soya	0.0	0.0	0
			Wheat	0.0	0.0	0
Postal Code			Sunflower	0.0	0.0	0
Region:			Date of visit			
Telephone:			Date printed			
Fax:			Farming Type	Livestock		
Cell Phone:			Farm name and Hectares			
			Total: Own land		0	Ha
Interest rate on Acc	12.00%	Debit	Total: Lease Land		0	Ha
	5.00%	Credit	Total		0	Ha

COMPOSITION OF FARMLAND (Ha)

Farm name: Own land	Dry lands	Irrigation	Grazing (N)	Grazing (P)	Sheds, house, stalls	TOTAL
						0
						0
						0
						0
						0
						0
						0
						0
						0
						0
						0
TOTAL	0	0	0	0	0	0
Farm name: leased land	**Dry lands**	**Irrigation**	**Grazing (N)**	**Grazing (P)**	**Sheds, house, stalls**	**TOTAL**
						0
						0
						0
						0
						0
TOTAL	0	0	0	0	0	0

Figure 3.5: Illustration of the inputs (in model format) for the client information

Source: Own interpretation

Figure 3.5 is an extract of how the model is structured and how inputs are used in computing specific outputs which are necessary to answer the research objectives. On a farming level, the operator of the model needs to simply insert information in the pink sections. All other sections and other subsections within this model are based on the same principal.

The purpose of the information is as follows:

- Interest rates: used in the calculations of cash flow and capital balances
- Regional information: location to markets and resources (used to base cost structures and silo differentials on)
- Production inputs: applied in the control where own feed commodities are used, i.e. to determine whether inputs are sufficient or whether feed commodities need to be bought in

3.3.2 Farm Pork Production Unit Inputs

The following section focuses on the pork production unit with emphasis on production information on sows, litters, the production unit in its entirety and a balanced production summary of a financial year's production and sales numbers. As a benchmark, production data and norms are included to evaluate whether the production unit is on form with industry standards, or underachieving. Figure 3.6 presents the layout that incorporates the systematic modelling approach of input, processing and output.

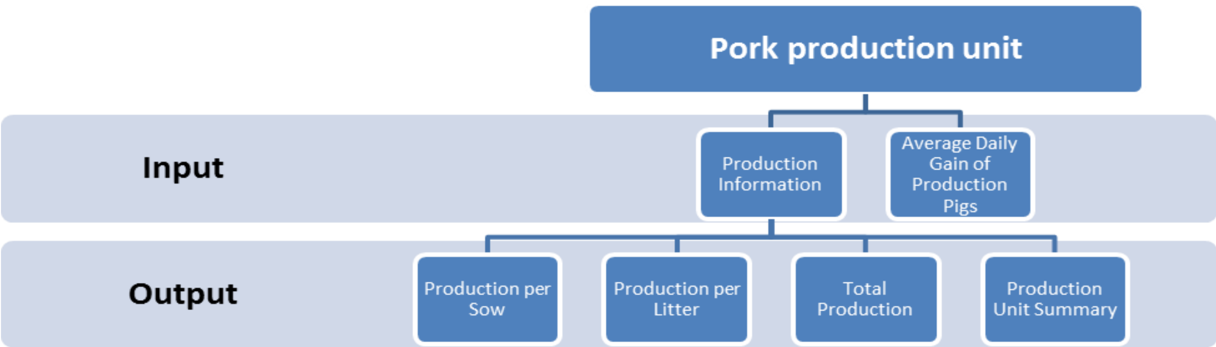

Figure 3.6: Structure of the Pork Production Unit
Source: Own interpretation

Inputs from current as well as historical data supplied by the producer are as follows:

- Number of production sows (sow unit indication)
- Production boars (producer indicates if boars or artificial insemination (AI) is used – model automatically calculates number of boars necessary for the production unit)
- Average farrowing percentage
- Average farrowing intervals in days
- Average pregnancy period in days
- Average lactating period in days
- Average dry period (automatically calculated from the farrowing intervals and pregnancy/lactation period days)
- Piglets born before mortality (per litter)
- Stillborn piglets (percentage)
- Mortality: piglets before weaning (percentage)
- Mortality: piglets after weaning (percentage)
- Sow and boar mortality (percentage)
- Sow and boar replacement per year (percentage)
- Sow: boar ratio (used in the calculation of boars necessary for production)
- Slaughter percentage of pigs

The abovementioned sections form the basis of the assumptions that calculations are based on. The critical success and credibility of the output of this modelling technique lies in the correctness of the information supplied to the model. The principle of “garbage in, garbage out” applies where, if the incorrect information is supplied, wrong results will be generated. The average daily gain for the different feed stages in the pig production cycle is included in the model.

The production unit summary gives the starting number of pigs for the following groups:

- Sows
- Sub-adult sows (gilts)
- Marketable sows
- Marketable boars
- Replacement boars
- Boars

To balance a year's unit summary, the following actions are factored in:

- Starting totals of pig groups
- Purchases of new genetic material/breeding stock
- Pigs sold (commercial and replacement)
- Mortality for pig groups
- Ending stock of pig groups

The tables[8] provide production information that has been calculated from the inputs provided as mentioned in the section above. Table 3.1 represents the layout for the output of a single production sow and the average production outputs associated per sow. Table 3.2 represents the production outputs per litter and Table 3.3 gives the total production of the unit.

Table 3.1: Production information output per sow

	Units	Measurement
Piglets born (before mortality)	27.38	Per sow/year
Piglets stillborn	2.29	Per sow/year
Piglets born	25.09	Per sow/year
Mortality: piglets before weaning	2.60	Per sow/year
Piglets weaned	22.49	Per sow/year
Mortality: piglets after weaning	1.00	Per sow/year
Pigs sold	20.99	Per sow/year

[8] Note: The data in the tables is for illustration only, based on a 500-sow established piggery unit and for illustration purpose only. Data was generated by means of the pork unit price-sensitivity model.

Table 3.2: Production information output per litter

	Units	Measurement
Litters	2.28	Per year
Piglets stillborn	1.00	Per litter
Piglets born	11.00	Per litter
Mortality: piglets before weaning	1.14	Per litter
Piglets weaned	9.86	Per litter
Mortality: piglets after weaning	0.50	Per litter
Pigs sold	9.64	Per litter

Table 3.3: Production information output of total production unit

	Units	Measurement
Litters	1 084	Per year
Piglets born (before mortality)	13 008	Per year
Piglets stillborn	1 086	Per year
Piglets born	11 922	Per year
Mortality: piglets before weaning	1 235	Per year
Piglets weaned	10 687	Per year
Pigs sold (excluding breeding sows & boars)	10 450	Per year

Table 3.4, as given by Robinson and Penrith (2009), established three levels of production targets for piggeries to benchmark against. However targets are adjusted as production efficiency develops. For the purpose of this study the data as recorded in the table was used as a guideline.

Table 3.4: Production targets

Measurement	Established piggeries	New producers	Critical indicators
Litters/sow/year	2.2	2.0	1.6
Born alive/litter	10.5	9.0	8.0
Weaned/litter	9.6	8.0	7.0
Sold/sow/year	20.0	15.0	14.0
Group FCR	4.0	4.5	5.0

Source: Robinson and Penrith (2009)

The three levels are:

- Established piggeries;
- New producers; and
- Critical indicators.

The following measurements are evaluated in a production unit:

- Litters/sow/year
- Born alive/litter
- Weaned/litter
- Sold/sow/year
- Herd Feed Conversion Ratio (HFCR)
- Grading results

In the model, these measurements are used to indicate where there are possible underperformances in the production unit. This early warning system can act as a risk-minimising instrument which can result in corrective action being taken in underperforming areas. A pork production unit is a synergetic form of farming where each stage of production to the next is critical.

Table 3.5: Water allocation for different pig groups

Pigs	l/day
Pregnant sows	9
Boar	9
Lactating sows	25-30
Piglets	5
Growing pigs	5
Baconer	10

Source: Knoesen [unknown] and SAPPO (2012)

Table 3.5 is an indication from Knoesen, Aucock and Gardner [unknown] and verified by SAPPO (2012) of the water usage required for drinking purposes in a production unit. This table, along with the total production of the unit, can give an indication of the water capacity required to run a production unit, and the reserve levels required where water cannot, for example, be pumped or supplied.

3.3.3 Feed Commodity Price Information

Feed commodity prices, as well as micro-added components, vary on a day-to-day basis. The varying outputs result in fluctuation on the markets and cause calculations to be challenging. In order to create a relevant and plausible output, certain assumptions have to be made regarding commodity prices.

Figure 3.7 explains the basic structure of this section of the model. The accuracy of the information in this section will determine whether the generation of a plausible scenario is possible and, if changes are made, how such changes will affect the farming cost structure.

The inputs necessary for this section are as follows:

- A list with individual feed components
- A source where prices are updated from
- The date when updates were controlled and changed
- The farming gate price (R/ton)

Certain components in the rations' prices can also be imported on the basis of price per bag and the weight of the bag.

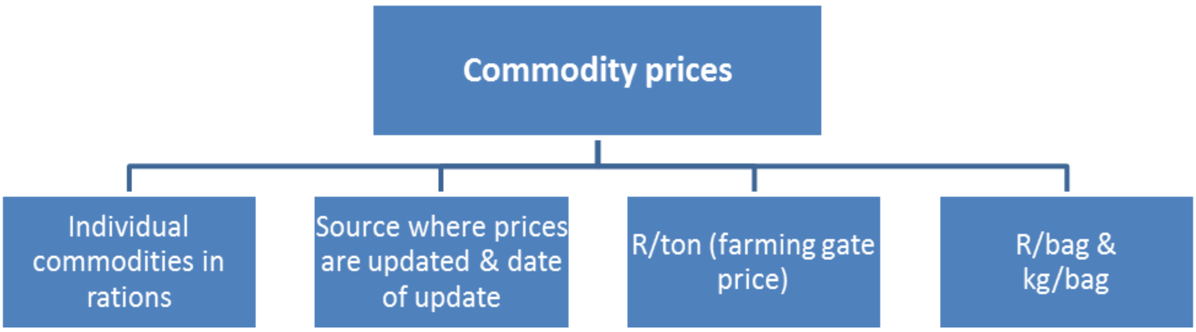

Figure 3.7: Feed commodity prices
Source: Own interpretation

For the purpose of this study, and where a ration is used, the custom-mixed commodities were supplied by Viljoen (2011). Five individual farm mix rations were balanced and the components analysed to form a basic feed structure of a piggery. The prices of the components in this structure can then be changed to create and simulate the affect that fluctuating feed component markets can have on a pork producer on a medium to long term.

The following commodity prices were regarded as constant for the purpose of this study. These commodities are:

- Premix vitamin and mineral
- Lysine
- Fish meal
- Feed lime
- Salt
- Monocalsium phosphate
- Methionine
- Threonine
- Tryptophan

Price changes were tested on the following feed commodities:

- Yellow maize
- Soya oil cake
- Sunflower oil cake
- Full fat soya
- Wheat bran

These commodities, as well as the rations, can be changed to the individual preference of a feed scientist or farmer.

3.3.4 Feed Rations, Price and Distribution in the Production Unit

Continuing with the systematic flow of this model, follows the distribution of prices and weight allocations per feed commodity to a specific feed group or ration, as well as the total cost of each ration. Figure 3.8 gives the diagrammatic layout of this section of the model. If a pork producer purchases a feed concentrate that is premixed, that concentrate is included in a ration along with a protein/energy feed source. As mentioned in Chapter 2, about 27 percent of pork producers purchase premixed feeds from registered feed manufacturers.

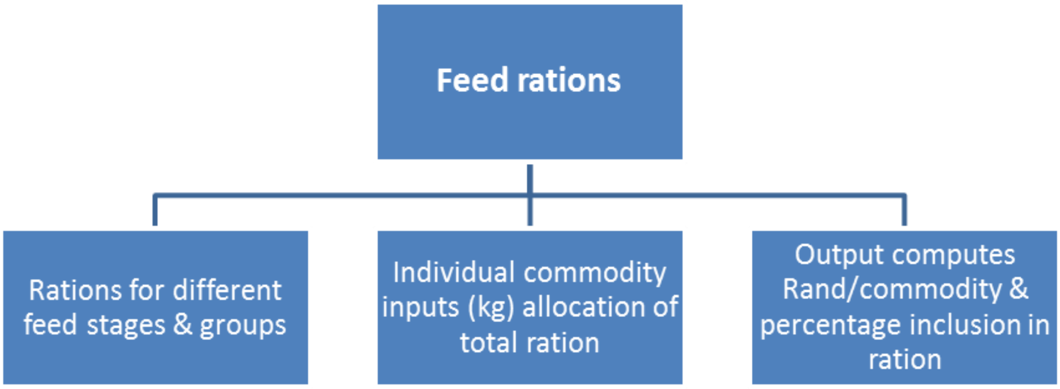

Figure 3.8: Feed ration distribution
Source: Own interpretation

For the purpose of this study and for the purpose of illustration, the following rations were used, namely:

- Creep feeders (live mass 4-10 kg)
- Weaners (live mass 25 kg)
- Link feeders (live mass 30 kg)
- Growers (live mass 70 kg)
- Finishers (live mass >70 kg)
- Gilts (adolescent sows)
- Lactating sows
- Sow and boar

As per the previous section, the model uses the input prices per commodity to calculate the cost per ration. The inputs necessary for this part of the model are the (per kg) inputs of a specific combination of commodities. It needs to be noted that the weight per ration must add up to 1 000 kg or 1 ton. With the weights per commodity imported, a percentage allocation is automatically calculated to indicate the percentage inclusion of a specific commodity in a ration. The purpose of this step in the model is to determine the cost per ration and the percentage inclusion of a commodity in a ration, and to indicate the different rations being used for the purpose of an effective feed flow on a farm.

3.3.5 Feed Utilisation and Procurement

From this point forward, all calculations are automatically computed, with the exception of a few variable inputs that are area-specific and need to be calculated for specific outcomes.

Figure 3.9 represents the structural layout of this section of the model and illustrates the inputs necessary to compute the specific
outputs.

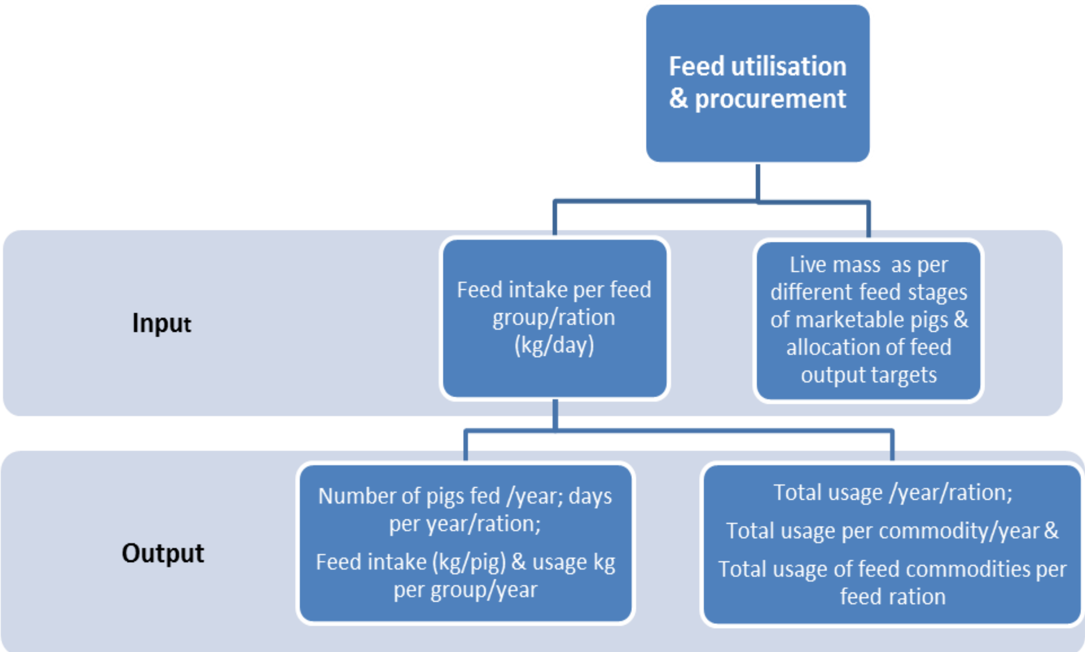

Figure 3.9: Feed utilisation and procurement of inputs

Source: Own interpretation

Inputs specifically necessary for this section are:

- Feed intake (kg/day) for each pig group (sows, boars and marketable pigs). This step is used in the calculation of total feed intake per pig per ration.
- Live mass for marketable pig groups. In conjunction with the average daily gain and feed intake per pig, the growth rate in days and cost of feed per marketable pig can be computed.
- Porker and baconer production split (finishers group). Given changes in market prices and condition, a pork producer can decide which percentage of his marketable pigs he wants to take to lighter porkers or heavier baconers.
- Usages of a feed ration (kg/group/year). This step is only necessary if a production unit varies from the defaulted model. If other feed commodities are not used as part of the usual diet, the model can be adjusted to accommodate changes by manually including the components into the input section.

Outputs calculated from this section:

- Number of pigs in a specific feed group. Groups are divided between sows (pregnant, lactating, dry, infertile and sub-adults), boars (production and replacements) and marketable pigs (weaner (9-10 kg), weaner (25 kg), link-feeder, porker and baconer).
- Days per year that a pig is in a specific feed group (this determines how much of a specific feed ration will be consumed per year with the associated commodity consumption).
- Feed intake per ration per pig (kg/year)
- Consumption of a feed ration per year (per feed group)
- Total feed consumption (kg) for sows, boars and marketable pigs. This should be used as a control to test and validate the output of the model.
- Total consumption of a ration per feed stage (kg) per year
- Total consumption (kg) of a specific commodity in a feed stage per year
- Total consumption (kg) of a specific commodity per year

The model is set up to be customised to the specific operation of any pork producer to facilitate a realistic replicating simulation of a farming situation. Although this model lacks certain phases or alternative options, it can still be customised to include any situation, for example, rearing pigs for different carcass weights and classes, but these customisations were excluded for the purpose of this study.

3.3.6 Feed Cost Cycles

The purpose of this section is to determine the cost on a weekly, cycle and yearly basis. In combination, the following information can be generated from inputs in the abovementioned sections of the model:

- Feed cost per week and cycle (per feed group/ration)
- Commodity cost per week and cycle for the piggery
- Commodity tonnage necessary per week and cycle
- Consolidated feed cost per feed group (per year)
- Consolidated feed cost per ration (per year)
- Consolidated cost and total usage per commodity (per year)

Figure 3.10 illustrates the abovementioned outputs as it is calculated to simulate a realistic cost and procurement structure on a farming level.

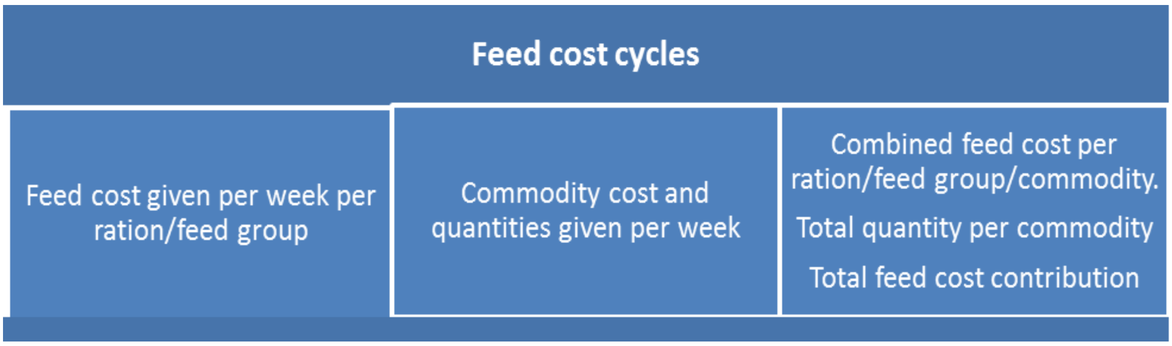

Figure 3.10: Feed cost cycles
Source: Own interpretation

The assumptions used for this section of the model are as follows:

- Annual costs and usage, based on a 'per cycle' cost multiplied by the litters per year;
- Weekly costs based on consumption of different feed groups multiplied by the cost per ration of the groups;
- Commodity costs calculated by multiplying the inclusion percentage in each ration by the price;
- Usage per week calculated by the inclusion percentage in each ration.

3.3.7 Gross Income from Pig Enterprise

For the purpose of simulation for this model, the farming income from pigs will only include the sale of production boars, sows, porkers and baconers. Figure 3.11 illustrates the farming income and the systematic flow of information from the inputs to usable representative outputs.

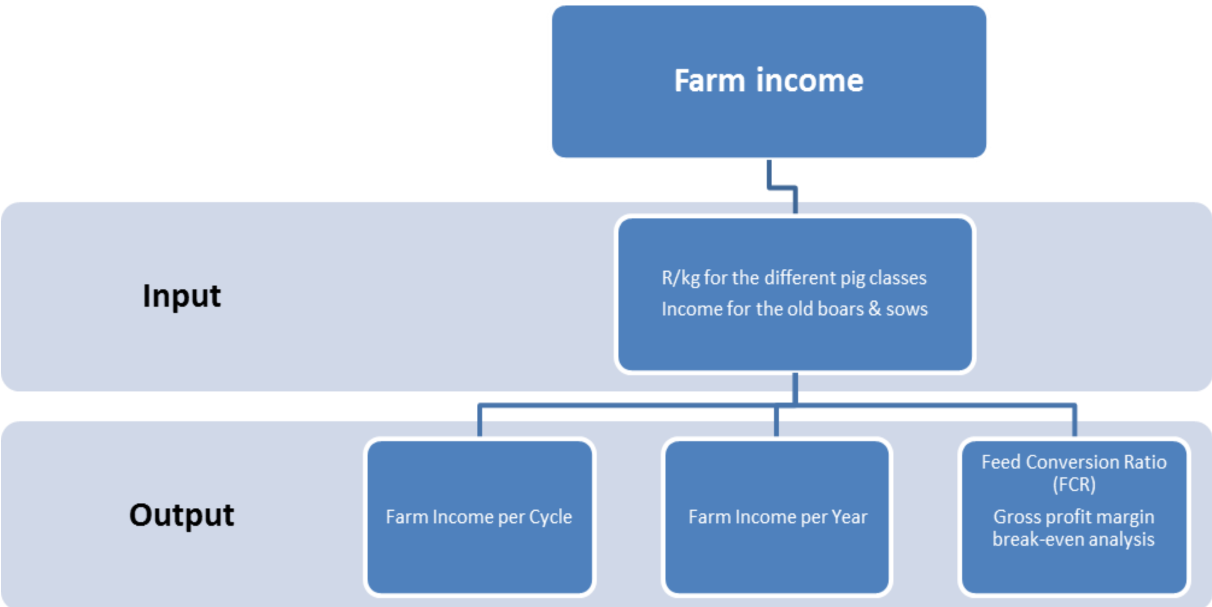

Figure 3.11: Farming income distribution

Source: Own interpretation

The continuous change in pork prices is a critical issue when simulating farming level scenarios and possible outcomes. With that in mind, the concept of introducing varying price spreads must be included in the calculations to create plausible 'what if' possibilities.

The following varying inputs are necessary for this section of the model:

- Sow[9] auction price
- Boar auction price
- Porker[10] prices (R/kg)
- Baconer prices (R/kg)

From previous computations, the following information is automatically calculated and added to the inputs that form part of the systematic approach. These calculations are:

- The kg on hoof (from slaughtered weight);
- The kg on hook (derived from slaughtered hoof weight multiplied by slaughter percentage);
- The number of pigs slaughtered per cycle and year; and
- The weight of pigs (total on hoof and hook) per cycle and year.

From the above prices and information, the following critical factors can be calculated:

- Income per carcass (porker and baconers) per cycle and year
- Total income per cycle and year
- Gross income (income-feed cost) per cycle and year
- HFCR
- Gross profit margin

[9] Sow and boar prices are calculated as a 'on the hoof' basis in total. The purpose is to restrict price fluctuations when scenario changes are tested on marketable pigs.

[10] For porker and baconer prices, a six month moving average will be used when farm-level simulations are performed.

- Critical break-even line (gross income)

The FCR is calculated on two bases, namely:

- On the hoof; and
- On the hook.

For both calculations, the total weight on the hoof and on the hook is divided by the total feed for the pigs slaughtered. This output is controlled with Table 3.4 were the critical FCR can be controlled to establish if the piggery is on norm or above/below norm.

On a gross income margin (income-feed cost) basis, two decision factors can be considered namely:

- Gross profit margin (percentage)
- Critical break line (gross income)

When a simulation is run, both the gross profit margin as well as the critical break-even line is calculated. For comparison (see Table 3.6), the gross profit margin from 25-55 percent is given, as well as the corresponding critical break line. This indicates to the producer where the unit is performing at the time, before all other expenses are taken into account.

Table 3.6: Farming Income and FCR per year[11]

Farm Income per Year

Pig group	Pigs for slaughter	c/kg	kg(Hoof)	kg(Hook)	Total weight in kg (Hoof)	Total weight in kg (Hook)	Total/Carcass	Total Income
Sows	202						R 2 200.00	R 443 520
Porkers (70 kg)	5225	R 18.80	70.0	50.4	365733	263328	R 947.52	R 4 950 561
Baconer (75-95kg)	5225	R 17.00	95.0	68.4	496352	357373	R 1 162.80	R 6 075 346
Boars	14						R 1 000.00	R 14 288
Total								R 11 483 715
Gross Income (Income -Feed Cost)							41.43	R 4 757 231

Feed Conversion

Total weight in kg (Hoof)	862085
Total weight in kg (Hook)	620701
Total feed for slaughterd pigs in kg	2 420 394
FCR (Hoof) Group	2.8
FCR (Hook) Group	3.9

Gross Profit Margin %	Critical Break Line (Gross Income)
55	R 6 316 043
50	R 5 741 858
45	R 5 167 672
40	R 4 593 486
35	R 4 019 300
30	R 3 445 115
25	R 2 870 929

Source: Own interpretation

[11] Diagram included for illustration purpose only.

3.3.8 Cash Flow Analysis

To evaluate the performance of any farming business and farming activity on the basis of only direct operations and costs is not sufficient for the purpose of decision-making. With the aid of a cash flow analysis of a year's financial performance, allocations of costs, as well as loan repayments, can be determined and evaluated. Figure 3.12 represents the structure of the cash flow analysis that is used for this simulation performance model.

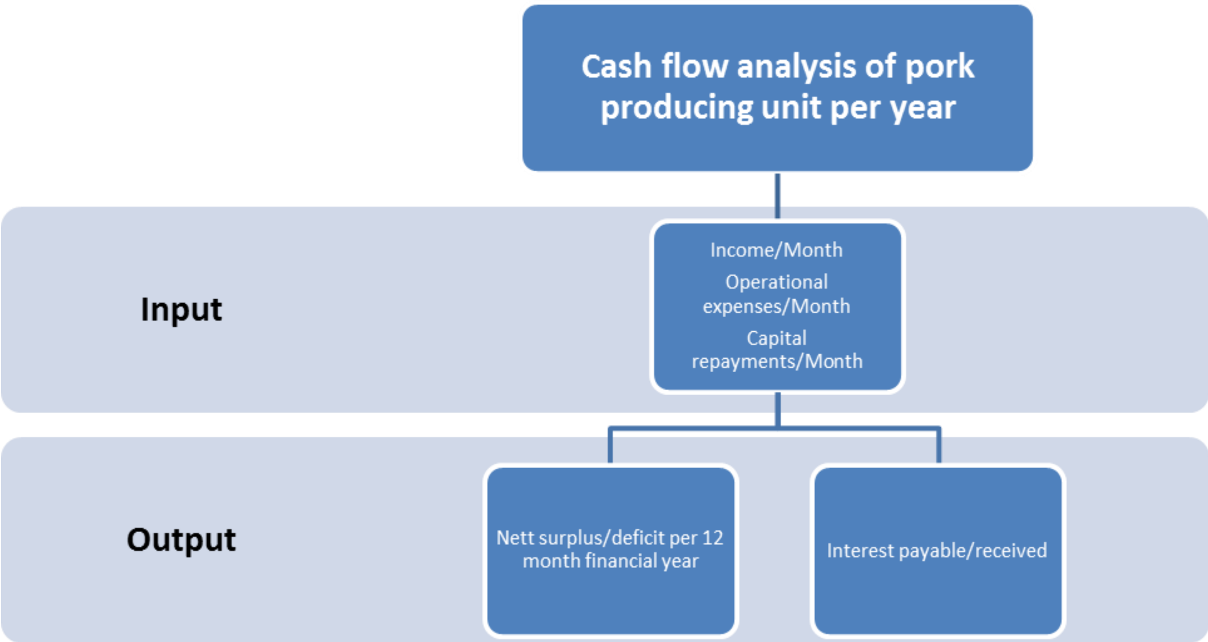

Figure 3.12: Cash flow analysis
Source: Own interpretation

The cash flow analysis makes provision for inputs for a monthly income, but is not limited. This income is derived from:

- Porkers;
- Baconers;
- Old sows (non-productive);
- Production sows;
- Sub-adult sows (gilts);
- Piglets;
- Old boars (non-productive);

- Production boars; and
- Young boars.

The cash flow makes provision for inputs for main cash expenditures. These expenditures are:

- Individual feed commodities;
- Wages;
- Electricity;
- Veterinary expenses;
- Farmer's salary;
- Fuel;
- Repairs;
- Recreational;
- Educational fees;
- Unemployment Insurance Fund (UIF); and
- Taxes and levies.

The cash flow also makes provision for capital payment on infrastructure, hire purchases and livestock loans for the pork production unit. Monthly surpluses/deficits for a pork production unit are calculated as follows:

Pork income
- pork expenses
- capital repayments on pork outlay
= nett income/deficit before interest

Net income/deficit before interest
+ bank beginning
- interest payable
+ interest received
= bank end

The purpose of these calculations is to evaluate whether the pork production unit performed financially positive and sustainable. Before changes to management, structure, farming methods and operations are considered, the impact must be tested on the 'bottom line' to ensure that decisions resulted in improvements at the end of the production year.

3.3.9 Feed Commodity Sensitivity Analysis

Part of the objectives of this study is to determine the scale or impact that changes in commodity prices have on the feed cost of pigs. Figure 3.13 diagrammatically illustrates the sensitivity analysis on maize, soya, sunflower and wheat. These grain commodities can all be hedged on the SAFEX grain markets and contribute (in original or processed form) more than 80 percent of the total feed cost.

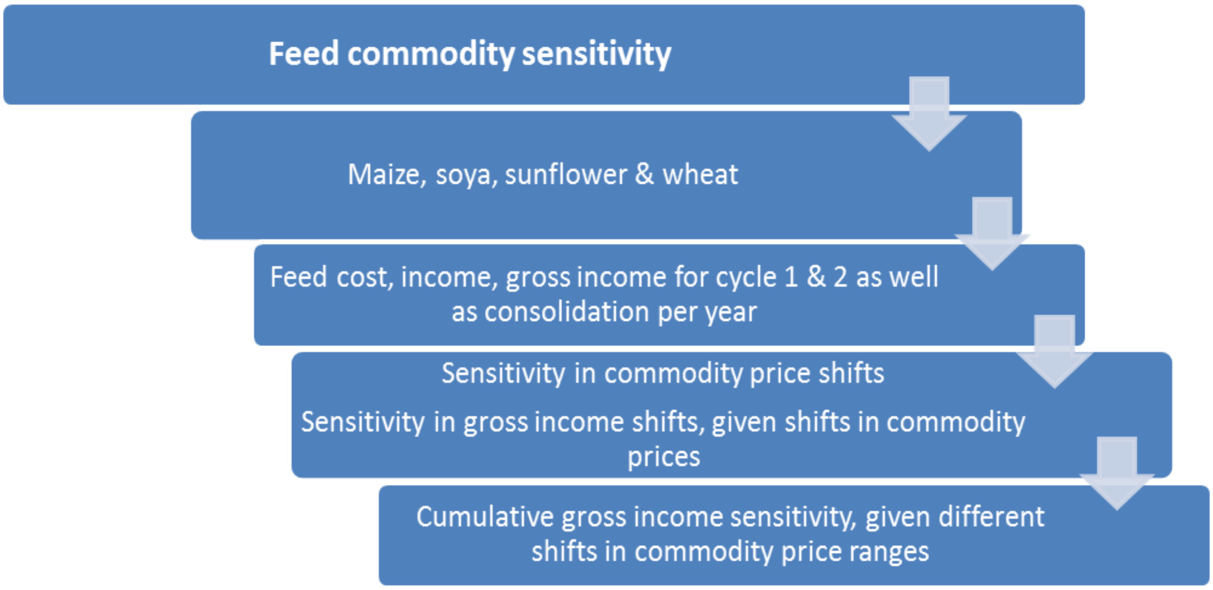

Figure 3.13: Feed commodity sensitivity evaluation
Source: Own interpretation

The model uses different price spreads for each of the abovementioned commodities to determine if the impact of fluctuating prices (given the volume and necessity of the commodity in the feed rations) poses a financial risk to the pork production unit. To determine the impact, two cycles are tested at different prices. The two cycles will be consolidated on an annual basis to provide the sensitivity and the impact on the financial output.

This part of the model calculates the following for each of the different annual price spreads and cycles:

- Cost per cycle half annually and annually (SAFEX price **x** usage in tons)
- Farming income (total income - cost of commodity)
- Gross income (total income - total feed cost)
- Sensitivity in commodity price single shift (on farming income)
- Sensitivity in commodity price (as percentage change from one price to another)
- Sensitivity in gross income, given a change in the commodity price
- Cumulative gross income sensitivity

The model is set up to evaluate changes between two price changes with the same increment changes. The model sensitivities indicate the overall effect of price fluctuation, considering the volume usage. The purpose of this information is to determine the necessity of hedging on the SAFEX grain markets. To perform any action involves costs. In order to maximise profits, costs must be contained as far as possible.

If the scale or impact in a price shift is below the acceptance level of the producer, the commodity cost package poses little risk to the producer. However, this study shows the impact that certain major commodities have on financial cash flow levels.

3.3.10 Strategy Analysis for Hedging with Black and Scholes

One of the objectives of this study is to determine the impact that changing commodity prices have on a pork production unit. In order to minimise risks associated with price fluctuations, steps which require the testing of certain actions need to be taken. Maize and soya make up more than 60 percent of the feed cost and more than 70 percent of the total mass associated with pig feeds. On the SAFEX grain markets, both maize and soya contracts trade on a daily basis. For the purpose of this study, the impact of using alternatives to minimise the price risk for maize, will be tested and analysed (see Figure 3.14 below).

Information that can be obtained on a daily basis for this section is as follows:

- Location to nearest silo (silo differential will be based on Randfontein silo)
- SAFEX spot price
- Future contract prices for two trading months, one in winter and one in summer (There are five trading months for SAFEX, namely March, May, July, September and December)
- At-the-money call option costs, determined by using the Black-Scholes formula

In this study, the different strategies available to a pork producer are limited to:

- Fixed price contracts;
- Minimum price options;
- Futures contracts; and
- An un-hedging strategy – buy feed components on the open market.

For maize quantities required on a farm, evaluations were created. Price spreads were used at variable intervals to create the scenario of fluctuating market prices. At a specific price level, a specific price for a quantity of a specific commodity that a production unit would need in the future was hedged for two separate months of the year. Different contract types and positions were compared with each other to determine which option presented the lowest price risk. Consolidated, the annual hedging principals were calculated and the different strategies evaluated to determine the best possible outcome.

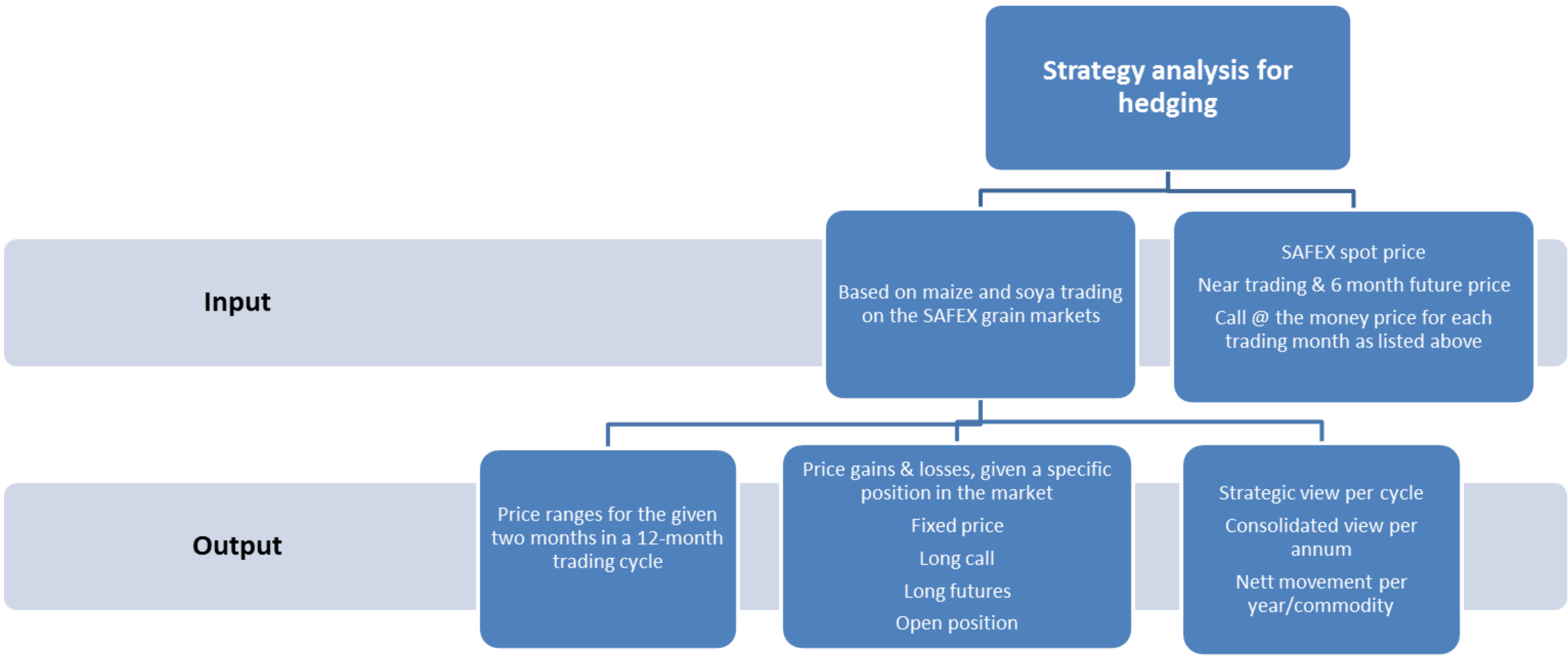

Figure 3.14: Strategy analysis for hedging

Source: Own interpretation

To be able to calculate the cost of an option, the Black-Scholes model was combined in this systematic model to aid the pork producer in evaluating different scenarios and options.

The Black-Scholes (B&S) formula used in the calculation for the price of a call option is explained by Geyser and Cutts (2007) as follows:

The formula for B&S

$$C(S,T) = SN(d_1) - Ke^{-rT}N(d_2)$$

where

$$d_1 = \frac{\ln(S/K) + (r + \sigma^2/2)T}{\sigma\sqrt{T}}$$
$$d_2 = d_1 - \sigma\sqrt{T}.$$

and

- K is the exercise price;
- S is the price of stock as currently being traded
- T is the time to expiration of the contract expressed as a fraction of years;
- r is the constant interest rate (zero for this study);
- σ is the constant stock volatility; and
- N is the standard normal cumulative distribution function.

Figure 3.15 illustrates the inputs and outputs needed to calculate an indicative cost of an option. The premium calculated by the Black-Scholes model can only serve as an indicative price, as the final premium cost is determined by an auction process.

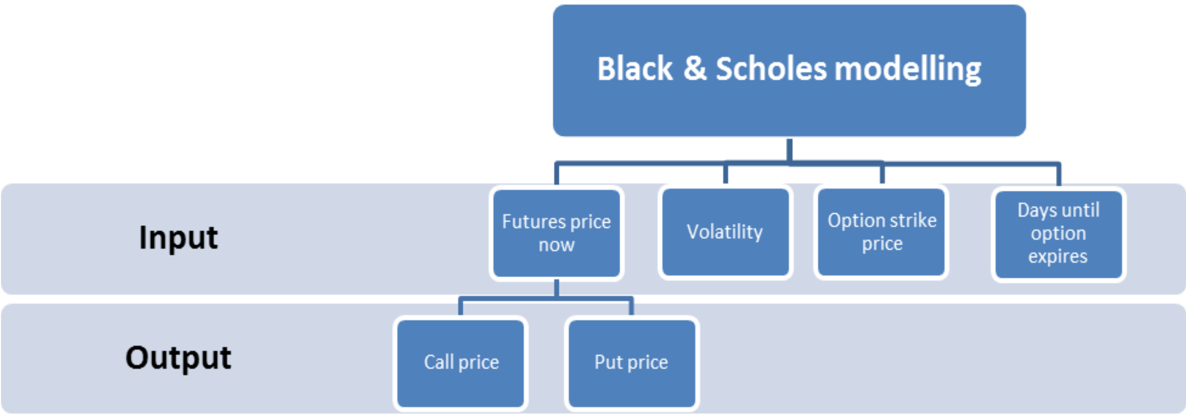

Figure 3.15: Black and Scholes Modelling
Source: Own interpretation

Table 3.7 shows that, to calculate an option's costs per ton, the following inputs needs to be imported:

- Futures price now (S)
- Volatility (σ)
- Option strike price (K)
- Days until option expires – years (T)

Table 3.7: Output[12] of a generic Black-Scholes model

Black and Scholes	
INPUTS	
Futures price now (S)	A
Volatility – annual (σ)	B
Option strike price (K)	C
Days until option expires – y ears (T)	D
OUTPUTS	
Call price Vc	R xx
Put price (Pp)	R xy

[12] Black-Sholes model included for illustration purposes only

3.3.11 Executive Summary of Model

To conclude the calculations and the systematic input/output model approach, a summary output is illustrated in Figure 3.16.

Figure 3.16: Diagrammatic output of the farming executive summary
<u>Source:</u> Own interpretation

The executive summary is subdivided in three groups, namely the production, feed and income summaries. Included under each of these summaries are:

3.3.11.1 Production Summary

- Pigs sold per sow/year
- Litters per year
- Pigs sold per litter
- Piglets born (before mortality) per year
- Total piglets stillborn per year
- Piglets born alive per year
- Yearly pre-weaning mortality
- Piglets weaned per year
- Pigs sold (excluding breeding sows and boars) per year

3.3.11.2 Feed Summary

- Total feed usage for sows (kg per year)
- Total feed usage for boars (kg per year)
- Total feed usage for marketable pigs (kg per year)
- Total (kg per year)

- Total feed usage per sow (kg per year)
- Total feed usage per boar (kg per year)
- Total feed usage per marketable pig (kg per year)
- Total per sow and litter (kg per year)

- Feed cost per cycle (R/cycle)
- Feed cost per year (R/year)
- FCR (Hoof) group (kg feed:1 kg live weight)
- FCR (Hook) group (kg feed:1 kg carcass)
- Feed cost per kg meat produced (R_feed cost/kg)

3.3.11.3 Income Summary

- Income per cycle (R/cycle)
- Gross income per cycle (R/cycle)
- Income per year (R/year)
- Gross income per year (R/year)

3.4 CONCLUSION

The purpose of this chapter was to illustrate the modelling techniques used to simulate a situation based on the concept of inputs, processes and outputs. These outputs form part of a chain of systematic approaches to create a simulation of a farming model that can be used to generate different market scenarios and conditions. Different outputs can assist a risk aversion producer to make decisions in an effort to reduce his risk exposure and create a barrier against the wave of market instabilities.

This chapter included the following subsections of the model:

- Farmer detail and operational information
- Farm pork production unit inputs
- Feed commodity price information
- Feed rations, price and distribution in the production unit
- Feed utilisation and procurement
- Feed cost cycles
- Gross income from pig enterprise
- Cash flow analysis
- Feed commodity sensitivity analysis
- Strategy analysis for speculative hedging with Black and Scholes
- Executive summary of model

This model will be used when simulations on real farming data are modelled and scenarios are created to simulate the impact on the pork production unit. The purpose of this form of modelling is to prepare a pork producer to take the necessary action on time to reduce the business's risk exposure in fluctuating market conditions.

CHAPTER 4

FEED INDUSTRY ISSUES AND RISKS FOR PORK PRODUCERS

4.1 INTRODUCTION

The purpose of this chapter is to identify feed-related issues and risks, in combination with the possible impacts that these risks have on a pork producer at farming level, and the South African pork industry. The process of identification is necessary to determine problem areas that need studying in order to better understand the dynamic complexity of the financial impact of these risks to pork producers. The general focus of this study is to minimise the financial risk of a pork producer. This focus can only be achieved when all the risks pertaining to the industry's feed aspect is understood and the associated impacts evaluated and tested. Comprehension of the analysis process with pre-selected research objectives is required before the impacts can be tested and results obtained. Thus, risks within the feed industry need to be understood before it can be included in the scenario analysis of a pork producer's financial position.

Due to the complexity of continuous changing markets, as well as management structures and business models that vary from producer to producer, the focus of this section is to assist in the feed decision-making process of the pork producer by considering relevant information. Contemplating the availability of different feed commodities, constant price changes and new feed mixes, it can become an almost impossible task to study the effect of these changes in its entirety. Hence it is assumed that, as identified for this study, only the applicable risk being tested is allowed to change, while all other factors are kept constant. This identified risk adequately indicates the scale of impact within the pork feed and pork industry structure.

With regard to open market trading and a relative constant pork producer price trend for pork meat over time, as well as cyclical changes, the deregulation in the feed commodity markets (BFAP, 2012), forced producers to comprehend the impact of price movements on their operational structures. This knowledge can place a producer in a strategically positive position to other uninformed producers, considering that the product (pork meat) is produced in a similar way but with different operational outlooks and structures.

4.2 BASIS STUDIES USED FOR THIS CHAPTER

The study by Louw *et al.* (2010) titled "Pork and broiler industry supply chain study with emphasis on feed and feed related issues" forms a basic structure for this chapter. The study made use of different research techniques, including desktop studies, on-farm structured interviews and corporate-level structured interviews with supply-chain stakeholders, statistical analysis and case studies. The study by Louw *et al.* (2010) identified the major issues and risks within the feed and pork industry.

These issues and risks are further explained and the impact of the risks determined at farming level.

In another South African study by Visser (2004), the emphasis is more on the consumer in the supply chain. However, Visser also focused on other critical issues further up the supply chain line that may lead to structural changes within the pork organisation. Visser (2004) stated that "*[p]ig production is a techno-scientific internationalized business that is continuously exposed to changes and risk. Changes in the Agri-Business are inter alia caused by changes in globalization, information technology, biotechnology and changes in consumer trends*". One of the areas that Visser focused on was the pig feeding industry. From this study, it became evident that information, up- and down-stream in the supply chain, forms an intricate role in decision-making. Changes in markets lead to risk, therefore the information presented to decision-makers must be of high quality and reveal an accurate reflection to guarantee a desired outcome.

The Teagasc Pig Production Development Unit published a study on the "*Development strategy for the Irish Pig Industry 2008 to 2015*" (Lynch *et al.,* 2008), with a global focus of where the industry is heading, on a local as well as an international level. The study gives a broad overview of the pork supply chain and focuses on large role-playing countries in the industry, how they operate and how their integral structure is formed. The study also looks at payment systems and performance indicators on pork farms.

These studies form a guideline to issues and trends, as experienced in the South African and international pork and feed industry, that needs to be acknowledged in determining the risk level to pork producers.

4.3 ISSUES WITHIN THE SOUTH AFRICAN FEED AND PORK INDUSTRIES

The following section focuses on the South African pork feed industry, indicating the issues relevant to the industry. These issues form the platform to develop and study new strategic methods to mitigate risk and minimise the impact of these risks for a pork producer.

4.3.1 General feed industry

Louw *et al.* (2010) highlighted a number of issues after interviews with industry role players and participants, as indicated by the South African feed industry. The following issues were singled out for the purpose of this study (Louw *et al.,* 2010):

- "*Management of price volatility of raw ingredients;*
- *Availability of good quality raw ingredients especially soya oil cakes;*
- *High commodity prices;*
- *Procurement of raw ingredients;*
- *Accurate forecasting of prices and demand;*
- *Feed to yield high performance and be cost efficient; and*
- *Constant improvement of feed formulations by food scientists*".

These issues are faced on a daily basis (Louw *et al.* (2010). Large and small feed manufacturers, as well as home mixers, have to manage these issues in order to maintain a competitive edge in this dynamic industry. These issues are included in this study to indicate the current and continuous environment that confronts feed manufacturers on all levels.

For a feed manufacturer to survive in the market, a continuously revised strategic evaluation of the market situation is necessary. New methods to gain and retain a competitive edge in the market must be developed with respect to risk mitigation of prices, improved feed quality, procurement, technological evolution and market information on demand shifts.

The reasons for the required innovative thinking is that the pork feed industry make use of the same raw ingredients as other feed industries, but in different quantities, variations, substitutes and additives. The competition is therefore high and with continuous pressure on issues such as traceability, a feed producer cannot afford to rely purely on public domain information.

Table 4.1 is a summary of feed industry business risks, as compiled by Louw *et al.* (2010). This table gives a broad perspective of some of the risks that feed manufacturers, as well as any person who mixes their own feed or procures premixed feeds, need to consider when making decisions. These risks form part of the reason why the systematic approach to the model was re-designed and studied, i.e., to reveal the sensitivity of a pork producer to changes in applicable commodity markets.

Table 4.1: Feed industry business risks

Risk	Risk Background
Risk at Micro-level	
Operational Risk	
Food safety	This is an international and domestic requirement. It impacts on business, consumers and suppliers and requires necessary control systems to be in place.
Product Market Risk	
Supply decreases	The supplier base can decrease which poses a serious risk that needs to be dealt with. A loss of consistent quality and quantity in terms of suppliers can lead to the market becoming stagnated and predictable. With the recent increases in production costs, the lack of sufficient supply becomes a reality.
Sudden demand changes	The demand for produce can change significantly in a short period of time. This creates risk in terms of adequate supply of produce and supply shortages. For example, the day to day sales of produce can change dramatically: on a specific day one unit of a specific produce can be sold, while forty units of the same produce can be sold the next day.
Price volatility	This is a function of global prices and seasonality, inconsis-tent supply of quality and quantity impacts on the risk of stakeholders on the market.
Lack of innovation and differentiation of products	The value-adding, processing and branding of all products needs to be in line with the developments and changes of consumer trends – risk if not done.
Financial risk	
Interest rate changes	Sudden changes in interest rates create risks in terms of credit repayment
Capital cost changes (interest costs)	Capital cost can change or increase, which creates a risk in terms of adequate capital resources necessary to expand.
Default on debt	Depending on financial structuring, a default on debt is possible, due to the abovementioned risks.
Control of overheads	The risk of not controlling overheads can lead to deficiencies in functioning and service levels.
Cash flow problems	Out of cash or cash flow problems can lead to management problems, payment problems, loss of suppliers, problems with service delivery, security, etc.
Input Risk	
Supplier failure	The supplier base should be protected. It could imply contracting. Trust is required in the system with regard to infrastructure/logistics, price, information, demand and payment on time.

Source: Louw *et al.* (2010)

With reference to feed producers, Table 4.2 is an extract from the study by Louw *et al.* (2010), indicating the impact of the risk on, and its probability of occurrence in the industry, and the scale of the impact with respect to other risks, as indicated by participants in the study. From the table, the following risks can be classified as high priority risks for feed producers, in order of standardised scales of impact:

1. Price volatility of feed
2. Finances and economical
3. Power outages
4. Political
5. Customer demand for product, competition and supply

From a feed producer's perspective, these issues have a major impact on the way business is conducted. Of these major issues in the industry, the risks that feed producers have very little, or no control over are the political stability [instability] and the state of the local and global economy. According to the table, the risk that has as a major influence in decision-making is the price volatility of feed.

Table 4.2: Risk impact assessment from the feed manufacturer's perspective

Risk	Impact (5=high-1=low)	Probability (%)	Standardised scale of impact
Political	***3.7***	***58***	***214.6****
Financial & economic	***4***	***74***	***296****
Labour skills	2.8	48	134.4
Labour strikes	4	30	120
Business	2.5	40	100
Price volatility of feed	***4.5***	***86***	***387****
Food safety	4.3	30	129
Power outages	***4.2***	***64***	***268.8****
Inventory	3.8	42	159.6
Theft & security	1.5	42	63
Disposable income of consumer	2	50	100
Customer, competition & supply	***3***	***64***	***192****
Environmental (e.g. waste management)	1.8	26	46.8

Source: Louw *et al.*(2010)

4.3.2 Pork feed industry

Louw *et al.* (2010) raised certain issues, as indicated by the South African pork and pork feed industry and highlighted after interviews with industry role players and participants. Some of these issues were singled out for the purpose of this study (Louw *et al.* (2010):

- “Quality of raw feed ingredients;
- Feed raw material price volatility;
- Market access for non-contract producers;
- Managing cash flow in this industry. Unlike with the [e.g.] broiler growers, own feed mixers and even premixed purchases must be paid before remuneration is received by the producer for pigs delivered;
- Availability, price and quality of fishmeal;
- Transportation of pigs as well as raw feed ingredients;
- Quality of soya, and the concern that most soya oilcakes must be imported. Many producers feel that the quality of South African soya oilcakes is not up to standards with international imports;
- Performance of pre mixed feeds”.

From these issues, it is apparent that pork producers face difficulties on a day to day basis with respect to feed commodities, prices and quality. Cash flow management and/or the lack of cash flow contribute to difficult decision-making and growing of the business. Apart from contractual supply, no contract growing agreements was found currently exist in the pork industry in South Africa as in the case with broiler production.

In the broiler industry, for example, a contract grower is supplied with pre-mixed feed at a certain contracted price. After the cycle of broilers is delivered to the abattoir and all costs deducted for feed, chicks and operational costs, the farmer receives his portion of the profit/loss. However, the producers in the pork industry are totally independent and must rely on their own financial facilities to produce a cycle of pork produce and continue to make a sustainable profit.

The risks of mixing feed themselves on a day to day basis, with respect to prices and quality/availability of feed, forces the producer to adapt his risks and risk mitigation strategies, or take the risk of making a loss and possibly lose the business.

Table 4.3 is another extract from the study by Louw *et al.* (2010), once again indicating the impact of the risk on, and its probability of occurrence in the industry and the scale of the impact with respect to other risks, as indicated by participants in the study but, this time, with regard to pork producers,. From the table, the following risks can be classified as high priority risks for pork producers, in order of standardised scales of impact:

1. Price volatility of feed
2. Financial and economical
3. Political

From a pork producer's perspective, these issues also have a major impact on the way they conduct business. Pork producers also have very little or no control over the political stability [instability] and the state of the local and global economy. From the table, the risk that poses a major influence to decision- making is, once again, the price volatility of feed. The risk of disease outbreak was not included in this study but is also of high importance to the industry.

Table 4.3: Risk impact levels and probabilities for pork producers

Risk	Impact (5 high-1 low)	Probability (%)	Standardised scale of impact
Political	***3.2***	***42***	***134****
Financial & economic	***3.4***	***66***	***227****
Labour skills	2.9	30	86
Labour strikes	3.0	20	60
Business	2.5	38	95
Price volatility of feed	***4***	***64***	***256****
Food safety	2.9	33	95
Power outages	2.8	37	102
Inventory	2.2	37	81
Theft & security	2.3	34	77
Disposable income of consumer	2.2	27	59

Risk	Impact (5 high-1 low)	Probability (%)	Standardised scale of impact
Customer, competition & supply	2.4	38	93
Environmental (e.g. waste management)	2.6	34	88

Source: Louw *et al.*(2010)

Visser (2004) also indicated that feeding and the quality of feed plays an important role in overall profitability. Other issues that were raised were: "... *the effect of nutrients on profitability, performance, animal welfare, environmental pollution, health and meat quality"* Visser (2004).

Two factors that Visser (2004) noted to be huge financial issues are the maize price fluctuations and the fact that a major component of RSA protein sources needs to be imported. Without a direct connotation, the rand/dollar volatility and instability of the global economy further influences the pork industry.

As quoted from Lynch *et al.* (2008), "*There is need for a market and policy analysis and strategic forecasting service including international benchmarking of productivity and production costs that would help producers make better informed business decisions"*.

In their study, the fluctuation in commodity prices, without a correlated response in the pork meat price, leads to a situation where producers are faced with bearing costs without proper compensation.

4.3.3 Procurement-related issues of raw feed commodities

In the study by Louw *et al.* (2010), the concerns were raised that, due to the scale at which raw feed commodities are purchased, there has to be a mechanism in place to regulate and govern volumes and prices. Louw *et al.* (2010) indicated that more that 60 percent of raw feed commodities are managed through contractual agreements on the SAFEX grain market. Within this system, quality, quantity, availability and prices can be electronically negotiated and hedged on the free trade market.

The advantages of these agreements are that prices, as well as quantity and quality, can be contractually secured and risks thus managed and hedged in these volatile markets. With the added advantages of different contractual agreements and option contracts, a feed procurer can engage in hedging to increase profit margins within limits. During delivery month, a feed manufacturer waits for a silo certificate to be allocated to him/her, after which he/she becomes the owner of the commodity in the allocated silo. It then becomes the responsibility of the feed manufacturer to transport the commodity to the plant/farm.

Disadvantages of this system are that, because buyers and sellers do not know one another and locations are sometimes far apart, unnecessary transportation and insurance costs are incurred, risks of theft or accidents during transportation are run, and loss suffered due to the possibility of rotting if raw feed ingredients are exposed to water or damp conditions.

By-products, such as bran and chop, are mainly sourced from the milling industries on a spot-price basis (spot price refers to the price as traded on the day of enquiry). However, associated risks are that the prices are derivatives of the grain markets and cannot be hedged on SAFEX. Quality and availability of these by-products can also not be guaranteed.

The continuous change of feed formulations can be to the advantage of pork producers and the feed industry in circumstances of changing input prices, as they can be substituted with cheaper, more available feed ingredients. This form of risk mitigation is called “active feed formulation”. Viljoen (2011) explains it as lowering ration costs by substituting too expensive feed ingredients in a specific ration with cheaper ingredients with limited change in nutritional value. However, with any change in feed rations, animals need time to adjust to a new feed formula, therefore a period of lower than usual growth can be experienced.

Disadvantages are that, with the new feed regulations, feed mixtures must be registered for the purpose of quality and tractability before being sold commercially. A pork producer who mixes on a smaller scale can overcome this situation, because the feed that he/she mixes is for his/her own use.

However, feed rations must only be changed by a feed nutritionist. As indicated by Visser (2004), most of the South African vitamins used in pre-mixes are mainly imported from countries such as the United States, Europe, Japan and China.

4.3.4 Volatility within the feed commodity industry

Volatility is defined as: "... *as a measure of risk in financial markets. It can estimate how far prices move or, alternatively, how far they are expected to move in a given time frame"* JSE (2012)

As explained by the JSE (2012), there is a 'lack of fear" in periods of low volatility, which suggests that investors feel that the market is steady and risks can be taken without the supposed fear of loss. However, during a period of high volatility, the market seems fearful and high and low price ranges can be observed. In the absence of volatility in markets, there is no reason for investors to seek an arbitrage opportunity to hedge and make a profit/loss, or to protect themselves from price fluctuations amidst seasonal changes and fundamental factors that affect market conditions.

Jordaan, Grove, Jooste and Alemu (2007) studied the true stochastic components (by using different statistical techniques) in the price of maize, wheat, sunflower and soybeans to give decision-makers in the industry a better understanding of the price risks involved in theses commodity markets. Price ranges were tested for the periods: 1997-2006 (maize and wheat), 2000-2006 (sunflower) and 2002-2006 (soybeans). The results showed that the levels of price volatility of only maize (white and yellow) and sunflower changed over the particular test time periods. The associated price risks were therefore found to be higher for the maize and sunflower markets than for the wheat and soybean markets.

With reference to the South African maize and wheat market on the SAFEX grain markets, Geyser and Cutts (2007) concluded in a study that the fundamental factors that drive these markets are mainly the Chicago Board of Trade (CBOT), the Rand/Dollar exchange rate, weather patterns and the domestic stock levels.

Geyser and Cutts (2007) also indicated that, for the test time period (2001-2006), SAFEX markets showed more volatility than other markets. From their study, it became apparent that white maize tends to be more volatile than yellow maize which is mainly used in the animal feed industry, when compared to the CBOT commodities market. For the purpose of this study, volatility will not be calculated but used as provided by SAFEX.

Huchet-Bourdon (2011) from the OECD questioned whether the price volatility in agricultural commodities increased over the past fifty years to possibly lead to more rapid price ranges, given the trend in the future. Huchet-Bourdon (2011) found that, there is not much difference in the present price volatility (the variation in volatility on a daily basis) compared to fifty years ago. With the exception of wheat, the price volatility of commodities at the time of the study was found to be higher than in the nineties but not higher than in the seventies.

From the study by Louw *et al.* (2010), Table 4.4 indicates how pork and feed producers perceive the impact that price volatility of different major raw feed commodities have on their operational business structure. The ranks in the table are based on five (5) for high and one (1) for low.

From the table, it is apparent that maize, soya and sunflower are the most important commodities with the highest impact on feed users. As indicated earlier in this study, more than 80 percent of the volume and cost of feed rations consist of these feed commodities.

Table 4.4: Impact measurement of price volatility on commodities

Commodity	Average rank
Maize	4.8
Soya	4
Sunflower	3.75
Vitamins	3
Additives	3
Other	2.5

Source: Louw *et al.* (2010)

4.4 CONCLUSION

Risks associated with the general feed and pork feed industry need to be understood before a strategic plan can be developed and these risks can mitigate the financial exposure to pork producers. In die feed industry, the following risks were classified as high priority, namely price volatility of feed commodities, finances and economic changes, power outages, political [instability], customers, competition and supply.
In the pig industry in South Africa, risks classified as priority were price volatility of feed commodities, financial and economic instability, and political risk. Visser (2004) also concluded that these issues, along with the effect of nutrients on profitability, performance, animal welfare, environmental pollution, health and meat quality, need to be accounted for during decision-making.

Procurement of feed commodities can give a home feed mixer an advantage, by procuring commodities in the desired quantities/qualities/prices, as required.

However, the scale at which some of these commodities are required can be a disadvantage, due to the fact that the economy of scale is lacking. The Rand/Dollar exchange rate further complicates matters because of protein sources and world stock levels that are sourced internationally and certain additives that are only available from foreign countries.

Price volatility, in especially the grain market, poses another risk that needs to be factored into decision-making and strategic planning processes. The SAFEX market had more volatility in prices over the test time period than other leading markets such as CBOT. The higher the volatility of a commodity, the more fear tends to be in that market, which leads to an increase in risk.

CHAPTER 5

PRICE SENSITIVITY OF DIFFERENT FEED COMMODITIES

5.1 INTRODUCTION

The focus of the previous chapter was to illustrate which factors impact on the profitability of a pork producer. It became evident that price volatility of basic feed commodities has the largest direct impact on the financial, procurement and management of a pork production unit of any size. Commodities that were rated to have the most significant impact on the feeding aspect of a pork producer, with respect to the volatility in prices, were maize, soya and sunflower.

This chapter focuses on the direct impact or scale that the change in price levels and thus the associated risks have on a pork producer. For the purpose of illustration, a representative medium-sized pork unit is used against a predetermined set of prices and operational criteria. The purpose of this chapter is to determine the direct impact or scale that feed commodity costs have on a pork producer, given the quantities needed and the price volatility that occurs on a daily basis.

5.2 ASSUMPTIONS USED FOR ILLUSTRATIVE PURPOSES

The following assumptions were used to identify and illustrate the impact that changing prices have on a pork production unit. These assumptions[13] formed the basis of all sensitivity analyses:

- Sow production unit of 500[14] production sows
- Yellow maize price SAFEX: R1 700[15]/ton – 1 422 tons consumed/year

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[13] Substitutes were not included to test the change of prices in a normal feed ration.

[14] In the study by Visser (2004), a pork production size of 500 sows was also used as a representative medium pork unit.

- Soya oil cake price: R4 000/ton – 348 tons consumed/year
- Sunflower oil cake price: R4 300/ton – 158 tons consumed/year
- Soya full fat price: R4 400/ton – 78 tons consumed/year
- Wheat bran price: R1 200/ton – 266 tons consumed/year
- Income per year: R11 700 000[16]

5.3 PRICE AND INCOME ELASTICITY

Before the application of price sensitivity can be implemented in a pork-based industry, the concept of price elasticity must firstly be explained. According to Penson *et al.* (2006) mainly three types of elastic configurations are used, but not limited to agriculture. These elasticity's are:

- Own-price elasticity – measures the sensitivity change in the price of a specific product;
- Income elasticity – measures the sensitivity to change in income; and
- Cross-price elasticity – measures the sensitivity in changing prices for two substitute, complimentary or independent products.

These configurations indicate the scale or impact that price changes in supply/demand have on the price of products/inputs as well as on the income or revenue generated.

Penson *et al.* (2006) also distinguish between **arc elasticity** (measuring price elasticity between two points on the demand curve) and **point elasticity** (measuring elasticity only at one point of the demand curve) by converting the original formula.

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[15] Prices of commodities used in this chapter are based on an average price and are explained in the next chapter.

[16] Based on farming income per annum at average prices for porkers, baconers, old sows and boars. Sales of genetics were excluded for the purpose of this study.

The formula for point price elasticity is given by Ferris (2005) as:

$$(\Delta P/P)\ (\Delta Q/Q) = (\Delta P\ \Delta Q)*(Q/P)$$

where a change in the price of the product over the base price is divided by the change in the quantity of the product over the original quantity.
To measure the sensitivity that feed commodities have on the gross income (income minus feed cost at a predetermined price for commodities and quantity level), the principal of price elasticity is used, by applying changes in commodity prices over changes in the gross income.

The sensitivity of yellow maize, soya (full fat and oil cake), and sunflower and wheat bran was tested to determine the impact that these commodities individually contribute to the overall feed cost in a pork unit. The principal of *ceteris paribus* is applied, where only the applicable variable or commodity is tested while keeping the other variables constant.

The point elasticity formula used for the sensitivity calculations is:

$$(\Delta P/P)\ (\Delta GI/GI) = (\Delta P\ \Delta GI)*(GI/P)$$

where P represents the price per ton of the commodity and GI represents the gross income for the pork production unit per year.

The following sections illustrate the results and findings of the purpose and rationale behind the identification and testing of these impact multipliers on a typical pork production unit and the pork industry of South Africa.

5.4 PRICE ELASTICITY GIVEN DIFFERENT FEED COMMODITIES

Based on the assumption criteria previously indicated in this chapter, feed commodities that were tested to determine the impact of changing prices on a pork producer were based on the principal of volume and specific commodity cost distribution.

In Annexure 1, the four commodities explained below, are indicated with different price ranges, and for each price range the sensitivity as well as the point elasticity was calculated. It was clear that, as commodity prices increase, the sensitivity decreases and the price elasticity increases. This occurs because the commodity price change (if held constant) reduces in percentage.

Annexure 1 reflects a farm-based scenario where all feed costs were included at the price levels given in the mentioned assumptions. Only the indicated commodity was allowed to change in order to observe the impact of the specific commodity on a production unit. The volume consumed for this unit as predetermined was also held constant over the tested price range.

Figure 5.1 illustrates the percentage distribution of costs associated with different feed commodities that, in combination, form the rations for the different feeds used in a piggery.

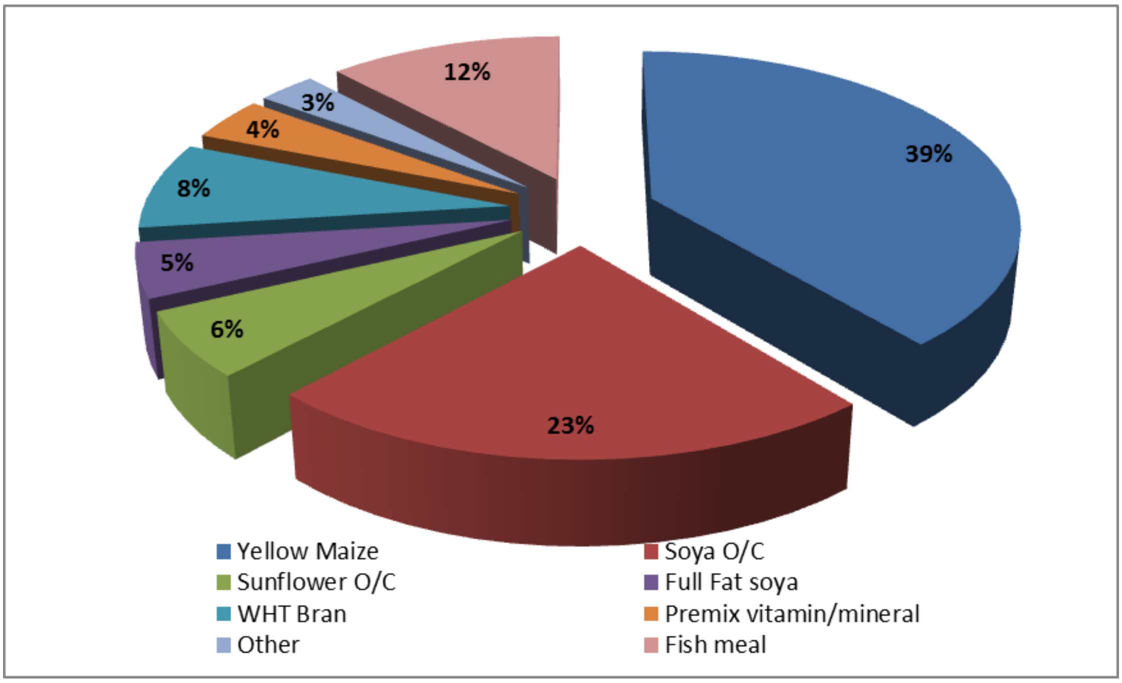

Figure 5.1: Percentage distribution of feed cost for a pork producer
Source: Own calculations

From the figure, the feed commodities that contribute more than 80 percent of the total feed costs are:

- Yellow maize – 39%;
- Soya oil cake (O/C) – 23%;
- Sunflower oil cake (O/C) – 6%;
- Soya full fat (FF) – 5%; and
- Wheat bran – 8%.

Fish meal, with a contribution of 12 persent of this ration, was excluded from the calculations, due its high and relative constant cost and the fact that it can easily be substituted by other protein commodities. Fishmeal is sometimes also difficult to obtain in the required quality and price.

Figure 5.2 illustrates the percentage distribution of the volume associated with different feed commodities that, in combination, form the rations for the different feeds used in a piggery.

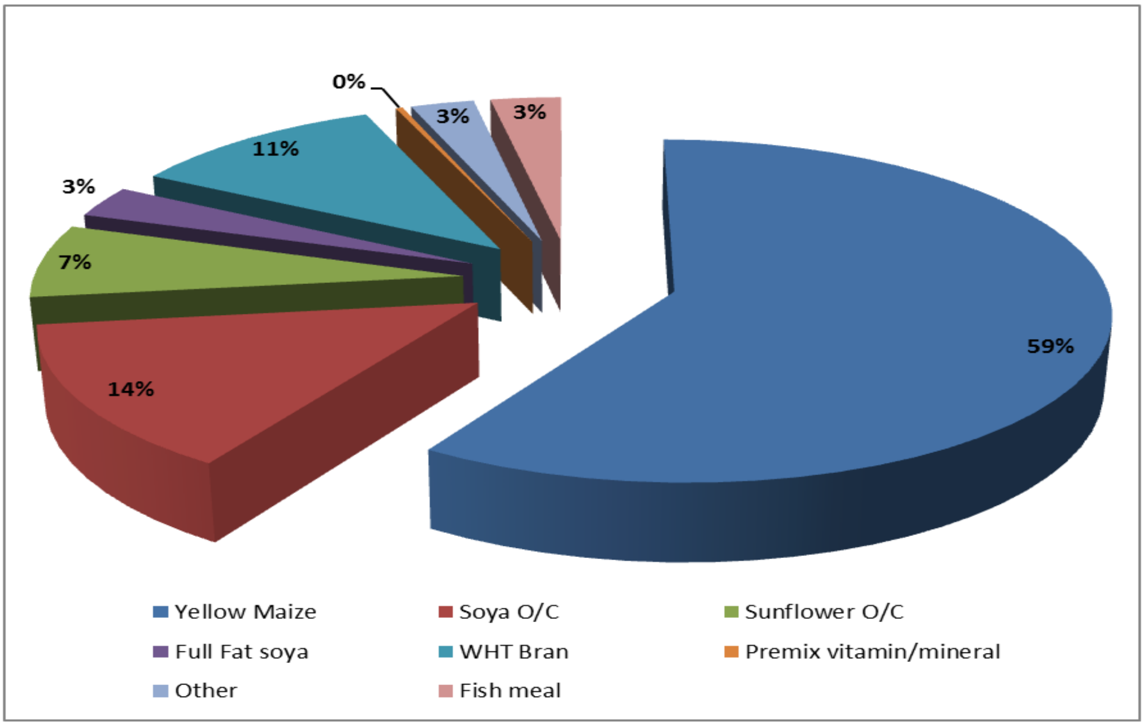

Figure 5.2: Percentage distribution of feed volume for a pork producer
Source: Own calculations

From the figure, the feed commodities that contribute more than 90 percent of the total feed volume are:

- Yellow maize – 59%;
- Soya oil cake (O/C) – 14%;
- Sunflower oil cake (O/C) – 7%;
- Soya full fat (FF) – 3%; and
- Wheat bran – 11%.

The following section will explain the elasticity properties for each of these commodities in a typical pork production unit. Annexure 1 gives a detailed output of price point elasticities for these commodities at different possible price ranges.

5.4.1 Yellow maize price elasticity

Table 5.1 shows the changes in income and the elasticity in price, given a specific point in the price spread at different price levels. For this application, a price for yellow maize was selected at R1 700/ton. The point elasticity at this price level was calculated at -0.26, thus, if the price of yellow maize changes by one (1) percent, the income-commodity cost will change by 0.26 percent in the opposite direction. This calculation is in line with expectations that, as a commodity price increases, the demand as well as the income distribution will decrease. For example, if the price of yellow maize increases by R100/ton, the income-commodity cost will decrease by 1.53 percent or R142 200 per year.

Table 5.1: Yellow maize price elasticity

YMAZ								
Sow Unit	500							
M-Q/Year(Tons)	1422							
Income per Year	R 11 717k							
R 100	R 1 300	R 1 400	R 1 500	R 1 600	R 1 700	R 1 800	R 1 900	R 2 000
Price Change %	-24	-18	-12	-6	0	6	12	18
Maize price *tons	R 1 848k	R 1 990k	R 2 133k	R 2 275k	R 2 417k	R 2 559k	R 2 701k	R 2 844k
Net Change	R 568k	R 426k	R 284k	R 142k	R 0	-R 142k	-R 284k	-R 426k
Income-Maize cost	R 9 869k	R 9 727k	R 9 584k	R 9 442k	R 9 300k	R 9 158k	R 9 016k	R 8 873k
Income Change %	6.12	4.59	3.06	1.53	0.00	-1.53	-3.06	-4.59
Elasticity %	-0.260	-0.260	-0.260	-0.260	#REF!	-0.260	-0.260	-0.260

Source: Own calculations

Figure 5.3 illustrates the point elasticity and the sensitivity of the gross income of a pork production unit, given different price spreads of the yellow maize market. The graph indicates how elastic and sensitive the gross income of a pork producer's financial position is, considering changes in the purchase price of the usage volumes of the commodity, as required on an annual basis. The graph has been scaled up to illustrate the range that yellow maize prices can vary before a negative gross income distribution is reached.

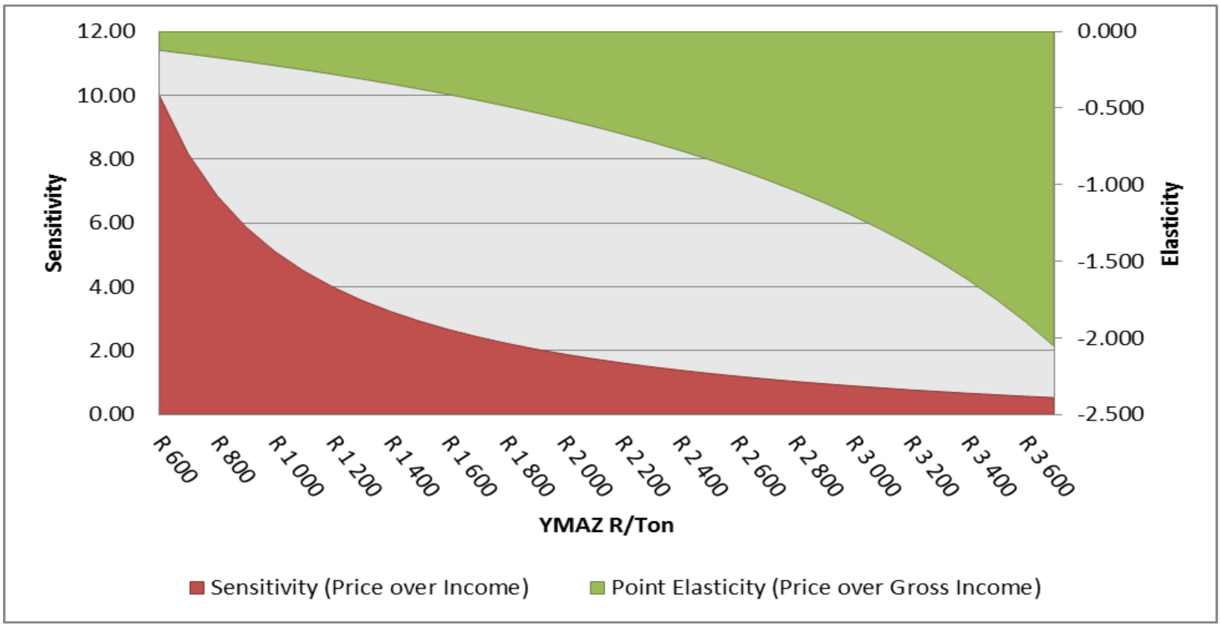

Figure 5.3: Yellow maize price point elasticity and sensitivity

Source: Own calculations

The sensitivity of this specific pork unit indicates a break-even price of R5 720/ton when only feed cost is considered and all other costs are held constant. In alliance with a specific pork producer's financial position, the price level of this commodity will vary when a substitute energy source, that may be cheaper than yellow maize, is used. This margin level can be predetermined and monitored to indicate to a producer when profit levels are undesirable and needs to be addressed accordingly.

5.4.2 Soya oil cake and full fat price elasticity

Table 5.2 and Table 5.3show the changes in income and the elasticity in price, given a specific point in the price spread at different price levels. For this application, a price for soya oil cake and full fat were selected at R4 000 and R4 400/ton, respectively. The point elasticity at this price level was calculated at -0.135 for soya oil cake and -0.030 for full fat soya.

If the price of soya oil cake changes by one (1) percent, the income-commodity cost will change by 0.14 percent in the opposite direction. This calculation is in line with expectations that, as a commodity price increases, the demand as well as the income distribution will decrease. For example, if the price of soya oil cake increases by R100/ton, the income-commodity cost will decrease by 0.34 percent or R34 800 per year.

If the price of soya full fat changes by one (1) percent, the income-commodity cost will change by 0.03 percent in the opposite direction. This calculation is in line with expectations that, as a commodity price increases, the demand as well as the income distribution will decrease. For example, if the price of soya full fat increases by R100/ton, the income-commodity cost will decrease by 0.07 percent or R7 800 per year.

Table 5.2: Soya oil cake price elasticity

SOYA O/C	[redacted]							
Sow Unit	500							
Q/Year(Tons)	348							
Income per Year	R 11 717k							
R 100	R 3 600	R 3 700	R 3 800	R 3 900	R 4 000	R 4 100	R 4 200	R 4 300
Price Change %	-10	-8	-5	-3	0	2	5	8
Price *tons	R 1 252k	R 1 287k	R 1 322k	R 1 357k	R 1 392k	R 1 426k	R 1 461k	R 1 496k
Nett Change	R 139k	R 104k	R 69k	R 34k	R 0	-R 34k	-R 69k	-R 104k
Income-Soya O/C cost	R 10 465k	R 10 430k	R 10 395k	R 10 360k	R 10 325k	R 10 291k	R 10 256k	R 10 221k
Income Change %	1.35	1.01	0.67	0.34	0.00	-0.34	-0.67	-1.01
Elasticity %	-0.135	-0.135	-0.135	-0.135	#REF!	-0.135	-0.135	-0.135

Source: Own calculations

Table 5.3: Soya full fat price elasticity

SOYA FF	[redacted]							
Sow Unit	500							
Q/Year(Tons)	78							
Income per Year	R 11 717k							
R 100	R 4 000	R 4 100	R 4 200	R 4 300	R 4 400	R 4 500	R 4 600	R 4 700
Price Change %	-9	-7	-5	-2	0	2	5	7
Price *tons	R 312k	R 319k	R 327k	R 335k	R 343k	R 351k	R 358k	R 366k
Nett Change	R 31k	R 23k	R 15k	R 7k	R 0	-R 7k	-R 15k	-R 23k
Income-Soya FF cost	R 11 405k	R 11 398k	R 11 390k	R 11 382k	R 11 374k	R 11 366k	R 11 359k	R 11 351k
Income Change %	0.27	0.21	0.14	0.07	0.00	-0.07	-0.14	-0.21
Elasticity %	-0.030	-0.030	-0.030	-0.030	#REF!	-0.030	-0.030	-0.030

Source: Own calculations

Figure 5.4 illustrates the point elasticity and the sensitivity of the gross income of a pork production unit, given different price spreads of the combined soya commodity market. The graph indicates how elastic/inelastic and sensitive the gross income of a pork producer's financial position is, given changes in the purchase price of the commodities used, as required on an annual basis.

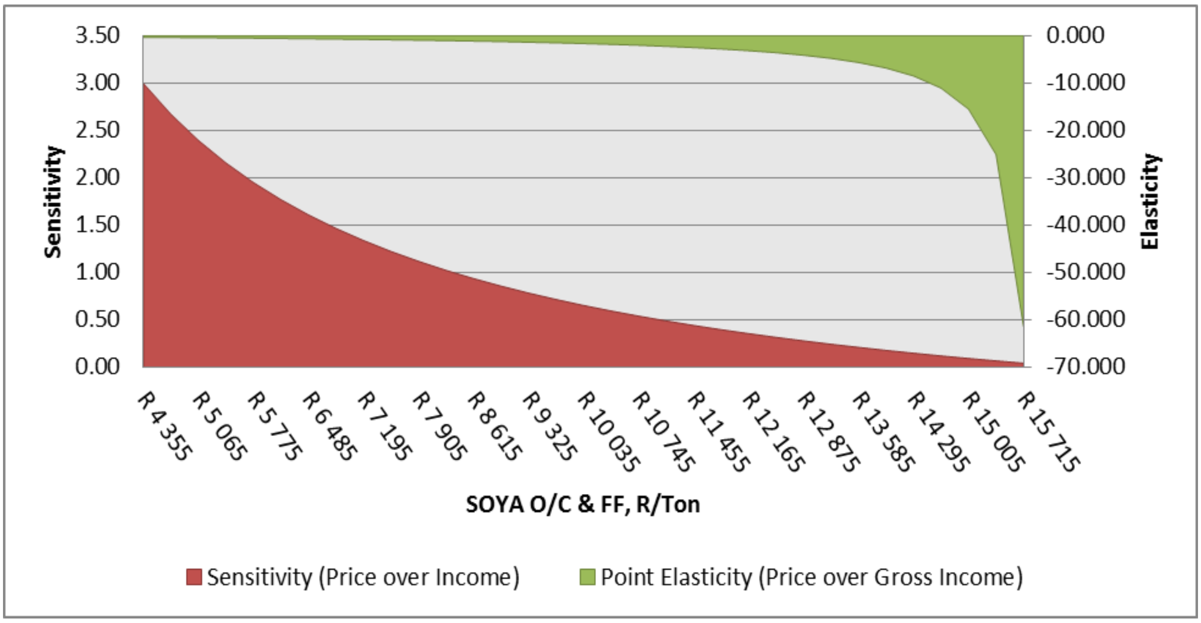

Figure 5.4: Combined soya oil cake and full fat point elasticity and sensitivity price

Source: Own calculations

The sensitivity of this specific pork unit indicated a break-even price of R17 600/ton, when only feed cost was considered and all other costs were held constant. In alliance with a specific pork producer’s financial position, the price level for this commodity will vary when a substitute protein source (for example fish meal) is used, that may be cheaper than soy products. This margin level can be predetermined and monitored (early warning approach) to indicate to a producer when profit levels are undesirable and need to be addressed accordingly.

5.4.3 Sunflower oil cake price elasticity

Table 5.4 shows the changes in income and the elasticity in price, given a specific point in the price spread at different price levels. For this application, a price for sunflower oil cake was selected at R4 300/ton. The point elasticity at this price level was calculated at -0.062, thus, if the price of sunflower oil cake changes by one (1) percent, the income-commodity cost will change by 0.06 percent in the opposite direction. This calculation is in line with expectations that, as a commodity price increases, the demand as well as the income distribution will decrease. For example, if the price of sunflower oil cake increases by R100/ton, the income-commodity cost will decrease by 0.14 percent or R15 800 per year.

Table 5.4: Sunflower oil cake price elasticity

SUNS O/C								
Sow Unit	500							
Q/Year(Tons)	158							
Income per Year	R 11 717k							
R 100	R 3 900	R 4 000	R 4 100	R 4 200	R 4 300	R 4 400	R 4 500	R 4 600
Price Change %	-9	-7	-5	-2	0	2	5	7
Price *tons	R 616k	R 632k	R 647k	R 663k	R 679k	R 695k	R 711k	R 726k
Nett Change	R 63k	R 47k	R 31k	R 15k	R 0	-R 15 k	-R 31k	-R 47k
Income-Sunflower O/C cost	R11 101k	R 11 085 k	R 11 070k	R 11 054k	R 11 038k	R 11 022k	R 11 006k	R10 991k
Income Change %	0.57	0.43	0.29	0.14	0.00	-0.14	-0.29	-0.43
Elasticity %	-0.062	-0.062	-0.062	-0.062	#REF!	-0.062	-0.062	-0.062

Source: Own calculations

Figure 5.5 illustrates the point elasticity and the sensitivity of the gross income of a pork production unit, given different price spreads of the sunflower oil cake commodity market. The graph indicates how elastic/inelastic and sensitive the gross income of a pork producer's financial position is, given changes in the purchase price of the commodities used, as required on an annual basis.

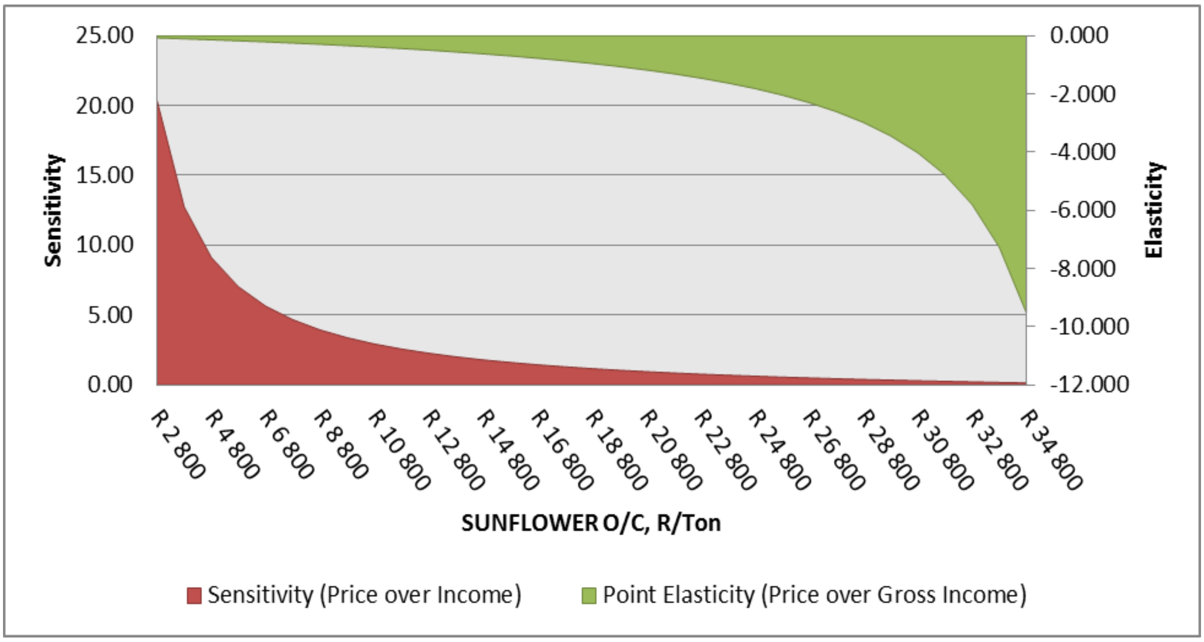

Figure 5.5: Sunflower oil cake price point elasticity and sensitivity

Source: Own calculations

The sensitivity of this specific pork unit indicated a break-even price of R39 000/ton, when only feed cost is considered and all other costs are held constant. In accordance with a specific pork producer's financial position, the price level for this commodity will vary when a substitute protein source (for example fish meal/soy) is used, that may be cheaper than sunflower products. This margin level can be predetermined and monitored to indicate to a producer when profit levels are undesirable and need to be addressed accordingly.

5.4.4 Wheat bran price elasticity

Table 5.5 shows the changes in income and the elasticity in price, given a specific point in the price spread at different price levels. For this application, a price for wheat bran was selected at R1 200/ton. The point elasticity at this price level was calculated at -0.03, thus, if the price of wheat bran changes by one (1) percent, the income-commodity cost will change by 0.03 percent in the opposite direction. This calculation is in line with expectations that, as a commodity price increases, the demand as well as the income distribution will decrease. For example, if the price of wheat bran increases by R100/ton, the income-commodity cost will decrease by 0.23 percent or R26 600 per year.

Table 5.5: Wheat bran price elasticity

WHT Bran	[redacted]							
Sow Unit	500							
Q/Year(Tons)	266							
Income per Year	R 11 717k							
R 100	R 800	R 900	R 1 000	R 1 100	R 1 200	R 1 300	R 1 400	R 1 500
Price Change %	-33	-25	-17	-8	0	8	17	25
Price *tons	R 212k	R 239k	R 266k	R 292k	R 319k	R 345k	R 372k	R 399k
Nett Change	R 106k	R 79k	R 53k	R 26k	R 0	-R 26k	-R 53k	-R 79k
Income-Wheat Bran cost	R 11 505k	R 11 478k	R 11 451k	R 11 425k	R 11 398k	R 11 372k	R 11 345k	R 11 318k
Income Change %	0.93	0.70	0.47	0.23	0.00	-0.23	-0.47	-0.70
Elasticity %	-0.028	-0.028	-0.028	-0.028	#REF!	-0.028	-0.028	-0.028

Source: Own calculations

Figure 5.6 illustrates the point elasticity and the sensitivity of the gross income of a pork production unit, given different price spreads of the wheat bran commodity market. The graph indicates how elastic/inelastic and sensitive the gross income of a pork producer's financial position is, given changes in the purchase price of the commodities used, as required on an annual basis.

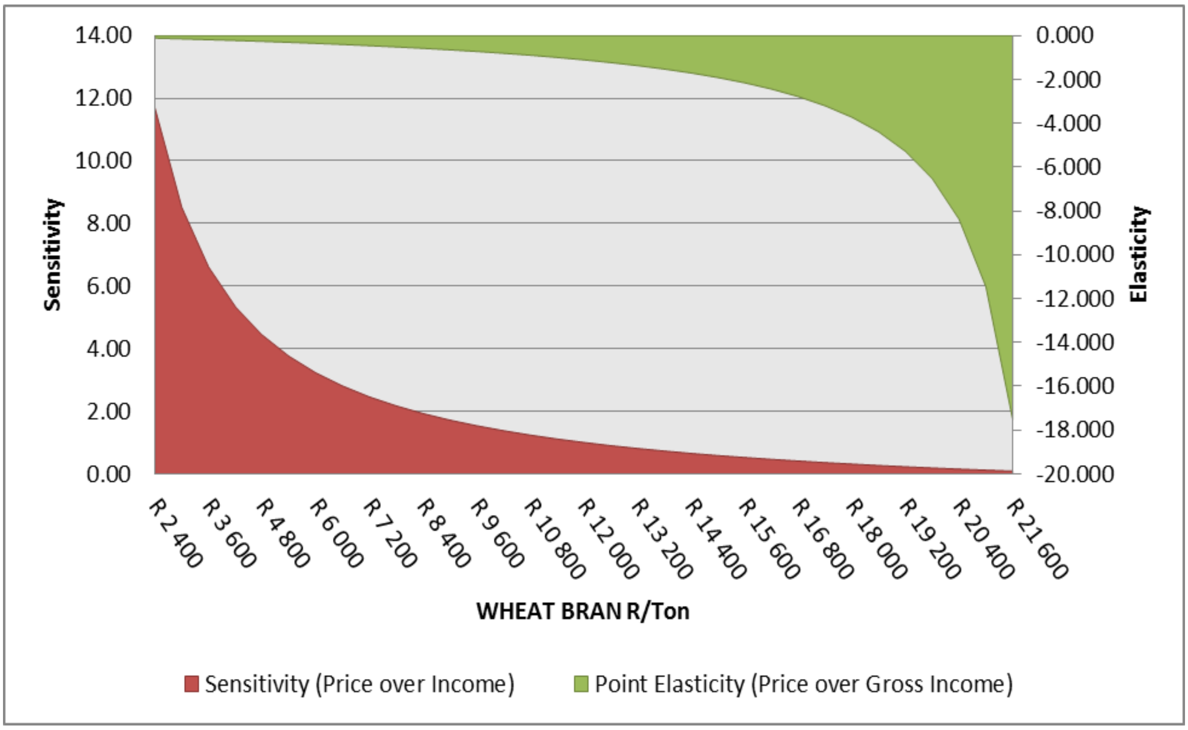

Figure 5.6: Wheat bran price point elasticity and sensitivity
Source: Own calculations

The sensitivity of this specific pork unit indicated a break-even price of R23 750/ton, when only feed cost is considered and all other costs are held constant. In alliance with a specific pork producer's financial position, the price level for this commodity will vary when a substitute energy source is used, that may be cheaper than wheat bran. This margin level can be predetermined and monitored to indicate to a producer when profit levels are undesirable and need to be addressed accordingly.

5.5 PRICE IMPACT ON A PORK UNIT

Commodity prices change constantly on a daily basis and it becomes a difficult time for a pork producer to make decisions to the benefit of his business. Table 5.6 shows what could possibly happen to a producer's annual income when feed commodity prices, as discussed above, change up- or downwards. A scenario was used where income was held constant, while maize, soya, sunflower and wheat products were allowed to change equally to simulate moving market conditions, given a starting price as in the assumptions.

Table 5.6: Gross income change

% change	-25%	-20%	-15%	-10%	-5%	0%	5%	10%	15%	20%	25%
Total feed cost	R5025k	R5283k	R5541k	R5798	R6056k	R6314k	R6571k	R6829k	R7087k	R7345k	R4702k
Income-cost	R6693K	R6435k	R6177k	R5920k	R5662k	R5404k	R5146k	R4889k	R4631k	R4373k	R4116
Gross income %	57.11	54.91	52.72	50.52	48.32	46.12	43.92	41.72	39.52	37.32	35.12
Change in gross income%	11.00	8.80	6.60	4.40	2.20	0	-2.20	-4.40	-6.60	-8.80	-11.00

Source: Own calculations

Earlier in this study, it was determined that feed cost make up around 70 percent of production and operational cost. Table 5.6 shows how the gross income reacts according to different price changes. For a 5 percent movement in commodity prices, the gross income change by 2.2 percent. For example, if the price decreases while income is kept constant, a producer receives more revenue than originally budgeted for. However, if feed cost increases by 25 percent, gross income will decrease by 11 percent to a critical break-even percentage of 35 percent.

This 35 percent can be interpreted as the only percentage of total income that can be allocated to operational cost, capital expansion and repayments, and living cost. Chapter 6 indicates the up- and downward price movements and the possibility for a South African pork producer to be exposed to the different market conditions.

5.6 CONCLUSION

The focus of Chapter 5 was on the direct impact or scale that commodity price fluctuations have on a pork producer and its financial position. For the purpose of illustration, a standardised 500 sow pork unit was used against a predetermined set of prices and operational criteria. The purpose of this chapter was to determine the direct impact or scale that feed commodity cost has on a pork producer, considering the required quantities and prices due to volatility market changes.

To measure the sensitivity that feed commodities have on the gross income (income minus feed cost at a predetermined price for commodities and quantity level), the principal of price elasticity was used, by applying changes in commodity prices over changes in the gross income. The sensitivity of yellow maize, soya (full fat and oil cake), sunflower and wheat bran was tested to determine the impact that these commodities individually contribute to the overall feed cost in a pork unit. The principal of *ceteris paribus* applied, where only the applicable variable or commodity was tested, while the other variables were kept constant.

From the price and volume distribution, the four commodities that contributed more than 80 percent of the total feed cost and volume were yellow maize, soya oil cake/full fat, sunflower oil cake and wheat bran. From the price elasticity and sensitivity calculations and evaluations, it became clear that volume, in conjunction with commodity cost, are important considerations that decisions from a managerial perspective can be based on. A pork producer can choose to be price elastic/inelastic at the levels of sensitivity towards price changes, given his preference to risk.

From the calculations, the following were noted: yellow maize was found to be the highest contributor to the total feed volume and tended to be more price-elastic than other feed commodities. Yellow maize still remains cheap in relation to other energy sources, but can be better managed on a risk aversion basis, by using future markets and price contracts. The sensitivity of each commodity became less effective as the increments stayed the same and the weight distribution in price increased.

For example, a R50 price change measured against a R1 000/ton maize price has a higher sensitivity with a lower elasticity impact than a R50 increase at R3 500/ton maize price. At the latter price level, the sensitivity decreases with respect to the maize price, with an increase in the elasticity of the commodity price.

CHAPTER 6

HEDGING STRUCTURE AND SCENARIO ANALYSIS

6.1 INTRODUCTION

To conclude this study, the concept of pork-related risks in the feed industry has to be understood. A pork producer model was developed to illustrate the inner operational workings with respect to the feed-related aspect. These outputs were measured against industry set standards. The components that contribute directly to the risks within this industry were analysed and the sensitivities that price changes have on a pork producer's profitability, given different market conditions, were measured. These price sensitivities and elasticity indicated that a producer faces high risks on a daily basis with respect to inputs, and that alternative measures are required to minimise the risks where possible and to set safety ranges in which the business can operate. These boundaries, seen as 'the rules of the game', are played on a daily basis.

Chapter 6 focuses on hedging alternatives on SAFEX and how it can impact on a pork producer's financial position on the short and long term. Scenarios based on historical price data are tested, illustrating the different break-even points and profitability levels that pork producers can achieve when certain alternatives remains constant. Alternative procurement strategies, that a pork producer can implement if he has the resources and capacity as required by the operational structure, will be discussed.

6.2 HEDGING ALTERNATIVES ON SAFEX

According to Ferris (2005), the term hedging is described as an appropriate action taken in the futures market to forward-price a cash product. Ferris (2005) explains hedging as having an opposite position in the futures market than in the cash crop market. For example, if a producer has a short (sell) position in the cash crop market, that position will be offset by a long (buy) position in the futures market.

This action gives a producer the benefit of rising prices and taking a profit, or he has to buy the contract out and pay the loss when prices are below the contracted price at the time of delivery or execution date.

The following section focuses on:

1. Price ranges at which the main commodities, namely yellow maize, sunflower, soya and wheat, traded on a daily basis on the commodity markets;
2. The correlation between prices, as traded for commodities and their by-products (for example, the market price for soya and for soya oil cake); and
3. Products or contracts available to a producer on SAFEX, that can be used to hedge future prices with.

These options are tested within the framework that a producer operates and an evaluation is made of whether a strategy to reduce the price risk of a producer is possible.

6.2.1 Commodity price analysis

This section focuses on the individual commodities, as determined in earlier chapters in this study. The by-products under each main commodity are discussed. The price ranges that were used for this section were based on daily spot-prices between January 2008 and July 2012, except for wheat bran, where the monthly prices ranged from January 2009 to October 2011.

6.2.1.1 Yellow maize

As found in Chapter 5, the highest contributor to feed rations in the different pork grower phases in terms of volume and cost is yellow maize. Figure 6.1 shows the yellow maize contract price, as it traded on SAFEX over a period of five years.

Figure 6.1: Yellow maize SAFEX price for the period Jan 2008 to Jul 2012
Source: GrainSA (2012)

From the figure, the following can be deduced: The red line indicates the average yellow maize price of R1 709/ton with a standard deviation of R394/ton, as calculated and indicated between the green lines. Thus, for the purpose of this section, the yellow maize price that was used, was set at R1 700/ton with a high range of R2 100/ton and a low range of R1 300/ton. Yellow maize contracts can be used directly from the SAFEX grain market and the maize can be directly used in the pork feeds.

6.2.1.2 Sunflower

Sunflower, in its raw oil seed form, is not usually included in pig rations. A by-product, sunflower oil cake, however, obtained after the oil is extracted from the oilseed of the plant, is sold for animal feed or other uses.For this reason, the sunflower price derived from SAFEX cannot be used directly in the calculations.

A pork producer can engage in synthetic hedging[17] of sunflower future contracts by reselling the physical product to oil presses at predetermined price levels, as determined by the individual parties, in order to gain an advantage of future prices and price hedging. However, because of the lower level of quantities needed by a medium- to small-scale producer, this method of risk mitigation must be approached with caution. Substitute products to sunflower oil cake must also be considered if price levels rise above the standard deviation range, as indicated below.

Figure 6.2 shows the prices for sunflower as traded on SAFEX and the derived sunflower oil cake price per ton over a period of five years. The correlation between sunflower and sunflower oil cake prices were calculated at 0.80. There is thus an 80 percent correlation between these two price sets. This means that, if the sunflower seed price changes, the sunflower oil cake price will react in the same order and direction.

[17] Synthetic hedging also known as cross price hedging, according to Ferris (2005), can be described as selling futures and buying options with a strike price close to the underlying future. Cross price hedging per definition is: “The act of hedging ones position by taking an offsetting position in another good with similar price movements. A cross hedge is performed when an investor who holds a long or short position in an asset takes an opposite (not necessarily equal) position in a separate security, in order to limit both up- and down-side exposure related to the initial holding” Investopedia (2012).

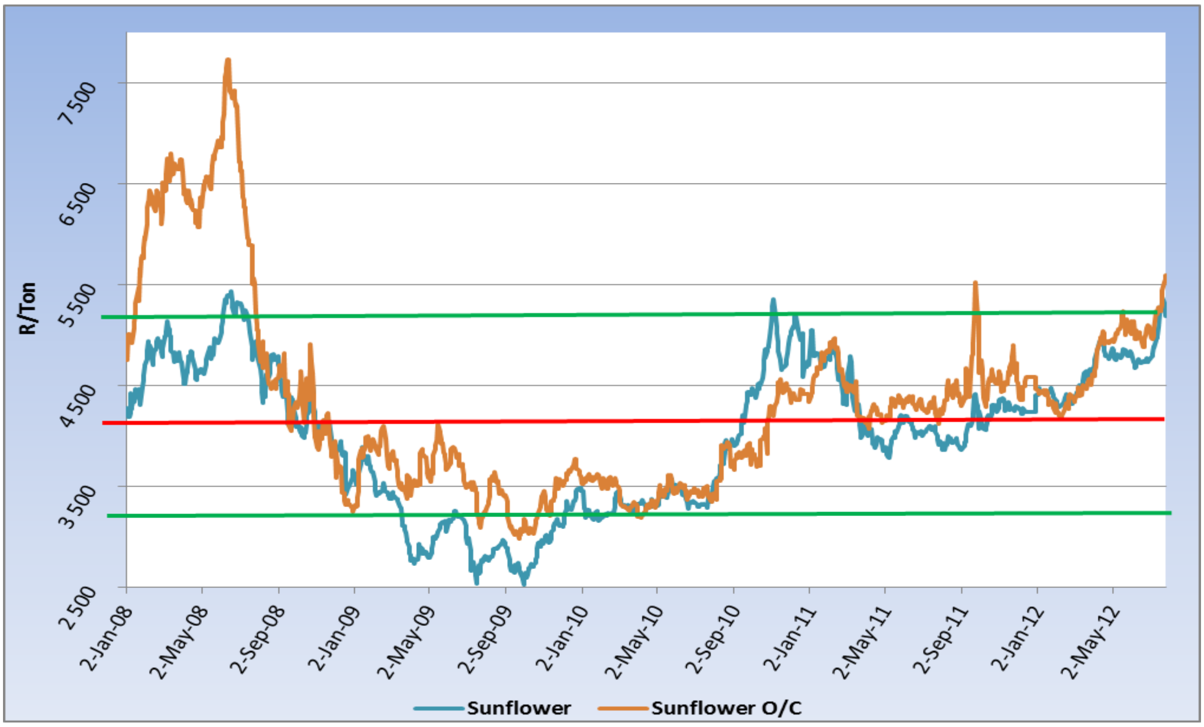

Figure 6.2: Sunflower SAFEX and sunflower oil cake market prices for the period Jan 2008 to Jul 2012

Source: GrainSA (2012)

The red line in Figure 6.2, shows the average sunflower oil cake price of R4 345/ton (R4 009/ton for sunflower) with the standard deviation for specifically the sunflower oil cake price indicated between the green lines. The standard deviations were calculated at R723/ton (sunflower) and R958/ton (sunflower oil cake) from the average price upwards as well as downwards. For the purpose of this section, the derived sunflower oil cake price that was used, was set at R4 300/ton, with a high of R5 200/ton and a low range of R3 400/ton.

6.2.1.3 Soya

As with sunflower, soya oil grains as a protein source is not used in its original form (tripsin inhibitor) as a commodity in feed rations. Full fat soya, as well as soya oil cake, are both processed or by-products of soya. As a result, the soya contract prices, as determined on SAFEX, cannot be used as just as it is, but can form the basis and platform for speculation.

Both full fat and oil cake soya products' correlation are calculated at 0.65, thus there is a 65 percent correlation between these price sets. This means that, if soya prices react, the full fat and oil cake price will react in the same order and direction. From the calculations, there was a direct correlation to the price of full fat soya and soya oil cake.

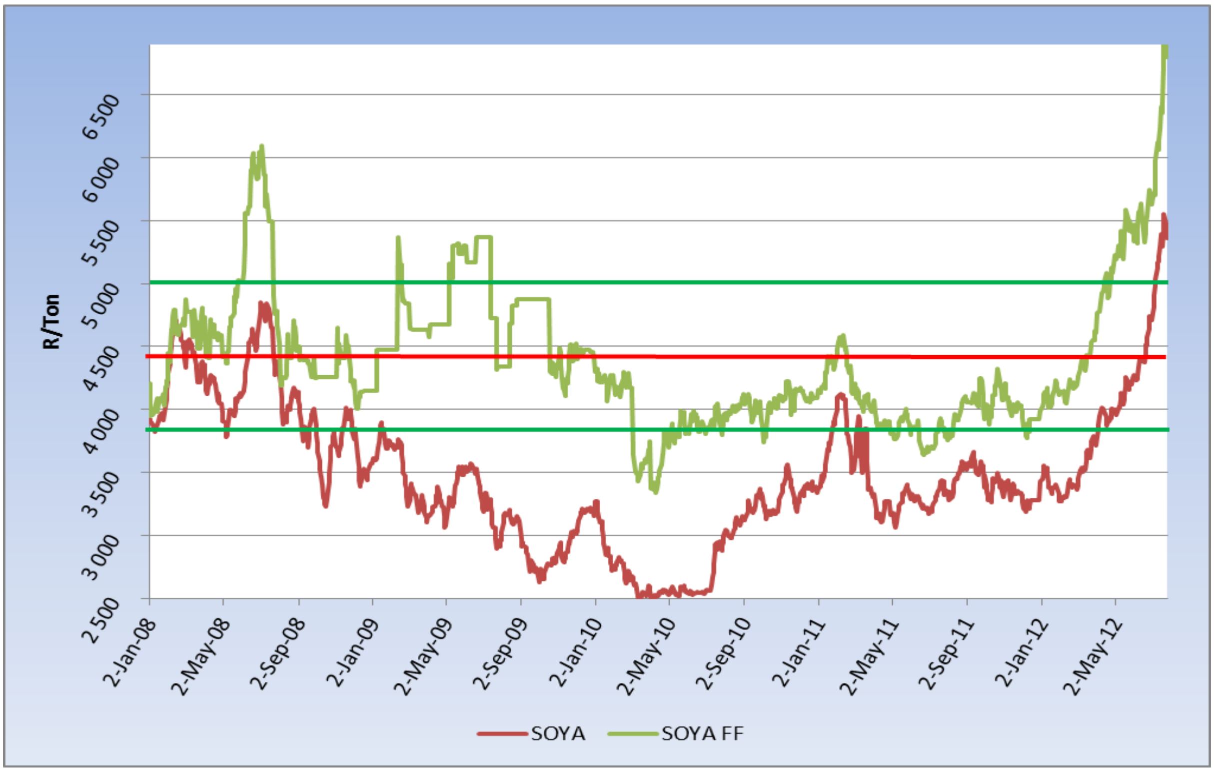

Figure 6.3: Soya full fat and soya market prices for the period Jan 2008 to Jul 2012

Source: GrainSA (2012)

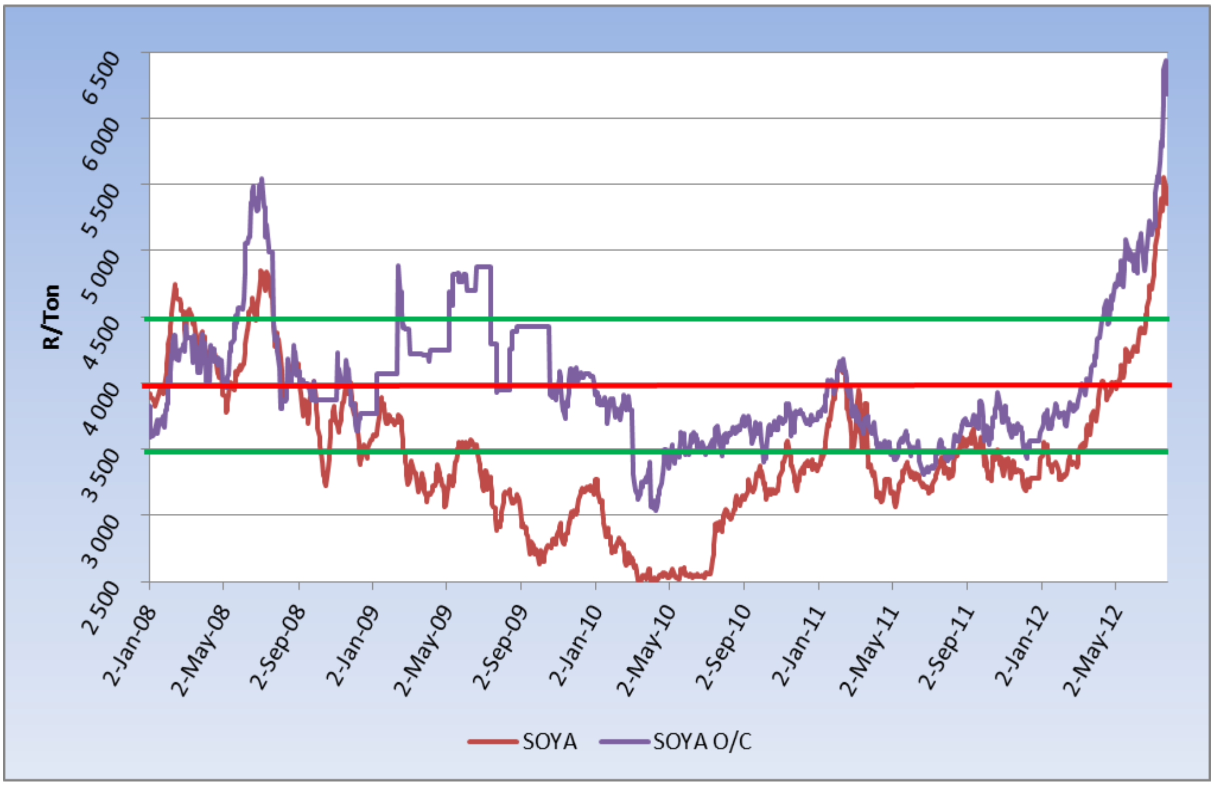

Figure 6.4: Soya and soya oil cake market prices

Source: GrainSA (2012)

Figure 6.3 and Figure 6.4 show the different market prices for soya, as traded on SAFEX, and the derived full fat and oil cake price per ton over a period of five years. From Figure 6.3, it is clear that the average price for full fat soya was calculated at R4 402/ton, as indicated by the red line, with a standard deviation of R566/ton. For the purpose of this section, the derived full fat soya price that was used, was set at R4 400/ton with a high of R4 950/ton and a low range of R3 850/ton.

From Figure 6.4, the following can be deduced: the average price for soya oil cake was calculated at R4 002/ton, as indicated by the red line, with a standard deviation of R514/ton. For the purpose of this section, the derived soya oil cake price that was used, was set at R4 000/ton with a high of R4 500/ton and a low range of R3 500/ton.

6.2.1.4 Wheat

It was not possible to calculate any accurate correlation between wheat bran and wheat prices traded on SAFEX, because prices were found to be reported on a monthly, not a daily basis. Wheat bran, as with hominy chop, is a waste product from the milling process of maize and wheat respectively. Chop and bran is mainly intended for the animal feed industry. Prices are therefore derived from supply and demand, given the cost of maize and wheat and the availability of these products.

Figure 6.5 shows the monthly average for wheat, as traded on SAFEX, and the monthly bran prices. From the figure, it can be argued that the trend, although in the same direction in certain instances, results in a problem area when considering the hedging of prices to minimise price risks. To include the impact that wheat bran prices have on a pork production unit, the following prices were determined: the average price for bran was set at R1 180/ton with a standard deviation of R170/ton; and the ranges that bran prices were tested at were R1 350/ton and R1 010/ton, respectively.

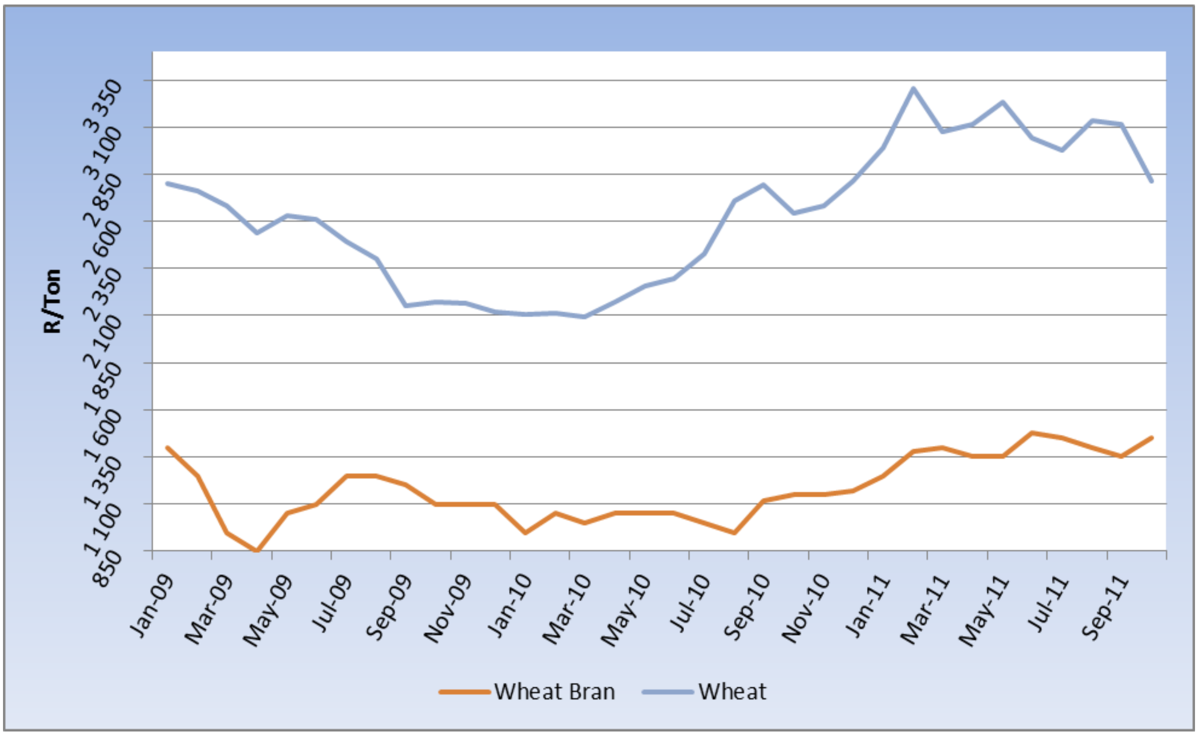

Figure 6.5: Wheat and wheat bran market prices

Source: GrainSA (2012)

6.2.2 Hedging alternatives and application

This section evaluates different procurement alternatives available to a pork producer that can enable him to minimise price risk and the occurrence of commodity risks.

Table 6.1: Different procurement strategies available to a pork producer

Strategy	Action	Risk level	Cost	Taking delivery or exit opportunity
Hedging with a futures contract	Buy a futures contract	• Sufficient cash flow needed to service margin calls • Fixed price, cannot participate in lower procurement prices	Margin finance cost of SAFEX position + trading cost. Receive interest on margin account, and pay silo cost after delivery is taken. Pay own transport cost.	Either take delivery of SAFEX silo certificate or offset futures position and buy commodity on spot market
Minimum price option	Buy a call option	Limited risk: • Initial cost limited to option premium and brokerage • Can participate in lower price levels	Call option premium cost + interest + finance cost of call cost + trading cost. Receive interest on margin account, and pay silo cost after delivery is taken. Pay own transport cost.	Have the right but not the obligation to take deliverance of the contract option (not required to deliver unless option is converted to a futures contract)
Over-the-counter fixed price contract with feed commodity producer/miller/ food processor	Engaged in a contractual agreement with the relevant parties	• Fixed price • Default risk	Cost are generated between contracted parties, as included in the predetermined price	Required to take delivery at the contracted price, in the contracted quantity and grade, on the contracted date
Un-hedged	No position with regards to taking delivery at a predetermined price	High risk: • Full upward and downward participation in prices • Availability of stocks/quality/ quantity. Pay a premium to procure commodities	Transaction cost when making a decision	No obligation to take delivery or pay contracted costs

Source: Based on SAFEX and transaction costs

Table 6.1 is a basic outline of the possible actions that a pork producer can take in procuring certain commodities that can be purchased on SAFEX in this instance. The table indicates the different (unlimited) alternatives available to a pork producer in the market environment. The table also gives an indication of the risk, cost and delivery or exit strategy of each specific option.

The four positions available to a pork producer in the market when procuring feed commodities includes a fixed price contract, a long future option, a long call option and an un-hedged position, as illustrated in Table 6.2. These positions are calculated in terms of a pork producer who has a 500-sow unit, consuming 1 422 tons of yellow maize annually or 711 tons semi-annually.

For illustration purposes, the following prices were used: the spot price in the trading month of July 2012 at R2 450/ton[18], a December 2012 option at R2 350 and July 2013[19] option at R1 900. To clearly show the impact of different price ranges in a pork unit, the assumption was that half[20] of the annual maize requirement was priced in July and the remainder maize stock in December. The price ranges used, varied from R1 550 to R3 200/ton. Option prices were calculated by using the Black-Scholes model with a volatility of 26.5 percent. No transaction or silo differential was taken into account. It was further assumed that the Randfontein silo had a zero silo differential. Storage, brokerage and interest were also deliberately excluded to indicate only the effect of varying prices on a position. Long future and fixed contract prices were used at R2 350/ton for December 2012 and R1 900/ton for July 2013.

[18] Prices selected for illustration purposes.

[19] July contracts used when maize deliverance prices in South Africa are traditionally low; December contracts used to indicate higher prices due to lower stock levels.

[20] Although pork producers procure feed on a much more regular basis, this situation was created to illustrate the effect only.

Table 6.2: Hedging strategies for yellow maize

	Maize market alternatives								**Location to nearest silo:**			**Randfontein**	
										Minimum		**Maximum**	
	Feed		**Usage/cycle**	**Usage/year**	**Base prices original**		**Cost/Feed commodity**		**SAFEX spot**	**July**	**Call @Money(Jul)**	**December**	**Call @ Money(Des)**
			Tons		**R/ton**								
	Maize		**639**	**1 422**	**R 2 125.00**		**Maize**		R 2 450	R 1 900	R 542	R 2 350	R 231
		R 150											
	Maize	**R 1 550**	**R 1 700**	**R 1 850**	**R 2 000**	**R 2 150**	**R 2 300**	**R 2 450**	**R 2 600**	**R 2 750**	**R 2 900**	**R 3 050**	**R 3 200**
July													
R 1 900	**Fixed price**	R 1 900	R 1 900	R 1 900	R 1 900	R 1 900	R 1 900	R 1 900	R 1 900	R 1 900	R 1 900	R 1 900	R 1 900
R 2 442	**Long call**	R 2 092	R 2 242	R 2 392	R 2 542	R 2 692	R 2 842	R 2 442	R 2 442	R 2 442	R 2 442	R 2 442	R 2 442
R 1 900	**Long future**	R 2 250	R 2 100	R 1 950	R 1 900	R 1 900	R 1 900	R 1 900	R 1 900	R 1 900	R 1 900	R 1 900	R 1 900
	Open position	R 1 550	R 1 700	R 1 850	R 2 000	R 2 150	R 2 300	R 2 450	R 2 600	R 2 750	R 2 900	R 3 050	R 3 200
	Maize	**R 1 550**	**R 1 700**	**R 1 850**	**R 2 000**	**R 2 150**	**R 2 300**	**R 2 450**	**R 2 600**	**R 2 750**	**R 2 900**	**R 3 050**	**R 3 200**
Dec													
R 2 350	**Fixed price**	R 2 350	R 2 350	R 2 350	R 2 350	R 2 350	R 2 350	R 2 350	R 2 350	R 2 350	R 2 350	R 2 350	R 2 350
R 2 581	**Long call**	R 1 781	R 1 931	R 2 081	R 2 231	R 2 381	R 2 531	R 2 681	R 2 581	R 2 581	R 2 581	R 2 581	R 2 581
R 2 350	**Long future**	R 3 150	R 3 000	R 2 850	R 2 700	R 2 550	R 2 400	R 2 350	R 2 350	R 2 350	R 2 350	R 2 350	R 2 350
	Open position	R 1 550	R 1 700	R 1 850	R 2 000	R 2 150	R 2 300	R 2 450	R 2 600	R 2 750	R 2 900	R 3 050	R 3 200

[redacted]													
Usage/cycle	July												
	Fixed Price	R1351 353	R 1 351 353	R 1 351 353	R 1 351 353	R1 351 353	R 1 351 353	1 351 353	R1 351 353	R1 351 353	R 1 351 353	R1 351 353	R 1 351 353
711	Long call	R1487 911	R 1 594 597	R 1 701 283	R 1 807 968	R1 914 654	R 2 021 340	R1 736 845	R1 736 845	R1 736 845	R 1 736 845	R1 736 845	R 1 736 845
	Long future	R1600 287	R 1 493 601	R 1 386 915	R 1 351 353	R1 351 353	R 1 351 353	R1 351 353	R1 351 353	R1 351 353	R 1 351 353	R1 351 353	R 1 351 353
	Open position	R1102 420	R 1 209 106	R 1 315 791	R 1 422 477	R1 529 163	R 1 635 849	R1 742 534	R1 849 220	R1 955 906	R 2 062 592	R2 169 278	R 2 275 963
	December												
	Fixed price	R1671 411	R 1 671 411	R 1 671 411	R 1 671 411	R1 671 411	R 1 671 411	R1 671 411	R1 671 411	R1 671 411	R 1 671 411	R1 671 411	R 1 671 411
	Long call	R1266 716	R 1 373 402	R 1 480 087	R 1 586 773	R1 693 459	R 1 800 145	R1 906 831	R1 835 707	R1 835 707	R 1 835 707	R1 835 707	R 1 835 707
	Long future	R2240 401	R 2 133 716	R 2 027 030	R 1 920 344	R1 813 658	R 1 706 973	R1 671 411	R1 671 411	R1 671 411	R 1 671 411	R1 671 411	R 1 671 411
	Open position	R1102 420	R 1 209 106	R 1 315 791	R 1 422 477	R1 529 163	R 1 635 849	R1 742 534	R1 849 220	R1 955 906	R 2 062 592	R2 169 278	R 2 275 963
[redacted]													
Usage/year	Fixed price	R3022 764	R 3 022 764	R 3 022 764	R 3 022 764	R3 022 764	R 3 022 764	R 3 022 764	R 3 022 764	R 3 022 764	R 3 022 764	R 3 022 764	R 3 022 764
	Long call	R2754 627	R 2 967 998	R 3 181 370	R 3 394 742	R3 608 113	R 3 821 485	R 3 643 675	R 3 572 551	R 3 572 551	R 3 572 551	R 3 572 551	R 3 572 551
1 422	Long future	R3840 688	R 3 627 317	R 3 413 945	R 3 271 697	R3 165 012	R 3 058 326	R 3 022 764	R 3 022 764	R 3 022 764	R 3 022 764	R 3 022 764	R 3 022 764
	Open position	R2204 839	R 2 418 211	R 2 631 583	R 2 844 954	R3 058 326	R 3 271 697	R 3 485 069	R 3 698 440	R 3 911 812	R 4 125 184	R 4 338 555	R 4 551 927
[redacted]													
Nett movement/ year for maize	Fixed price	-R 817 924	-R 604 553	-R 391 181	-R 177 810	R 35 562	R 248 933	R 462 305	R 675 677	R 889 048	R 1 102 420	R 1 315 791	R 1 529 163
	Long call	-R 549 787	-R 549 787	-R 549 787	-R 549 787	-R 549 787	-R 549 787	-R 158 606	R 125 889	R 339 261	R 552 632	R 766 004	R 979 375
R 3 022 764	Long future	-R1635 849	-R 1 209 106	-R 782 362	-R 426 743	-R 106 686	R 213 372	R 462 305	R 675 677	R 889 048	R 1 102 420	R 1 315 791	R 1 529 163

Source: Own calculations

Options were purchased ‘at the money’. This means that prices on the futures market were very nearly the same as the option price at the time of purchase. The premium cost for the July 2013 option was more expensive than the December 2012 option, because of the time lapse since the month of the hedge.

When a position is taken for the different price ranges, the average price either yields a profit or a loss. Based on the annual and semi-annual usage of yellow maize, a calculation was made to reflect a different price than when a producer takes a profit or risk a loss, given his position. From the table it is clear that, using a long futures position and the over-the-counter fixed price contract, the hedge showed a loss when price levels went below the contracted price, and a profit when prices went above it.

As reflected in these calculations, the minimum price option renders to have a constant loss when prices traded below it, whereas a producer could participate in profits when prices traded above the minimum price option. With the unhedged position, the producer had an open exposure to prices but could risk substantial losses, as well as profits, depending on his/her procurement strategy.

Pork producers should be aware that they must still be advised by a qualified professional on all the market alternatives and the position to take in their specific operation. When using any instrument, it is always important to be informed and guided in a strategy to minimise price risk exposure. Alternatives were only used to illustrate the effect of price change variations and the profit and loss scenario.

6.3 SCENARIO ANALYSIS WITH INFLUENCE ON A PORK PRODUCER

For the purpose of this study, the following scenarios focus on the evaluation of major feed commodity (or products of a commodity) price changes , namely yellow maize, soya products such as full fat and oil cake, sunflower oil cake and wheat bran.

This section is based on a 500-sow production unit. For each commodity scenario, the average prices, as calculated in the above section, were used as basis and held constant for all commodities.

The reason for keeping these commodity prices constant was to determine the impact that a price change, in combination with the usage volume of the tested commodity, have from a low to a high level on the gross income of the production unit. A 500-sow unit was selected because it is a medium production unit size that would show a definite outcome change, given input price changes. All income prices for porkers sold were also held constant because of the focus of this study being on input cost only.

The tables below indicate market prices per ton per commodity as well as the changes in prices (in Rand and percentage) for different price scenarios. Included in the evaluation is the annual commodity cost for the production unit and the changes in cost, given the applicable scenario. The input volume is based on a 500-sow production unit. Finally, the tables include a gross income per annum for the unit as well as a gross income percentage change, given a change in the commodity price.

The purpose of this evaluation is to arrive at possible outcomes that a pork producer may face and have to take into account when doing risk evaluations of the industry. This is only an illustration of a possible scenario for an individual pork unit and will change for each pork unit and size, given different constraints.

6.3.1 Scenario 1 – Yellow maize price change

From Table 6.3 the average calculated price per annum was R1 700/ton, with an upper range of R2 100/ton and a lower range of R1 300/ton.

Table 6.3: Yellow maize price scenario

Scenario	Lower	Average	Upper
Market price/ton	R 1 300	R 1 700	R 2 100
Rand change/ton	R 400		R 400
% change in price/ton	-30.77		23.53
Commodity cost per annum	R 1 849 000	R 2 418 000	R 2 987 000
% contribution to feed cost	32.24	38.35	43.46
Gross income per annum	R 5 982 000	R 5 413 000	R 4 844 000
Gross income margin (%)	51.05	46.19	41.34
Change in gross income (%)	9.51		-10.51

Source: Own calculations based on pork model

At a 23.5 percent increase in the price for yellow maize, the gross income decreased by 10.5 percent. On the contrary, when the price decreased by 30.8 percent, the gross income increased by 9.5 percent. As calculated earlier in this chapter, the standard deviation was kept at R400 per ton.

6.3.2 Scenario 2 – Soya product price change

From Table 6.4 below the average calculated price per annum was R4000/ton, with an upper range of R4 500/ton and a lower range of R3 500/ton.

Table 6.4: Soya oil cake price scenario

Scenario	Lower	Average	Upper
Market price/ton	R 3 500	R 4 000	R 4 500
Rand change/ton	R 500		R 500
% change in price/ton	-14.29		12.50
Commodity cost per annum	R 1 219 000	R 1 393 000	R 1 567 000
% contribution to feed cost	19.88	22.09	24.18
Gross income per annum	R 5 587 000	R 5 413 000	R 5 239 000
Gross income margin (%)	47.68	46.19	44.71
Change in gross income (%)	3.12		-3.22

Source: Own calculations based on pork model

At a 12.5 percent increase in the price for soya oil cake, the gross income decreased by 3.22 percent. On the contrary, when the price decreased by 14.3 percent, the gross income increased by 3.12 percent. As calculated earlier in this chapter, the standard deviation was kept at R500 per ton.

From Table 6.5, the calculated average price per annum was R4 400/ton, with an upper range of R4 950/ton and a lower range of R3850/ton.

Table 6.5: Full fat soya price scenario

Scenario	Lower	Average	Upper
Market price/ton	R 3 850	R 4 400	R 4 950
Rand change/ton	R 550		R 550
% change in price/ton	-14.29		12.50
Commodity cost per annum	R 300 000	R 343 000	R 386 000
% contribution to feed cost	4.79	5.44	6.08
Gross income per annum	R 5 456 000	R 5 413 000	R 5 370 000
Gross income margin (%)	46.56	46.19	45.83
Change in gross income (%)	0.79		-0.79

Source: Own calculations based on pork model

At a 12.5 percent increase in the price for full fat soya, the gross income decreased by 0.8 percent. On the contrary, when the price decreased by 14.3 percent, the gross income increased by 0.8 percent. As calculated earlier in this chapter, the standard deviation was kept at R550 per ton.

6.3.3 Scenario 3 – Sunflower oil cake price change

From Table 6.6, the calculated average price per annum was R4 300/ton, with an upper range of R5 200/ton and a lower range of R3 400/ton.

Table 6.6: Sunflower oil cake price scenario

Scenario	Lower	Average	Upper
Market price/ton	R 3 400	R 4 300	R 5 200
Rand change/ton	R 900		R 900
% change in price/ton	-26.47		20.93
Commodity cost per annum	R 538 000	R 681 000	R 823 000
% contribution to feed cost	8.74	10.8	12.77
Gross income per annum	R 5 555 000	R 5 413 000	R 5 270 000
Gross income margin (%)	47.41	46.19	44.98
Change in gross income (%)	2.57		-2.63

Source: Own calculations based on pork model

At a 20.9 percent increase in the price for sunflower oil cake, the gross income decreased by 2.63 percent. On the contrary, when the price decreased by 26.5 percent, the gross income increased by 2.57 percent. As calculated earlier in this chapter, the standard deviation was kept at R900 per ton.

6.3.4 Scenario 4 – Wheat bran price change

From Table 6.7, the calculated average price per annum was R1 180/ton, with an upper range of R1 350/ton and a lower range of R1 010/ton.

Table 6.7: Wheat bran price scenario

Scenario	Lower	Average	Upper
Market price/ton	R 1 010	R 1 180	R 1 350
Rand change/ton	R 170		R 170
% change in price/ton	-16.83		14.41
Commodity cost per annum	R 268 000	R 314 000	R 359 000
% contribution to feed cost	4.29	4.98	5.65
Gross income per annum	R 5 458 000	R 5 413 000	R 5 368 000
Gross income margin (%)	46.58	46.19	45.81
Change in gross income (%)	0.83		-0.83

Source: Own calculations based on pork model

At a 14.4 percent increase in the price for wheat bran, the gross income decreased by 0.8 percent. On the contrary, when the price decreased by 16.8 percent, the gross income increased by 0.8 percent. As calculated earlier in this chapter, the standard deviation was kept at R170 per ton.

Yellow maize, as a commodity, may give a pork producer an advantage if he/she effectively hedges price risks or take the risk of exposure against unfavourable prices. The volume used in feed rations for the other tested commodities are low enough not to be a significant contributor to the price variation risk.

6.4 VALIDATION OF STUDY

One of the key instruments within this study was the application of a feed price sensitivity and management model to simulate different 'what if' scenarios. The use and application of this model is fundamental to the validity of the outputs as produced. For the purpose of this study a validation of the model and concept was done to assure that the outputs are realistic and in line with industry expectations.

According to Saunders, Lewis and Thornhill (2009) to validate findings are to evaluate if the outputs as produced are true and realistic. Leedy and Ormrod (2010) define validity of a measurement instrument as the degree to which the instrument measures what it is designed to measure. Thus for the purpose of this study the measurements of the instrument (the model) and tests (scenario analysis) as run for different production units and prices will give an indication of the accuracy and expectations and also indicate where adjustments are needed to make the outputs more realistic.

The model was based on inputs from different pork producers and the norms and standards from published information were used. However, no model can be regarded as 100 percent accurate. The model, as revised and redesigned, was presented to SAPPO in November 2011 and the concept accepted for use in the field.

On two separate occasions, the model was used for the purpose of financial application to production loans. The loans were granted based on the clear line of information available to decision makers who otherwise had very little knowledge of the industry. Another case, in which the model was applied, was when a producer wanted to know what price increase limits for maize his operations would be able to tolerate before his financial position would be affected negatively. Numerous small scale pork producers, who only partake in the growing of pigs, enquired on the break-even scenario about when, on their particular scale, it would become viable to begin keeping sows and producing their own piglets instead of procuring on auctions.

The information on production, cost and income, in conjunction with the risks in the industry, could be used to determine the profitability and repayment ability of different pork producers. Although alternative risk mitigation strategies are available to pork producers, it was important for decision makers to realise what is available, in the context of a pork producer, to minimise input cost risks. Numerous financial institutions are not positive towards providing funding loans for the production of animal feeds, unless a clear operational plan and input cost examination can be delivered with an evident line of a positive outcome, given different market conditions.

6.5 CONCLUSION

To conclude this chapter, a producer must realise that when dealing with market prices beyond his control, he/she should seek advice from a qualified professional who can assist in decision-making to minimise risk and price movements.

This chapter showed the price movement over a period of five years, as well as the determined average and standard deviation price ranges, to form a basis for the possible scenario analyses. The commodities tested were yellow maize, soya, sunflower and wheat and, within each commodity, specific feedstuff in a pork ration was used.

The scenarios illustrated the risk that a producer may face on an annual basis and which commodity may pose to be the largest issue during price fluctuation. Maize was seen as the highest contributor and risk during up- and downward movements.

Different alternatives to hedging price risks on the market were tested and the impact of taking a decision in the market, illustrated. The calculations proved that each alternative yields its own risks and opportunities. The minimum price option posed the lowest risk by paying a premium but still allowing a producer to benefit from rising prices.

CHAPTER 7

SUMMARY AND RECOMMENDATIONS

7.1 GENERAL SUMMARY

For any industry or business to be successful, a number of elements on ways to manage risks need to be factored in. In agriculture, continuously changing circumstances force businesses to find new innovative methods to adjust their business models and characteristics to ensure that associated risks are managed and their businesses remain sustainable.

In order to minimise the risks associated with the pork feed industry of South Africa, economical tools, along with strategic scenario analyses, can be developed as an aid on industry level for policy purposes and to support decision-making on a farm. This study was based on the re-development of a feed price sensitivity model and indicates the size and impact of shifts in commodity prices. From the outputs obtained, scenarios could be developed and tested, and risk-minimising strategies analysed to better manage a pork producer's financial position.

The following objectives were discussed and the conclusions are as follows:

- *The redesigning of a feed input price-sensitivity model for pork producers who mainly use home mixing*

The modelling techniques that were used were to simulate a situation based on the concept of inputs, processes and outputs. These outputs form part of a chain of systematic approaches that create a simulation of a farm model that can be used for different market scenarios and conditions. The different outputs can assist a risk-averse producer to make decisions to reduce his/her risk exposure and create a barrier against market instabilities. This model can be used when simulations on real farm data are modelled and scenarios are created to simulate the impact on the pork production unit.

The purpose of this form of modelling is to prepare a pork producer to take the necessary proactive steps to reduce his/her business's risk exposure in changing market conditions. The improvement of this model resulted in providing producers information on 'what if' situations within their operating environment.

To measure the sensitivity of feed commodity prices on the gross income (income minus feed cost at a predetermined price for commodities and quantity level), the principle of price elasticity was applied, by using the changes in commodity prices over the changes in gross income. The sensitivity of yellow maize, soya (full fat and oil cake) and sunflower and wheat bran was tested to determine the impact that these commodities individually contribute to the overall feed cost in a pork unit. From the price elasticity and sensitivity calculations and evaluations, it became clear that volume, in conjunction with commodity costs, are important considerations which decisions from a managerial perspective can be based on.

A pork producer can choose to be price-elastic/-inelastic according to the available prices and the way these prices affect his/her profit levels, as well as the levels of sensitivity towards price changes consistent with his/her preference to risk. Yellow maize was found to be the highest contributor to the total feed volume and tended to be more price-elastic than other feed commodities. Yellow maize still remains cheap in relation to other energy sources but can be managed better on a risk-aversion basis, by using future markets and price contracts. The sensitivity of each commodity became less effective as the increments remained the same and the weight distribution in price increased.

- *Identification of risks directly affecting feed costs and thus profit margins*

As associated with the general feed and pork feed industry, risks need to be understood before a strategic plan can be developed and these risks mitigated to lower the financial exposure that pork producers are subjected to. In die feed industry, risks classified as high priority are price volatility of feed commodities, finances and economic changes, power outages, political [instability], customer preference, competition, and supply of inputs.

Procurement of feed commodities can give a home feed mixer an advantage, by procuring commodities in the desired quantities/quality/prices, as they are required. The scale at which some of these commodities are required can, however, be detrimental due to the fact that economy of scale is lacking. Price volatility in especially the grain market poses another risk that needs to be factored into the decision-making and strategic planning process. The higher the price volatility of a commodity, the more fear tends to be in that market, which leads to an increased level of risk.

- *Identification and testing of risk management and mitigation techniques such as hedging, and the use of alternatives available to a pork producer; and identification and testing of possible outcomes of risk mitigation strategies to hedge short-term raw feed input costs and associated risks*

Four alternatives available to a pork producer in managing his/her price risk, given his risk preference, were evaluated, discussed and tested. The tested alternatives were *hedging with a futures contract, taking a minimum price option, over-the-counter fixed price contract and an un-hedged position.* These alternatives were simulated and given a pork producer's risk aversion preference to volatile prices. The best outcome reflected from the minimum price option. Short-term inputs can also be hedged, however, the day to day requirements between pork producers of different sizes and volume capacity does not allow for procurement of certain inputs on a semi-annual basis only. Therefore the use of synthetic hedging is applied where a producer can participate in changing markets to offset his/her purchases on the spot market. However, when financial decisions are made, a pork producer must seek advice from a professional financial advisor and not base decisions on his/her own conclusions.

- *Scenario evaluation of different market conditions to determine the possible market scenarios that may have an effect on the financial position of a pork producer*

The price movement over a period of five years and the average and determined standard deviation price ranges were used to form a basis for the scenario analyses. The commodities tested were yellow maize, soya, sunflower and wheat. Within each commodity its specific feedstuff were used, as in a pork ration. The scenarios illustrated the risk that a producer can face on an annual basis and also which commodity emanates as the largest issue when prices fluctuate. Maize was seen as being the highest contributor of risk to upward/downward movements.

7.2 RECOMMENDATIONS FOR THE SOUTH AFRICAN PORK INDUSTRY AND FURTHER RESEARCH OPPORTUNITIES

This study was mainly based on a farm level approach. However, policy makers can use this model to simulate changes in policy of input industries and to reflect the downstream supply chain implications on pork producers and consumers. This study is unique to the South African pork industry but can be adapted for use in other intensive animal production industries as well.

Only certain risk mitigation strategies and hedging alternatives were discussed in this study. In practice, there are numerous actions that a producer can take. For example, if a pork producer produces his/her own maize crops, the yield can be increased by using the full potential of the soil. Any imbalances in the chemical composition of the soil must be corrected with variable applications of lime and fertiliser, as indicated by a soil survey. By rectifying the imbalances in the soil chemical composition and using it correctly, it can the result in a harvest of a ton of maize/ha more than usual under dry land and even more under irrigation.

Further expansion of this study is possible by, for example, constructing a weekly simulation model to include variable input costs and producer prices and to simulate the impact on a pork producer’s daily cash flow more accurately. This model can then be used in combination with a feed ration balance model to optimally balance the nutritional composition of pork feeds and also address the financial implications.

Considering the high volumes of imported pork cuts and the cyclical demand for pork meat, SAPPO can use this model with refinements to determine the impact on a local producer if the prices of pork meat decrease. This information can then be used as motivation for implementing import restrictions or better the control thereof in order to protect local producers. Furthermore, the model can be used to provide new entrants with information based on financial simulations. This will enable them to determine at which feed cost levels profits can be expected or, on the contrary, what can be done on the input side to ensure a profit.

Home pork feed mixers can use this model, as intended, for the purpose of testing the outcome of changing inputs and input prices and the effect on the production unit in general. Within limits, and with the assistance of a qualified animal feed nutritionist, the optimal composition for production efficiency and cash flow levels can be achieved through proactive actions and implementations.

SAFEX should be promoted to perceive the application of this model as an opportunity to hedge input prices to producers. Understanding how the markets work and what different products are available to producers are of key importance. Numerous courses and literature studies are available for any person to better understand SAFEX as well as the workings of products and associated transaction costs. However, speculation is not recommended because it does not form part of the core business of a pork producer.

In the future, SAFEX can introduce the trade of meat contracts as seen on other futures markets in the world. This can give pork and other meat producers the opportunity to effectively hedge their outputs as well as input price risks. SAFEX should be seen as an interdisciplinary role player in a pork producer’s financial structure. The stigma of SAFEX being incomprehensible should be lifted through deeper research of the application of SAFEX on a farm level. Pitfalls are possible if the wrong decisions based on unaccredited information are made.

Small-scale producers often lack information on trends in the industry's technological progress and base their decisions on old methods and outdated information. Communication through training programmes and field days on financial management with farm and production application could be offered on a regular basis by SAPPO in conjunction with regional offices and tertiary institutions to inform producers on current issues and what the future of industry holds.

By gaining sufficient knowledge, the efficiency of production, cost management and health issues, an increase in market share can be achieved on all size levels. Information is made available to producers on a daily basis through the internet and literature, and it is necessary to communicate studies on the subject to producers. The purpose and outcome of these studies must be understood and practically implementable by receptive producers.

With price volatilities in the input markets, the decision-making process regarding production and input pricing becomes more complex. For a producer with good farming knowledge but little understanding of improved risk management, the issue of a typical income-cost squeeze arises. This means that, as inputs increase and income decreases, a producer experiences a lowered turnover and profit levels with cash flow implications. The only option in this case is to expand and invest relative expensive borrowed capital and run the risk of receiving a lower return on investment than with another investment opportunity. Policy makers must acknowledge these occurrences and devise policies that will address and protect the entire value chain in this context.

With population expansions, climate change and land reform, issues of food security is high on the political agenda. Pork meat can be seen as one of the main protein sources to be produced in the future. The intensive scale on which pigs can be reared implies that, with adequate infrastructure and control, pork production can be seen as an important food source for the future masses.

According to the National Credit Act (No. 34 of 2005), financial institutions are required to prove that an analysis has been done on the repayment capacity of the business and applicant of the loan, before a loan of any kind will be granted.

Within the cash flow, and in conjunction with different market scenarios, the production, inputs, expenses and loan repayments must be accurate enough to demonstrate the financial position and pay-back ability. This model can assist financial institutes to understand the ways in which a pork unit operates and the major costs included in the operational structure.

The future of pork expansion domestically and globally lies in the expansion of research with respect to the supply value chain in South Africa and especially Africa. Pork can be intensively produced and managed on a small as well as a commercial scale. Food security is becoming a major issue. In order to implement different projects and research of a typical South African-based pork unit model in Africa, issues and concerns can be tested and evaluated. Pork meat and product processing plants make use of only a few large scale producers that can supply in volume, but smaller producers can also be contracted.

The question remains what can be done to reassure a production price on a contracted basis and the use of smaller producers to deliver to processors according to specifications and accreditation. With globalisation increasing, small producers are decreasing due to economy of scale and because of limited producer price protection on the output side.

Consumer trends and needs are of the most important aspects that need to be taken into consideration in any industry. No logical value exists in producing a product that is not required by consumers and therefore has less value in comparison with alternative products. Consumer surveys and studies are essential to give pork producers an understanding of how their existing business models should change to accommodate changes in their market environment.

Information and communication are tools to be used now and in the future. Communication through the internet and cell phones revolutionises the way that information on existing issues (such as pork prices, grain prices, imports/exports, trends, new developments, etc.) are communicated and used to gain a competitive advantage. However, ways in which information can be processed and used on farm level still needs to be understood.

The gap lies with producers receiving information but not using the technology because it is either unavailable to them or they do not understand its value in the given format.

Any agricultural industry does not rely on only one set of information to base decisions upon. Because researchers mainly focus on their respective fields of study, the value of incorporating different disciplines is sometimes only mentioned but not fully incorporated into primary research. Interdisciplinary relationships with respect to animal science, animal health nutrition, agricultural economics, soil science, SAFEX and offset markets need to be fully incorporated in the outputs. This will enable true delivery of exact research outputs that can be used by role players in the applicable industry to base good judgement decisions on for the future.

In this study, as well as previous studies on the South African pork value chain, there was a sense of distrust between producers. When interviews were conducted, producers felt that their information, although anonymous, would rather be used against them than to their advantage.

With the Competition Commission constantly investigating different markets, producers were apprehensive. However, it created distrust between researchers and the people with credible information to base decisions and outcomes on. For any future research in the pork industry as well as agricultural industries, producers must receive this information and experience the benefits to assist in restoring the trust relationship between research and the industry.

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ANNEXURE

YMAZ

[redacted]

	Rand					
SAFEX RxSilo	**Cost/ Year**	**Gross Income / Year (Feed cost)**	**Sensitivity change in maize cost shift**	**Sensitivity change in Gross Income shift**	**Sensitivity**	**Point Elasticity**
R 600	R 853 486	R 6 972 317				-0.122
R 700	R 995 734	R 6 830 069	16.67	-2.04	8.17	-0.146
R 800	R 1 137 982	R 6 687 821	14.29	-2.08	6.86	-0.170
R 900	R 1 280 229	R 6 545 573	12.50	-2.13	5.88	-0.196
R 1 000	R 1 422 477	R 6 403 326	11.11	-2.17	5.11	-0.222
R 1 100	R 1 564 725	R 6 261 078	10.00	-2.22	4.50	-0.250
R 1 200	R 1 706 973	R 6 118 830	9.09	-2.27	4.00	-0.279
R 1 300	R 1 849 220	R 5 976 583	8.33	-2.32	3.58	-0.309
R 1 400	R 1 991 468	R 5 834 335	7.69	-2.38	3.23	-0.341
R 1 500	R 2 133 716	R 5 692 087	7.14	-2.44	2.93	-0.375
R 1 600	R 2 275 963	R 5 549 840	6.67	-2.50	2.67	-0.410
R 1 700	R 2 418 211	R 5 407 592	6.25	-2.56	2.44	-0.447
R 1 800	R 2 560 459	R 5 265 344	5.88	-2.63	2.24	-0.486
R 1 900	R 2 702 706	R 5 123 096	5.56	-2.70	2.06	-0.528
R 2 000	R 2 844 954	R 4 980 849	5.26	-2.78	1.90	-0.571
R 2 100	R 2 987 202	R 4 838 601	5.00	-2.86	1.75	-0.617
R 2 200	R 3 129 450	R 4 696 353	4.76	-2.94	1.62	-0.666
R 2 300	R 3 271 697	R 4 554 106	4.55	-3.03	1.50	-0.718
R 2 400	R 3 413 945	R 4 411 858	4.35	-3.12	1.39	-0.774
R 2 500	R 3 556 193	R 4 269 610	4.17	-3.22	1.29	-0.833
R 2 600	R 3 698 440	R 4 127 362	4.00	-3.33	1.20	-0.896
R 2 700	R 3 840 688	R 3 985 115	3.85	-3.45	1.12	-0.964
R 2 800	R 3 982 936	R 3 842 867	3.70	-3.57	1.04	-1.036
R 2 900	R 4 125 184	R 3 700 619	3.57	-3.70	0.96	-1.115
R 3 000	R 4 267 431	R 3 558 372	3.45	-3.84	0.90	-1.199
R 3 100	R 4 409 679	R 3 416 124	3.33	-4.00	0.83	-1.291
R 3 200	R 4 551 927	R 3 273 876	3.23	-4.16	0.77	-1.390
R 3 300	R 4 694 174	R 3 131 628	3.13	-4.34	0.72	-1.499
R 3 400	R 4 836 422	R 2 989 381	3.03	-4.54	0.67	-1.618
R 3 500	R 4 978 670	R 2 847 133	2.94	-4.76	0.62	-1.749
R 3 600	R 5 120 918	R 2 704 885	2.86	-5.00	0.57	-1.893
R 3 700	R 5 263 165	R 2 562 638	2.78	-5.26	0.53	-2.054
R 3 800	R 5 405 413	R 2 420 390	2.70	-5.55	0.49	-2.233
R 3 900	R 5 547 661	R 2 278 142	2.63	-5.88	0.45	[redacted]

[redacted]

SOYA

[redacted]

[redacted]	Rand					
SAFEX RxSilo	**Cost/ Year**	**Gross Income / Year (Feed cost)**	**Sensitivity change in soya cost shift**	**Sensitivity change in Gross Income shift**	**Sensitivity**	**Point Elasticity**
R 3 800	R 1 619 313	R 5 181 058				-0.313
R 3 900	R 1 661 926	R 5 138 445	2.63	-0.82	3.20	-0.323
R 4 000	R 1 704 540	R 5 095 831	2.56	-0.83	3.09	-0.334
R 4 100	R 1 747 153	R 5 053 218	2.50	-0.84	2.99	-0.346
R 4 200	R 1 789 767	R 5 010 604	2.44	-0.84	2.89	-0.357
R 4 300	R 1 832 380	R 4 967 991	2.38	-0.85	2.80	-0.369
R 4 400	R 1 874 994	R 4 925 377	2.33	-0.86	2.71	-0.381
R 4 500	R 1 917 607	R 4 882 764	2.27	-0.87	2.63	-0.393
R 4 600	R 1 960 221	R 4 840 150	2.22	-0.87	2.55	-0.405
R 4 700	R 2 002 834	R 4 797 537	2.17	-0.88	2.47	-0.417
R 4 800	R 2 045 448	R 4 754 923	2.13	-0.89	2.40	-0.430
R 4 900	R 2 088 061	R 4 712 310	2.08	-0.90	2.32	-0.443
R 5 000	R 2 130 675	R 4 669 696	2.04	-0.90	2.26	-0.456
R 5 100	R 2 173 288	R 4 627 083	2.00	-0.91	2.19	-0.470
R 5 200	R 2 215 902	R 4 584 469	1.96	-0.92	2.13	-0.483
R 5 300	R 2 258 515	R 4 541 856	1.92	-0.93	2.07	-0.497
R 5 400	R 2 301 129	R 4 499 242	1.89	-0.94	2.01	-0.511
R 5 500	R 2 343 742	R 4 456 629	1.85	-0.95	1.96	-0.526
R 5 600	R 2 386 356	R 4 414 015	1.82	-0.96	1.90	-0.541
R 5 700	R 2 428 969	R 4 371 402	1.79	-0.97	1.85	-0.556
R 5 800	R 2 471 583	R 4 328 788	1.75	-0.97	1.80	-0.571
R 5 900	R 2 514 196	R 4 286 175	1.72	-0.98	1.75	-0.587
R 6 000	R 2 556 810	R 4 243 561	1.69	-0.99	1.70	-0.603
R 6 100	R 2 599 423	R 4 200 948	1.67	-1.00	1.66	-0.619
R 6 200	R 2 642 037	R 4 158 334	1.64	-1.01	1.62	-0.635
R 6 300	R 2 684 650	R 4 115 721	1.61	-1.02	1.57	-0.652
R 6 400	R 2 727 264	R 4 073 107	1.59	-1.04	1.53	-0.670
R 6 500	R 2 769 877	R 4 030 494	1.56	-1.05	1.49	-0.687
R 6 600	R 2 812 491	R 3 987 880	1.54	-1.06	1.46	-0.705
R 6 700	R 2 855 104	R 3 945 267	1.52	-1.07	1.42	-0.724
R 6 800	R 2 897 718	R 3 902 653	1.49	-1.08	1.38	-0.742
R 6 900	R 2 940 331	R 3 860 040	1.47	-1.09	1.35	-0.762
R 7 000	R 2 982 945	R 3 817 426	1.45	-1.10	1.31	-0.781
R 7 100	R 3 025 558	R 3 774 813	1.43	-1.12	1.28	-0.802
R 7 200	R 3 068 172	R 3 732 199	1.41	-1.13	1.25	[redacted]

[redacted]

SUNS

[redacted]

	Rand					
SAFEX RxSilo	Cost/ Year	Gross Income / Year (Feed cost)	Sensitivity change in sunflower cost shift	Sensitivity change in Gross Income shift	Sensitivity	Point Elasticity
R 4 000	R 633 362	R 5 455 094				-0.116
R 4 100	R 649 196	R 5 439 260	2.50	-0.29	8.61	-0.119
R 4 200	R 665 030	R 5 423 426	2.44	-0.29	8.38	-0.123
R 4 300	R 680 864	R 5 407 592	2.38	-0.29	8.16	-0.126
R 4 400	R 696 698	R 5 391 758	2.33	-0.29	7.94	-0.129
R 4 500	R 712 532	R 5 375 924	2.27	-0.29	7.74	-0.133
R 4 600	R 728 366	R 5 360 090	2.22	-0.29	7.54	-0.136
R 4 700	R 744 200	R 5 344 256	2.17	-0.30	7.36	-0.139
R 4 800	R 760 035	R 5 328 422	2.13	-0.30	7.18	-0.143
R 4 900	R 775 869	R 5 312 588	2.08	-0.30	7.01	-0.146
R 5 000	R 791 703	R 5 296 753	2.04	-0.30	6.85	-0.149
R 5 100	R 807 537	R 5 280 919	2.00	-0.30	6.69	-0.153
R 5 200	R 823 371	R 5 265 085	1.96	-0.30	6.54	-0.156
R 5 300	R 839 205	R 5 249 251	1.92	-0.30	6.39	-0.160
R 5 400	R 855 039	R 5 233 417	1.89	-0.30	6.26	-0.163
R 5 500	R 870 873	R 5 217 583	1.85	-0.30	6.12	-0.167
R 5 600	R 886 707	R 5 201 749	1.82	-0.30	5.99	-0.170
R 5 700	R 902 541	R 5 185 915	1.79	-0.30	5.87	-0.174
R 5 800	R 918 375	R 5 170 081	1.75	-0.31	5.75	-0.178
R 5 900	R 934 209	R 5 154 247	1.72	-0.31	5.63	-0.181
R 6 000	R 950 043	R 5 138 413	1.69	-0.31	5.52	-0.185
R 6 100	R 965 877	R 5 122 579	1.67	-0.31	5.41	-0.189
R 6 200	R 981 711	R 5 106 745	1.64	-0.31	5.30	-0.192
R 6 300	R 997 545	R 5 090 911	1.61	-0.31	5.20	-0.196
R 6 400	R 1 013 379	R 5 075 077	1.59	-0.31	5.10	-0.200
R 6 500	R 1 029 213	R 5 059 243	1.56	-0.31	5.01	-0.203
R 6 600	R 1 045 047	R 5 043 409	1.54	-0.31	4.92	-0.207
R 6 700	R 1 060 882	R 5 027 575	1.52	-0.31	4.83	-0.211
R 6 800	R 1 076 716	R 5 011 741	1.49	-0.31	4.74	-0.215
R 6 900	R 1 092 550	R 4 995 906	1.47	-0.32	4.65	-0.219
R 7 000	R 1 108 384	R 4 980 072	1.45	-0.32	4.57	-0.223
R 7 100	R 1 124 218	R 4 964 238	1.43	-0.32	4.49	-0.226
R 7 200	R 1 140 052	R 4 948 404	1.41	-0.32	4.42	-0.230
R 7 300	R 1 155 886	R 4 932 570	1.39	-0.32	4.34	-0.234
R 7 400	R 1 171 720	R 4 916 736	1.37	-0.32	4.27	[redacted]

[redacted]

WHT

	Rand					
SAFEX RxSilo	Cost/ Year	Gross Income / Year (Feed cost)	Sensitivity change in wheat cost shift	Sensitivity change in Gross Income shift	Sensitivity	Point Elasticity
R 800	R 212 669	R 5 856 863				-0.036
R 900	R 239 253	R 5 830 279	12.50	-0.45	27.54	-0.041
R 1 000	R 265 836	R 5 803 696	11.11	-0.46	24.37	-0.046
R 1 100	R 292 420	R 5 777 112	10.00	-0.46	21.83	-0.051
R 1 200	R 319 004	R 5 750 529	9.09	-0.46	19.76	-0.055
R 1 300	R 345 587	R 5 723 945	8.33	-0.46	18.03	-0.060
R 1 400	R 372 171	R 5 697 361	7.69	-0.46	16.56	-0.065
R 1 500	R 398 754	R 5 670 778	7.14	-0.47	15.31	-0.070
R 1 600	R 425 338	R 5 644 194	6.67	-0.47	14.22	-0.075
R 1 700	R 451 922	R 5 617 610	6.25	-0.47	13.27	-0.080
R 1 800	R 478 505	R 5 591 027	5.88	-0.47	12.43	-0.086
R 1 900	R 505 089	R 5 564 443	5.56	-0.48	11.68	-0.091
R 2 000	R 531 673	R 5 537 860	5.26	-0.48	11.02	-0.096
R 2 100	R 558 256	R 5 511 276	5.00	-0.48	10.42	-0.101
R 2 200	R 584 840	R 5 484 692	4.76	-0.48	9.87	-0.107
R 2 300	R 611 423	R 5 458 109	4.55	-0.48	9.38	-0.112
R 2 400	R 638 007	R 5 431 525	4.35	-0.49	8.93	-0.117
R 2 500	R 664 591	R 5 404 941	4.17	-0.49	8.51	-0.123
R 2 600	R 691 174	R 5 378 358	4.00	-0.49	8.13	-0.129
R 2 700	R 717 758	R 5 351 774	3.85	-0.49	7.78	-0.134
R 2 800	R 744 342	R 5 325 191	3.70	-0.50	7.46	-0.140
R 2 900	R 770 925	R 5 298 607	3.57	-0.50	7.15	-0.145
R 3 000	R 797 509	R 5 272 023	3.45	-0.50	6.87	-0.151
R 3 100	R 824 092	R 5 245 440	3.33	-0.50	6.61	-0.157
R 3 200	R 850 676	R 5 218 856	3.23	-0.51	6.37	-0.163
R 3 300	R 877 260	R 5 192 272	3.13	-0.51	6.13	-0.169
R 3 400	R 903 843	R 5 165 689	3.03	-0.51	5.92	-0.175
R 3 500	R 930 427	R 5 139 105	2.94	-0.51	5.72	-0.181
R 3 600	R 957 011	R 5 112 522	2.86	-0.52	5.52	-0.187
R 3 700	R 983 594	R 5 085 938	2.78	-0.52	5.34	-0.193
R 3 800	R 1 010 178	R 5 059 354	2.70	-0.52	5.17	-0.200
R 3 900	R 1 036 761	R 5 032 771	2.63	-0.53	5.01	-0.206
R 4 000	R 1 063 345	R 5 006 187	2.56	-0.53	4.85	-0.212
R 4 100	R 1 089 929	R 4 979 603	2.50	-0.53	4.71	-0.219
R 4 200	R 1 116 512	R 4 953 020	2.44	-0.53	4.57	

Source: Own calculations