Research Report

Suitable Supply Chain Strategies for the Delivery of Naturally Fed Beef from the Limpopo Province

By

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Declaration

I, Abraham Groenewald, herewith declare that the language of this research report has been edited by Ms. Barbara Hönck.

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List of Abbreviations

AMIE	Association for Meat Importers and Exporters
ARC	Agricultural Research Council
B2B	Business to Business
B2C	Business to Consumer
CPI	Consumer Price Index
ERP	Enterprise Resource Planning
GDP	Gross Domestic Product
ID	Identity
IT	Information Technology
KPI	Key Performance Indicator
LSU	Large Stock Unit
MESA	Meat Exporters South Africa
NERPO	National Emerging Red Meat Producers Organisation
NFMT	National Federation of Meat Traders
PETA	People for the Ethical Treatment of Animals
RMAA	Red Meat Abattoir Association
RPO	Red Meat Producers Organisation
SACA	South African Consumers Association
SAFA	South African Feedlot Association
SAFLA	South African Federation of Livestock Auctioneers
SAMIC	South African Meat Industry Company
SAMPA	South African Meat Packers Association
SANWS	South African National Weather Service
SHALC	Skins, Hides and Leather Council
TQM	Total Quality Management
UK	United Kingdom
USA	United States of America
USDA	United States Department of Agriculture

Executive Summary

This goal of this research was to develop and evaluate a number of suitable supply chain strategies for the delivery of naturally fed beef from the Limpopo province in South Africa. The Limpopo province is the northernmost province of South Africa, and consists mainly of "savanna" grassland. It is traditionally known as a good cattle farming region.

For the purposes of this research, "naturally fed" beef is defined as beef from cattle that:

- Lived and grazed on natural pasture.
- Have not gone through a feedlot process, where growth hormones and antibiotics are given to the animals to accelerate growth.
- Has been processed in such a way, at all points of the supply chain, that it conforms with all the legal requirements of South Africa regarding beef.

This research has determined that the markets for natural and organic beef in the USA have grown very rapidly over the past decade. It is accepted that the South African market typically lags behind the American market by about 10 to 15 years. Furthermore, a significant amount of beef consumers who took part in this research indicated that they are concerned about growth hormones given to cattle in feedlots. They are also concerned about animal welfare and would typically be willing to pay a premium for naturally fed beef. This indicates that a strong market for naturally fed beef could develop over the next decade in South Africa.

Two types of naturally fed beef, "Type A" and "Type B" beef, have been conceptually developed. Type A beef is produced in the Waterberg region, with higher rainfall and more water resources, where pasture can be planted and irrigated. Type B beef is produced on farms in the drier Bushveld regions, on completely natural farmland and without any irrigation of pastures. The research determined that consumers are willing to pay premiums for these products. Specifically, it determined that a premium of 10% (based on the standard average carcass price for feedlot produced beef) could probably asked for type A beef, and a premium of 20% could be asked for type B beef.

Process and cost information regarding the required elements of the supply chain for naturally fed beef, such as farming, abattoirs, logistics, processing and packing and retail channels were obtained. This information was used to perform numerical simulations on a number of different supply chain configurations. The influences of the following parameters were considered through the simulations:

- Supply chain configuration (process close to market versus process close to source).
- Market size.
- Sales premium.
- Input costs.
- B2C versus B2B markets.
- Type A versus Type B beef.

The simulations indicated the following:

- It is far more profitable to produce type A beef than it is to produce type B beef. This is due to the fact that farmland is extremely expensive and the grazing capacity in the drier regions of Limpopo is very low.
- Through effective branding and advertising, natural beef should be positioned in such a way that both sales volumes as well as price can be increased, since the combination of these two factors has a very positive impact on profitability.
- The supply chain configuration is not very significant in terms of influencing profits.
- Profitability is reduced when opting for contract at a reduced price. However, as a lower risk, lower return option it could be considered, especially if the more profitable type A beef is sold.
- For the base case simulation, the increase of operational costs by 10 % to 20 % has a significant impact on the supply chain, as it results in supply chain losses.

Key recommendations

- It is recommended that naturally fed beef from Limpopo can be produced, in a profitable way, as a differentiated alternative to feedlot produced beef.

- It is recommended that the cattle should preferably be produced on irrigated pasture, typically in the Waterberg region (type A beef), rather than on natural arid farmland (type B beef).

- It is recommended that the key success factors of the Brazilian beef industry be investigated. Brazil has grown tremendously as an exporter of beef since 2000. There may be valuable lessons to learn for the South African beef industry.

- It is recommended that more pre-processed beef be manufactured and sold, as there is a definite growing trend in terms of buying pre-packaged meat. This would imply processing the beef close to the source (farms) and transporting case ready packages to the market.

- It is recommended that a significant effort be put into branding and advertising of naturally fed beef, in order to increase sales volumes and enable a premium of about 15 % above normal, feedlot produced beef.

- It is recommended that the supply chain is managed as a process, by a dedicated and unbiased vantage point manager. The vantage point manager should ensure that the supply chain works together as a single team.

- It is recommended that the focus of the vantage point manager should be on optimizing the system as a whole, as opposed to optimizing each business unit separately.

- It is recommended that much better use is made of the farmland in Limpopo, by using better pasture management and developing synergies between game and cattle farming.

- It is recommended that further research be conducted to determine how the supply chain profit should be distributed to each of the business units in the supply chain.

Chapter 1: Introduction to the research

1.1 Introduction

Meat has been part of the man's diet for many millennia. It remains a natural source of protein, and when consumed in the right quantities in the right combination with other food groups, it generally forms part of a healthy diet.

Beef is one of the important meat types available in the world. It will probably remain an important source of protein in the foreseeable future, despite a number of external pressures that caused a decline in per capita consumption during the past decades.

Generally, consumers are becoming more health conscious and are starting to ask more questions about the long term effects of eating certain foods. Questions are asked about the effects of growth hormones and stimulants used to increase the growth rate of animals that are used for meat production. Consumers are also becoming more aware of animal cruelty and are more likely to demand that animals live good and natural lives – even though, somewhat ironically, they will eat the meat of the animal after it has lived its "good life". Consumers are also becoming more demanding and expect higher levels of mass customization.

"Natural" and "organically" produced meat is therefore becoming more popular as an alternative to conventional, "mass-produced" meat. The same trend also holds for beef, where naturally fed beef is developing as an alternative to feedlot produced beef. Feedlot produced beef is sourced from cattle that spend about 4 months in a confined feedlot and are given growth hormones to obtain an artificially high growth rate, which cannot be obtained in a natural way.

The Limpopo province in South Africa, which consists of mainly savanna veld, has traditionally been a major source of good quality beef cattle in South Africa. It is also the only South African province that shares borders with Botswana, Zimbabwe and Mozambique - hence the option of cross border cooperation could always be kept in mind. However, in recent years cattle farming in this province have declined as traditional cattle farms are converted into game farms. In fact, bushveld farms bought

and sold at astronomically high prices are becoming “playgrounds of the rich” and are bought as investments, without the owners having to produce anything. Some of the farms even have their own “private zoo” of exotic game. On the other hand, cattle farming is becoming less profitable and attractive and is thus declining.

Given the fact that South Africa is already a net importer of beef, the sustainability of converting the Limpopo province into one big game farm should be questioned. Surely there is room and undoubtedly a huge market for tourism, hunting and even venison as an alternative source of protein. But there will probably also always be the need for cattle farms too. After all, the population needs to be fed. It is not within the scope of this research to propose what balance should be struck between game and cattle farming. It remains an important issue to keep in mind, nonetheless.

An investigation into supply chain strategies for naturally fed beef from Limpopo provided a challenging research environment, through which a better understanding of supply chain management and the beef industry was developed.

1.2 Problem statement

The problem, or main question to be addressed through this research is:

“What supply chain strategies would be suitable for the profitable delivery of naturally fed beef from the Limpopo province?”

For the purposes of this study, naturally fed beef is defined as:

- beef from cattle that have not been confined in feedlots but have spent their lives on natural pasture
- beef from cattle that have not been fed any growth stimulants and related antibiotics which causes unnaturally fast muscle growth
- beef that complies with all other national laws and regulations with regards the production of meat and beef.

1.3 Research objectives

As mentioned in section 1.2, the problem is to determine which supply chain strategies will be suitable for the delivery of naturally fed beef from Limpopo. In order to find a possible solution or solutions to the stated problem, the following research objectives were formulated:

- To develop an "integrated supply chain" approach for the delivery of naturally fed beef from Limpopo.
- To gain insight into the external factors that would impact on an integrated supply chain for the delivery of naturally fed beef from Limpopo.
- To gain insight into the internal operational elements of an integrated supply chain for the delivery of naturally fed beef from Limpopo.
- To gain insight into the way in which such a supply chain should be managed.
- To gain insight into the expected market requirements for naturally fed beef from Limpopo.
- To design supply chain configurations that would likely be successful in delivering the products according to market requirements.
- To perform numerical simulations on the supply chain configurations as developed above, evaluate and rank them according to profitability.

1.4 Limitations of study

For this study, the market is assumed to be within the boundaries of South Africa. The reason for this decision is based on the fact that South Africa is currently a net importer of beef and it would not be beneficial to the country to export more beef. Furthermore, according to the Red Meat Abattoir Association (Neethling, 2008), there is currently not a single abattoir in South Africa that complies with European standards.

In some cases, relatively small sample sizes were obtained through the questionnaires. This was due to time restraints and the fact that questionnaires for multiple role players were developed and sent out.

Due to the lack of perfect information, some assumptions have had to be made, especially regarding the market size, location and pricing of naturally fed beef. This will inevitably lead to some uncertainty in the results obtained by the simulation models. However, this uncertainty has been mitigated to a degree by performing sensitivity analyses on the parameters that have the greatest impact on the profitability of the supply chain.

1.5 Research type

The research can be classified as applied research, since the aim was to solve a specific problem regarding suitable supply chain strategies for naturally fed beef from Limpopo.

To a certain degree, the research is also explorative in the sense that "conceptual market offerings" for naturally fed beef from Limpopo have been developed. These conceptual offerings were tested in the market, but the results from the questionnaires should be viewed as explorative and tentative.

Both quantitative and qualitative techniques were used. Quantitative methods were used for the value delivery processes in the supply chain that could be quantified, whereas qualitative research was used for instance in determining the market preferences and sizes.

1.6 Research Methodology

The research was performed through a nine step process. Only the process steps are listed below, but details regarding each step are discussed comprehensively in Chapter 3 of this report:

Step 1: A literature survey.
Step 2: Unstructured interviews and discussions.
Step 3: Visits to farms, abattoirs and butcheries.

Step 4: Gathering, processing and interpretation of data through structured questionnaires to farmers, abattoirs, butcheries, meat processors and meat retailers.

Step 5: Development of conceptual naturally fed beef products.

Step 6: Gathering, processing and interpretation of data through structured questionnaires to consumers of beef, to test the market for the conceptual products as developed in Step 5.

Step 7: Estimation of the market size and requirements for naturally fed beef from Limpopo.

Step 8: Synthesis of the insight gained through steps 1 to 7 above, to design supply chains for naturally fed beef that would likely be successful.

Step 9: Simulation and evaluation of the supply chain designs as were developed in step 8.

1.7 Report structure and organisation

The report is structured in the following way:

Chapter 2 describes the philosophy, theories and approach regarding the research as well as the management of the supply chain. Chapter 3 gives a comprehensive description of the research methods. Chapter 4 describes the external environment that impacts on the supply chain, and needs to be taken into consideration when developing supply chain strategies. Chapter 5 describes the elements of production that would be required to produce naturally fed beef from the Limpopo province. Chapter 6 describes the market for beef and naturally fed beef.

The numerical simulations of the different supply chain configurations are discussed in Chapter 7. Finally, the conclusions and recommendations are discussed in Chapter 8.

Chapter 2: An integrated supply chain for naturally fed beef from Limpopo

2.1 Introduction

Following the background of the beef industry, as presented in chapter 2, this chapter will explain the "integrated supply chain view" for naturally fed beef from Limpopo. The objectives of this chapter are to:

- give a definition of supply chain management
- explain the most important features of a supply chain
- discuss the management tasks of a supply chain
- explain the view of an integrated supply chain operating as a single team
- consider the current South African beef supply chain and from it derive a conceptual, high level supply chain for naturally fed beef
- briefly explain the "system's view", where in order to optimise the whole, the separate parts cannot all be optimised.

2.2 Definition and aspects of supply chain management

According to Hugo, Badenhorst-Weiss & van Biljon (2006), supply chain management can be defined as follows:

"Supply chain management is a management philosophy aimed at integrating a network (or a web) of upstream linkages (sources of supply), internal linkages inside the organisation and downstream linkages (distribution and ultimate customers) in performing specific processes and activities that will ultimately create and optimise value for the customer in the form of products and services which are specifically aimed at satisfying customer demands.

The supply chain itself is defined as follows: (Hugo et al., 2006)

"The supply chain is the network of organisations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services in the hands of the ultimate customer."

The most important features of a successful supply chain are:

- It needs to be **customer driven**. The customer in reality defines the product and this information is fed back into the supply chain, such that the customer in reality becomes a partner in the supply chain.
- Sales planning must be **demand driven**, not production driven. Sales volume and mix need to drive the flow through the supply chain and the very structure of the supply chain needs to be designed according to demand patterns.
- Manufacturing and operations need to be **synchronised with demand**, flexible to adapt to market changes, cost effective, quality conscious and need to reduce cycle times.
- **Efficient logistics** processes need to be in place. This implies that inventory management, transportation, distribution systems, warehousing and order processing and delivery should be integrated with demand and internal processes of the supply chain.
- It needs to have **an integrated information system**, where demand from the end user needs to be communicated to the supply chain – right through to the primary producer. This will keep supply chain operations synchronised and will reduce losses and eliminate unnecessary inventory holding through the supply chain.
- **Sourcing** of products and services, including outsourcing, is a very important process in the supply chain.

2.3 *The integrated supply chain within the context of its competitive environment*

The point of view taken throughout this study is that a supply chain should function as a fully integrated, single unit, hence work together as a cohesive team with a common goal. It can be argued that the goal of this integrated supply chain is to deliver the best possible customer value, in a profitable and sustainable fashion. The end result of integrated supply chain co-operation should also be to increase the value for each of the individual businesses that participates in the chain.

A practical example would be to compare a supply chain to a rugby team. The team as a whole only scores a try if a player crosses the try line with the ball and touches down. If a player knocks the ball on with an open try line just before him, the team as a whole does not score any points, no matter how brilliant the team has played to create the try scoring opportunity. In a beef supply chain, the "try is scored" only when the final consumer buys the beef from the butchery or supermarket – and is satisfied. One weak link in the chain would thus jeopardize brilliant performance from all other partners in the chain.

A schematic description of an integrated supply chain, functioning within its competitive space, is shown in Figure 2. 1 (Lawrence, Weber and Post, 2005 and author's own compilation). As can be seen, the competitive space is subject to external forces, which are continuously changing the environment in which the supply chain must compete. The external forces that will have an impact on the environment of the supply chain include:

- The natural environment.
- Technology.
- Government and politics.
- The ethical environment.
- Stakeholder expectations.
- The media.
- Economic factors.
- Legislation.

Depending on the nature of the business the relative importance of the above mentioned external forces will vary.

Through strategic planning, the current and expected future trends of the external forces must be analysed and their effects on the competitive space must be assessed. The design of the supply chain structure as well as the management thereof, will be strongly related to the way in which the collective management of the supply chain views the future developments of the competitive environment.

The more accurate the predictions of management regarding the future trends in the external forces and the better the assessment of how the changing forces will affect the competitive space, the more rugged will be the design and management of the supply chain and the higher the probability of survival and business success.

It is therefore in the best interest of the supply chain to not only work together as a team, but to understand clearly what common goal it is working towards, and why.

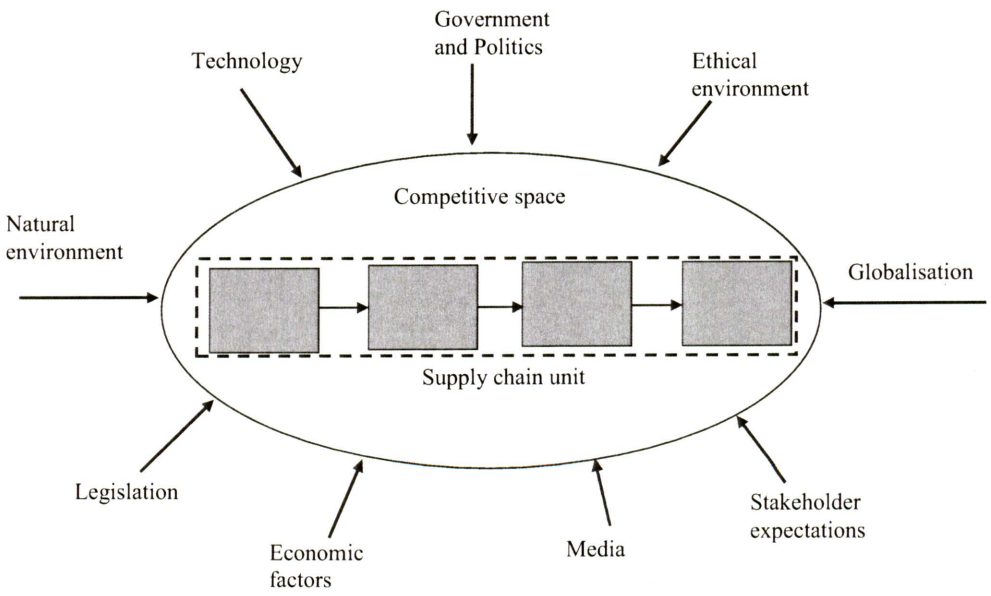

Figure 2. 1 – The integrated supply chain within the context of its competitive space.
Source: Lawrence, Weber and Post, 2005 and author's own compilation

2.4 The integrated supply chain for naturally fed beef from Limpopo

The general supply chain view as described in section 2.3 can now be applied to the supply chain for naturally fed beef from Limpopo. A representative diagram of the South African beef supply chain is shown in Figure 2. 2 (Olivier, 2004).

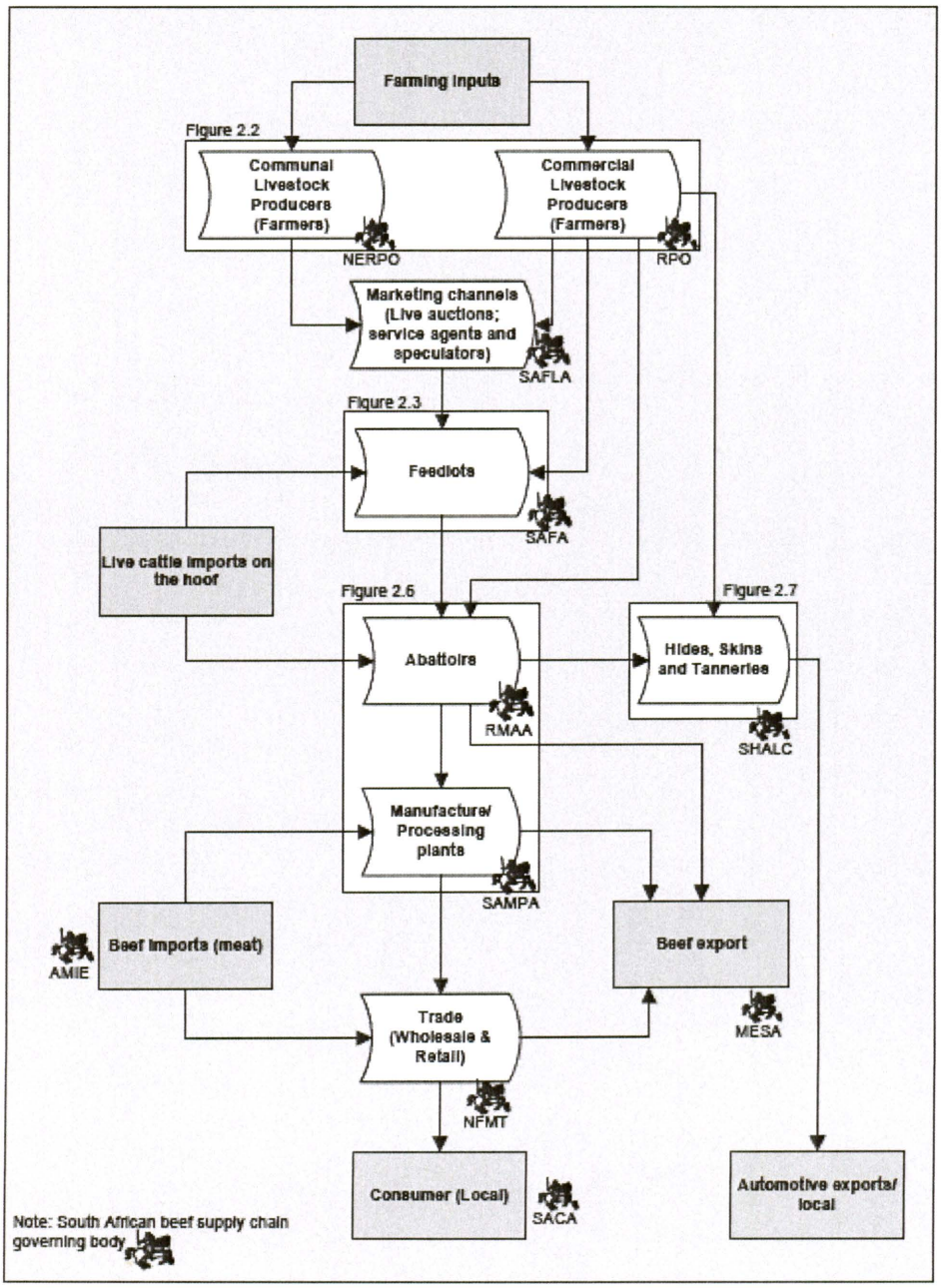

Figure 2. 2 - Diagram of the current South African beef supply chain.
Source: Olivier, 2004

For the purposes of this research project, which focuses only on naturally fed beef, some of the supply chain elements as shown in Figure 2. 2 are not included. The following assumptions were made, which implies that only selected elements were used in the supply chain for the natural beef:

- Only commercial farming processes were considered.
- The auctioneering element was not required or considered in this study.
- Imports and exports of cattle were not considered as it would result in an overly complex supply chain.
- The hides and skins processing and use by the automotive industry was not considered.
- Feedlots were not considered, since the focus of the study was specifically to consider the supply chain for naturally fed beef.

Given the above assumptions, the supply chain for naturally fed beef from Limpopo are shown diagrammatically in Figure 2. 3. As can be seen, this supply chain consists out of 7 elements, namely:

- Beef cattle farming in Limpopo
- The abattoir function
- Meat processing and packing function
- The sales channel
- Logistics (inventory, warehousing, transportation)
- The market for naturally fed beef (final consumer)
- The management function, typically as performed by a vantage point manager.

The supply chain as shown in Figure 2. 3 is only a conceptual, or high level process model. It gives a generic base from which different supply chain configurations can be designed. The detail design of the supply chain can only be completed once the market requirements, as well as the characteristics of the supply chain elements are understood. Analyses of detailed supply chain configurations are performed in chapter 8, following the chapters describing the operational, market and managerial elements of the supply chain.

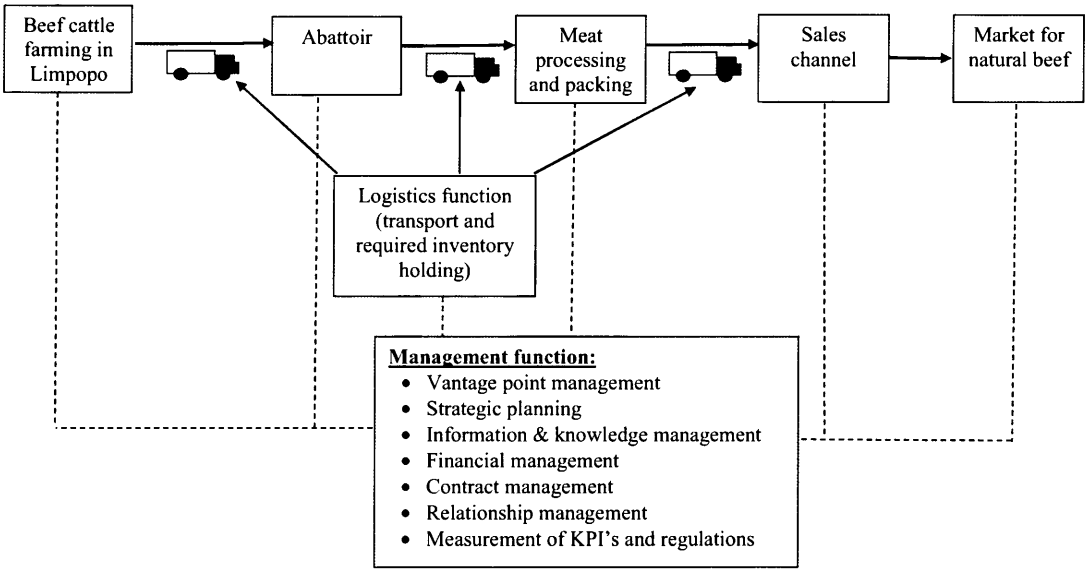

Figure 2. 3 - Conceptual supply chain for naturally fed beef from Limpopo.
Source: Author's own design

2.5 *The systems view – optimization of the whole instead of the parts*

A system is built up from a number of elements, with certain interrelationships between these elements. The combination of the characteristics of the elements and their interrelationships determines the characteristics of the system as a whole. One of the counter intuitive attributes of a system is that to optimise the performance of a system as a whole, one should in fact not optimise each element in the system individually. This principle is part of the so-called "theory of constraints". (Goldratt and Cox, 2004)

To illustrate this concept, consider the following two simplified examples:

Example 1 – Process with an internal constraint

Consider the process as shown in Figure 2. 4. The market demand for the completed product is 12 units per day. The bottleneck, or constraint, in this system is the manufacturing of component A, of which only eight parts a day can be manufactured. (The constraint is thus internal). Even though we can produce 12 component B's, it will be a waste of effort to do so because payment only occurs when the final product is delivered to the market. If, in the name of a high utilization rate, component B is

continuously produced at a rate of 12 parts per day, the stockpile before the assembly process will continue to grow by four parts per day. This will tie up cash, more storage space will be required and components can get lost or damaged – this is certainly not optimal.

The system as a whole is thus the most efficient when only eight component B's are produced every day – hence the utilization rate for component B is only 67 %.

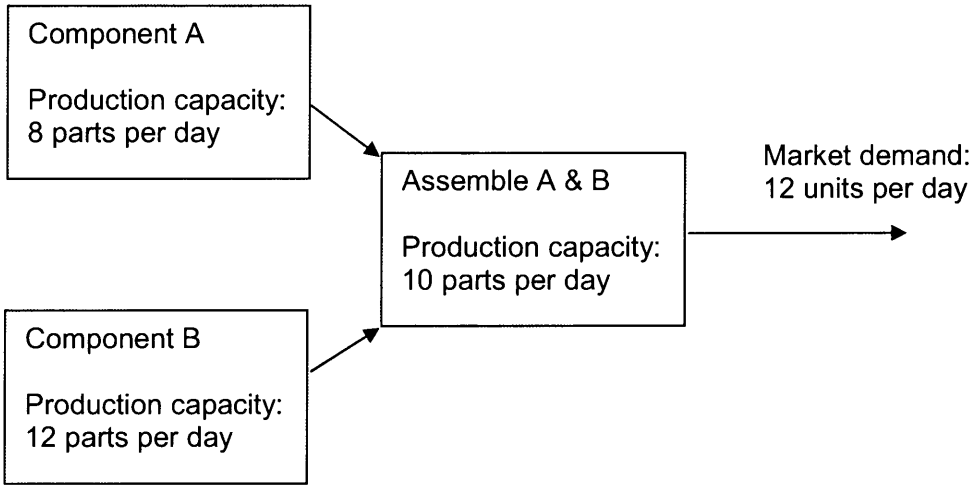

Figure 2. 4 – Simple production process and market demand.
Source: Author's own design

Example 2 – Process with an external constraint

Consider the case where a factory is manufacturing a product. The capacity of the factory is 3000 products per month. Assume that the fixed cost of this factory is R100 000 per month. Variable cost is R 60 per product. Assume that, based on economic demand theory, the product has a high price elasticity. Hence:

- If the product is sold at R 100; 3000 products are sold per month.
- If the product is sold at R 150; 2000 products are sold per month.
- If the product is sold at R 200; 1000 products are sold per month.

The respective profits for these three scenarios are:

- Profit 1 = (100-60)x3000 – 100000 = R 20 000.
- Profit 2 = (150-60)x2000 – 100000 = R 80 000.
- Profit 3 = (200-60)x1000 – 100000 = R 40 000.

The second option, resulting in a profit of R 80 000, is the most profitable. Note that this option is neither the one with the highest profit margin per product, nor the one where the production is fully utilized. Once again production of this factory is only at two thirds of the maximum capacity, hence utilization is at 67 %.

These two examples illustrate the fact that to optimise system performance, the performance of all links in the chain cannot be optimised. It is important to determine where the constraint is, in other words external or internal, and manage the business around the constraint.

2.6 Managing the supply chain

According to Hugo et al (2006), the following are important tasks to be performed to ensure successful supply chain management:

- Design the supply chain for strategic advantage. The supply chain should be managed as a single system, to gain strategic advantage in the market in terms of customer requirements.
- Create a seamless supply chain operation by coordinating and integrating all activities and processes.
- Implement long term relationships. Collaborative relationships through partnering, strategic alliances and non-formal associations all assist in adding value to the supply chain. This would require the services of highly skilled relationship managers.
- Managing supply chain information. Free flow of relevant information is one of the most important enabling factors of an integrated supply chain.

- Assessing the performance of the entire supply chain. The most important supply chain metrics should be measured and the supply chain should be improved continuously to increase efficiency, customer value and profitability.

Some of the most important aspects of managing a supply chain for naturally fed beef will now be discussed in further detail:

Process management as opposed to functional management

The traditional model for managing a network of businesses is more or less as follows: Each business unit works separately to produce required products or services and to pass them on to downstream business units who then perform further processing. This sequence of events continues until the final product or service is delivered to the customer. The philosophy of management in this model is that every business works on its own, and tries to optimise its own situation. This is performed through functional management, where each department in the business such as engineering, production, finance, procurement, human resources etc. operate within functional silo's, hence with communication barriers between each department. The reasoning behind this structure is that it will provide the most efficient company, with each department functioning as a specialised unit, resulting in optimal departmental efficiency. However, as discussed earlier in section 2.5 of this report, in order to optimise the system as a whole, the objective should not be to optimise the elements individually.

Rather, in order to optimise the system as a whole, one should view the supply chain from a process point of view. In an optimised process, each process element is not necessarily working at optimum capacity or efficiency. Instead, the process elements operate in such a fashion that the combined effect of the interrelationships between the elements results in optimum process performance.

In a complex supply chain though, this concept is not easy to sell to the members nor to implement and manage, and will probably present the manager with his toughest challenge. It is not within the scope of this research to go deeper into this aspect. It is however important to take note that this approach can dramatically increase the competitive advantage of the supply chain, if all the elements play together as one team.

Vantage point management

Relating to the process management approach as described above, the concept of the so-called "vantage point manager" should be adopted.

The basic definition of business management includes planning, organisation, execution and control in order to successfully reach the business objectives. The vantage point manager will thus have to ensure that these four aspects are in place.

However, vantage point management goes beyond the basic definition of management. Vantage point management can be compared to "helicopter view management". A helicopter can move up and down vertically, but also forward and backwards. The vantage point manager should be able to watch the process as a whole (from a height), but also be able to zoom into the details (like helicopter hovering just above the ground). He should have access to all information across the supply chain (like helicopter moving forwards and backwards). Just as a helicopter can climb very high and see the horizons, the vantage point manager must also be able to scan the external environment, in order to make strategic decisions.

According to Storey (2002), the key general management issues regarding managing a supply chain are:

- **Logics** – This element is concerned with the logic or rationale that is used to base decisions on. For instance – on what basis is a decision made on whether activities are outsourced or sourced internally? At what level in organizations are decisions about integrative relations made?
- **Structure** – Where outsourcing is chosen, does a firm choose to source from one or many suppliers, and why? Across how many tiers in the supply chain is influence attempted? How are the institutionalized, functional "barons" dissolved or contained in order to enable supply chain management?
- **Practices and processes** – What scope of influence and intervention is exercised by customers in supplier operations? Who manages the supply chain and how? What norms and rules operate under the form of supply chain management practiced?
- **Change** – What "unlearning" of traditional assumptions and behaviour patterns is required? What institutionalized patterns of behaviour tend to impede supply

change management? What is the change strategy adopted as part of the implementation of the supply chain?

- **Capabilities** – What range of new roles is required? What behavioural attributes and capabilities are most needed by those occupying these roles? What specialised capabilities are required and where are these capabilities sourced from?

The simulations performed in Chapter 7 of this report are, to an extent, examples of vantage point management since each supply chain configuration is viewed as a singular process with a common goal. At the same time details about each separate element in the process is available. This enables the manager to analyse different supply chain configurations, as well as the economic potential of each supply chain.

The bullwhip effect and an integrated information system

The bullwhip effect is caused by the combination of a lack of communication between supply chain partners and variability in demand and demand forecasting.

The higher the variability in demand, the more inaccurate demand forecasting becomes. In order to protect against stock outs in this environment, higher levels of inventory must be kept (Paik and Bagchi, 2007). When the final link in the chain, such as the retail outlet, experiences variable demand, it would typically order variable amounts of supply from the previous element in the chain, for instance the wholesaler. Because of the lack of communication between the two businesses, the wholesaler can also only forecast what the demand from the retailer might be. The forecast inaccuracy is thus amplified, and the only way to protect against stock-outs would be for the wholesaler to keep even higher levels of inventory. As this effect goes on along the supply chain, the forecast inaccuracy is continuously amplified. The end result is that the producers in the beginning of the chain keep far more inventory than is really required. This unnecessary inventory holding results in cash being tied up in unproductive inventory, more storage space required, damage and losses. It also causes the supply chain to be much less responsive to change.

The suggested ways to solve this problem are:

- Install an integrated information system that makes final demand figures available to all supply chain participants. This will ensure that production is "pulled" through the supply chain, as opposed to being pushed.
- Manage the supply chain according to the principles of the "Theory of Constraints". This is discussed in more detail in the following section:

Identifying and managing the constraint

As was shown in section 2.5, the key to optimising the profit for a business system is to manage the constraint of the business effectively. The following steps are suggested for optimal process performance (Goldratt and Cox, 2004):

Step 1: Identify the system's constraint (bottleneck). Is the constraint internal or external, and where exactly is it located?

Step 2: Decide how to exploit the constraint. Is the constraint resource performing optimally? If not, take action to increase productivity of the constraint.

Step 3: Subordinate all other processes to the constraint. Hence, non-constraint processes should not work faster than the constraint, as this will only lead to waste. The constraint resource should also be protected by an inventory buffer, but inventory buffers are not required for any other non-constraint resources.

Step 4: Elevate the system's constraints. This may mean using capital investment to increase the capacity of a production constraint. If the constraint is in the market, advertising, product differentiation or research and development may need to be increased in order to increase sales.

Step 5: Go back to step 1. If the constraint has now been "broken", hence the bottleneck has shifted to a different place, repeat the process on that resource.

A comparison between two supply chains (Holt, 2007), the first a non co-operative supply chain and the second a co-operative supply chain managed according to the theory of constraints, is shown in Figure 2. 5 (Holt, 2007) and Figure 2. 6 (Holt, 2007) respectively.

It can be seen that unnecessary inventory is held along the non co-operative supply chain, whereas inventory is only held before the production constraint and the market in the second supply chain, which is desirable.

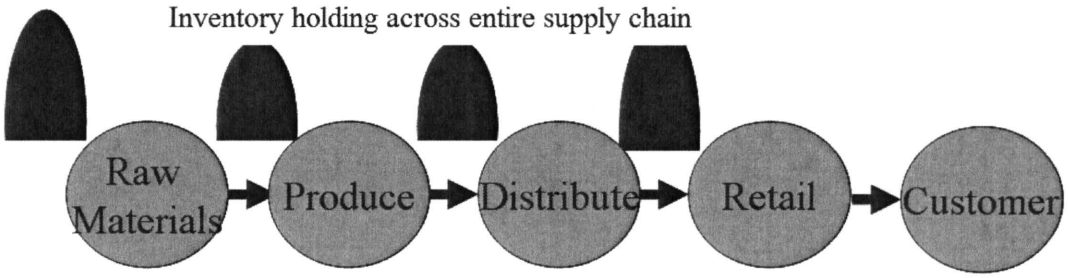

Figure 2. 5 – Example of inventory holding when each business is working separately.
Source: Holt, 2007

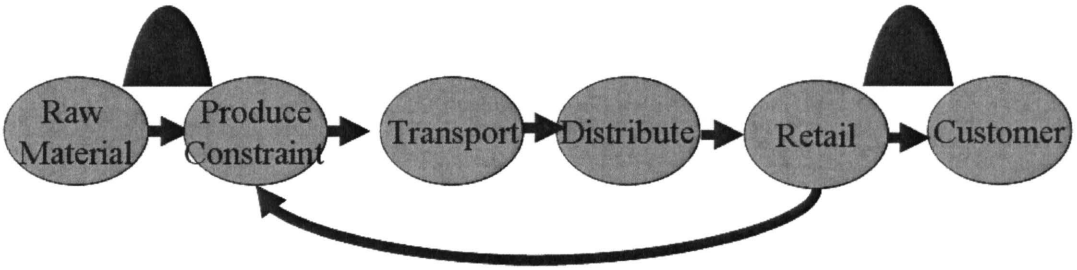

Figure 2. 6 - Example of inventory holding when businesses are working together, with the focus of management being on the system's constraint.
Source: Holt, 2007

Relationship and contractual management

It has been said that relationship management is the "glue that holds the supply chain together". Earlier it was argued that the supply chain should work together as one team. However, no team is guaranteed that good players will always stay loyal to the team. Star players are often attracted by other teams that are willing to pay good money and will not stay if they are not satisfied with the environment. Similarly, a supply chain cannot assume that all of its members will simply remain within the supply chain. The operating environment within the supply chain needs to be such that members feel that it makes economic sense and they want to stay within the structure.

According to Hugo et al. (2006) the long term success of partnerships in the supply chain depends on three factors, namely:

- Mutual strategic and operational goals.
- Two way performance measurements.
- Formal and informal feedback mechanisms.

It is therefore important that these three factors be given high priority as part of the relationship management strategy across the supply chain.

Measurement and continuous improvement of supply chain performance

In order to measure and continually improve supply chain performance, it is suggested (Hugo et al, 2006) that there are four main steps that need to be taken:

- Map the supply chain.
- Measure supply chain performance.
- Benchmark and compare.
- Improve performance.

An example of supply chain mapping is provided in Chapter 7 of this report, where the maps for two main supply chain configurations were developed (refer to Figure 7. 1 and Figure 7. 2).

Theoretical supply chain performance (operational and financial) was also tracked by the simulation models developed in Chapter 7.

In a sense, benchmarking measurements were also performed as the financial performance of nine simulation cases were compared in terms of total supply chain profit and total supply chain return on investment.

In a real life situation, it is suggested that a well-established measurement method such as the balanced scorecard be used to evaluate supply chain performance. The balanced scorecard measures performance in four key areas, namely financial, customer, business processes and innovation and learning.

Typical key performance indicators (KPI's) that should be measured include:

- Customer satisfaction (for instance perfect order fulfillment, forecasting accuracy, on time delivery).
- Time (for instance supply chain response time, end-to-end pipeline time, order cycle time).
- Costs (for instance total supply chain costs, finished good inventory turns, costs of excess capacity, costs of shortages).
- Assets (for instance supply chain inventory days, net asset turns, cash-to-cash cycle times).
- Innovation (for instance new product technology introductions, new process technology development, strategic partnership development).

The Japanese word for continuous improvement is kaizen. This forms the base of the Total Quality Management (TQM) philosophy which is a "never ending and all encompassing cycle", consisting of four activities: Plan, Do, Check, Act.

- Plan: The process is analysed, and problems and constraints are identified.
- Do: The plan is now implemented. Depending on the level of risk associated with making changes, the implementation can be done on small scale first (high risk) or on large scale (low risk).
- Check: The results of the implemented plan are evaluated and reviewed.
- Act: If the problem has been successfully solved or the process improved, the method is accepted and standardised.

At this point the author would like to stress that a combination of a continuous improvement process and a theory of constraint approach as discussed earlier is likely to be the most effective method to build competitive advantage in the supply chain.

2.7 Summary

This chapter has defined supply chain management and the importance thereof. Important supply chain management theory has been discussed. A conceptual framework has been developed for both the external environment and the internal

elements and linkages in the supply chain for naturally fed beef from Limpopo. The most important issues discussed in this chapter are:

- An integrated supply chain competes as a single unit or team within its competitive space that is influenced by external forces.
- The supply chain should be managed as a process, as opposed to a collection of separate functional silos.
- The importance of optimizing the system as a whole, as opposed to trying to optimise each of the components separately, was illustrated using the theory of constraints.
- The supply chain should be managed by an unbiased vantage point manager who focuses on optimizing the process as a whole.
- The vantage point manager should excel in relationship management.
- The performance of the supply chain as a whole should be measured and improved continuously in order to build sustainable competitive advantage.

In chapter 3, the research methodology will be discussed.

Chapter 3: Research Methods

3.1 Introduction

An introduction to the research, as well as the main research objective (to determine suitable supply chain strategies for the delivery of naturally fed beef from Limpopo), was discussed in Chapter 1. The underlying philosophy that forms the cornerstone of the research was explained in Chapter 2. The objective of this chapter is to explain the research methodology that was followed to arrive at the research objective.

3.2 Problem statement

The problem, or main question to be addressed through this research is:

"What supply chain strategies would be suitable for the profitable delivery of naturally fed beef from the Limpopo province?"

For the purposes of this study, naturally fed beef is defined as:

- Beef from cattle that have not been confined in feedlots, hence they have spent their lives on natural pasture.
- Beef from cattle that have not been fed any growth stimulants and related antibiotics which causes unnaturally fast muscle growth.
- Beef that complies with all other national laws and regulations with regards the production of meat and beef.

3.3 Research objectives

In order to answer the question as defined in the problem statement, the following objectives need to be achieved:

- To develop a unique approach in terms of an integrated supply chain for the delivery of naturally fed beef from Limpopo.
- To gain insight into the external factors that would impact on an integrated supply chain for the delivery of naturally fed beef from Limpopo.

- To gain insight into the internal operational elements of an integrated supply chain for the delivery of naturally fed beef from Limpopo.
- To gain insight into the way in which such a supply chain should be managed.
- To gain insight into the expected market requirements for naturally fed beef from Limpopo.
- To design supply chain configurations that would likely be successful in delivering the products according to market requirements.
- To perform numerical simulations on the supply chain configurations as developed above, and evaluate and rank them according to profitability.

3.4 Research type

The research can be classified as applied research, since the aim was to solve a specific problem regarding suitable supply chain strategies for naturally fed beef from Limpopo.

To a certain degree, the research is also explorative in the sense that "conceptual market offerings" for naturally fed beef from Limpopo have been developed. These conceptual offerings were tested in the market, but the results from the questionnaires should be viewed as explorative and tentative.

Both quantitative and qualitative techniques were used. Quantitative methods were used for the value delivery processes in the supply chain that could be quantified, whereas qualitative research was used for instance in determining the market preferences and sizes.

3.5 Research methodology

The research methodology can be viewed as a nine step process, where all the steps follow sequentially on each other. These nine steps are listed below:

Step 1: A literature survey.
Step 2: Unstructured interviews and discussions.
Step 3: Visits to farms, abattoirs and butcheries.

Step 4: Gathering, processing and interpretation of data through structured questionnaires to farmers, abattoirs, butcheries, meat processors and meat retailers.

Step 5: Development of conceptual naturally fed beef products.

Step 6: Gathering, processing and interpretation of data through structured questionnaires to consumers of beef, to test the market for the conceptual products as developed in Step 5.

Step 7: Estimation of the market size and requirements for naturally fed beef from Limpopo.

Step 8: Synthesis of the insight gained through steps 1 to 7 above, to design supply chains for naturally fed beef that would likely be successful.

Step 9: Simulation and evaluation of the supply chain designs as were developed in step 8.

These steps are now discussed in more detail in the remainder of this section.

Step 1 - Literature survey

A literature survey was conducted to provide a basic background for the research. Literature regarding the following topics was surveyed:

- Theory of supply chain management.
- The current economic climate in South Africa.
- The market for beef as well as naturally fed and organic beef, in South Africa and in global markets.
- Technology in the beef supply chain.
- The ethics surrounding production of meat from animals.
- Beef cattle farming in the Limpopo province. In this regard the most important aspects included pasture types, rainfall patterns and carrying capacity of land.
- Literature regarding production processes in the supply chain, including abattoirs, logistics, processing and sales channels.
- Operations management theory.

Step 2 - Unstructured interviews and discussions

A number of informal interviews and discussions were held with key people. As the author had no previous experience of the beef industry on commencing the research, nor were there comprehensive and integrated primary sources of information available, it was important to have discussions with some of the important role players in the industry. This step was intended to assist in building a frame of reference upon which the research could be built. In most cases, these discussions helped to form an understanding of the factors influencing the beef supply chain and aided in defining the research questions for the structured questionnaires. The following people were interviewed:

- The chief executive officer of the South African Meat Industry Company (SAMIC) (Booysen, 2007). SAMIC is the custodian of the red meat industry in South Africa. The vision of SAMIC is to promote the long term global success of the South African red meat industry. Mr Booysen provided insight into the strategic and business perspective of the red meat industry in South Africa.
- A lecturer at the department of Agricultural Economics at the University of Pretoria (Louw, 2008). This provided insight into the role of the beef industry in the South African economy and some expected future trends regarding the beef industry.
- Managing Director (Neethling, 2008) of the South African Red Meat Abattoir Association (RMAA). Insight and information regarding abattoir processes in Limpopo was gained.
- A writer of recipe books (Paarman, 2007). A perspective was gained from the end consumer, i.e the person who prepares a meal using meat and beef.
- A senior researcher (Westfall, 2008) at the Agricultural Research Council (ARC) in Irene, who specializes in pastures and forage. Insight into pasture requirements for beef cattle was obtained.
- A specialist in climate change (Archer, 2008) of the Department of Archaeology and Environmental Studies, University of the Witwatersrand. An understanding of possible future trends regarding the climate in Limpopo was gained.
- A nutritional scientist (Du Bruyn, 2008) who did a master's degree at the Agricultural Research Council (ARC) in Irene regarding the technical aspects of

beef and who is also a lecturer at Vista University. Insight into the technical attributes of naturally fed beef was gained.

Step 3 - Visits to farms, abattoirs and butcheries

As was mentioned in the previous step, the author had no previous experience of the beef supply chain. It was therefore deemed necessary to visit a number of role players in the beef supply chain, to gain a better understanding of the process. Informal discussions were held with managers of these businesses, and where possible photographs were taken of their operations. This served to give some practical understanding of the supply chain and also assisted to gain enough knowledge to define the structured questionnaires in a sensible way. The following people were visited:

- A beef cattle farmer and feedlot owner near Gravelotte (Warren, 2008).
- A beef cattle farmer near Gravelotte (Van der Merwe, 2008).
- A beef cattle farmer near Vivo (Smit, 2008).
- A manager of the Venkor abattoir near Polokwane (Venter, 2008).
- A manager of Doornbult feedlot near Polokwane (Potgieter, 2008).
- A manager of Vaalwater butchery (Steenkamp, 2008).
- A beef cattle farmer near Alma (Van Heerden, 2008).
- A manager of King's Meat Deli in Erasmuskloof, Pretoria (Viljoen, 2008).

Step 4 - Structured questionnaires to farmers, abattoirs, butcheries, meat processors and meat retailers

Structured questionnaires were sent to the following role players in the beef supply chain:

- Beef cattle farmers in the Limpopo province.
- Abattoirs in the Limpopo province.
- Butcheries and meat processing plants.
- Retailers of meat.

The purpose of these questionnaires were to obtain relevant information which could be used in the simulation models (performed in step 8). The questionnaires sent out to the above mentioned role players are located in Appendix A. Some of the technical aspects regarding the questionnaires will now be discussed:

Questionnaire for beef cattle farmers

This questionnaire consisted of 14 questions. The main purpose of the questionnaire was to determine the operational parameters such as number of cattle in the breeding stock, number of cattle sold each year, size of farmland used, type of cattle used, production system used and main risks associated with farming in Limpopo. The operational and capital costs were also required.

A few questions were asked about issues of secondary importance, such as the time that the farmer had been farming in Limpopo and his opinion about the future of cattle farming in Limpopo.

Applicable farmers were located by contacting the Red Meat Producer's Organisation (RPO) in Limpopo. They provided a list with Limpopo farmers' names and contact details. The questionnaire was sent out to 20 farmers in Limpopo, either by e-mail or fax, depending on the preference of the farmer. 11 farmers responded, hence a return rate of 55 % was achieved. Of the 11 farmers who responded, nine farmers use the weaner production system and two uses the speculation system on irrigated pasture in the Waterberg.

The sample of nine farmers is somewhat small, but probably reasonable. The sample of two farmers who use irrigated farmland is very small, but it is unlikely that the costs and production capacity on other irrigated pasture would differ radically from the values obtained on these two farms. The objective of this research was also to develop simulation models for integrated supply chain models and to compare different scenarios, rather than to have perfectly accurate information at each step of the model. Hence, for the purposes of this research, these sample sizes were considered acceptable.

The data was processed by entering the farmers' responses into a spreadsheet model (Microsoft Excel). The typical information required was either averaged values or percentages. Averaged values (for instance unit costs) were simply calculated by adding the values and dividing them by the total number of relevant units. Percentages (for instance cost component **x** as a percentage of total cost) were calculated by adding all the values for cost component **x** and dividing them by the sum of all the total costs. Due to the relatively small sample sizes obtained no data was filtered out – hence everything was used.

Questionnaire for abattoirs in Limpopo

This questionnaire consisted of 11 questions. The main purpose of the questionnaire was to determine the operational parameters such as capacity, utilization rate, percentage of income derived from beef cattle processing and processing time. Operational and capital costs were also required.

Suitable abattoirs were obtained from a list received from the RMAA (Red Meat Abattoir Association). The questionnaire was sent out to 12 abattoirs in Limpopo, either by e-mail or fax, depending on the respondent's preferences. Seven abattoirs responded, hence a response rate of 58 % was obtained. Taking into account that there are currently only 22 operating abattoirs (RMAA, 2008) in the Limpopo province, the response from seven abattoirs is seen as reasonable.

The data was processed by entering the abattoirs' responses into a spreadsheet model (Microsoft Excel). The typical information required was either averaged values or percentages. Averaged values (for instance unit costs) were simply calculated by adding the values and dividing them by the total number of relevant units. Percentages (for instance cost component **x** as a percentage of total cost) were calculated by adding all the values for cost component **x** and dividing them by the sum of all the total costs. Due to the relatively small sample sizes obtained no data was filtered out – hence everything was used.

Questionnaire for butcheries and meat processing plants

This questionnaire consisted of 13 questions. The main purpose of the questionnaire was to determine the operational parameters such as quantity processed and sold,

percentage of income derived from beef products, percentage split between hind and fore quarter meat sold, percentage of naturally fed beef sold and process time. Operational and capital costs were also required.

The questionnaire was sent out to seven butcheries, all by e-mail. Four butcheries responded, hence a response rate of 57 %. The sample size is therefore also relatively small. However, for the purposes of this study it is seen as adequate.

Unfortunately, only one central meat processing plant that was willing to share information could be located. This is a very small sample and it would be better if information from more of these plants can be obtained.

The data was processed by entering the butcheries' responses into a spreadsheet model (Microsoft Excel). The typical information required were either averaged values or percentages. Averaged values (for instance unit costs) were simply calculated by adding the values and dividing them by the total number of relevant units. Percentages (for instance cost component **x** as a percentage of total cost) were calculated by adding all the values for cost component **x** and dividing them by the sum of all the total costs. Due to the relatively small sample sizes obtained no data was filtered out – hence everything was used.

Questionnaires for meat retailers

These questionnaires consisted of 15 questions. The main purpose of the questionnaires was to determine the operational parameters such as quantity of beef sold, percentage of income derived from beef products, percentage split between hind and fore quarter meat sold, percentage of naturally fed beef sold and process time. Operational and capital costs were also required.

These questionnaires were sent out to five retailers (four large chain retailers and one specialized meat franchise), all by e-mail. Three retailers responded, hence a return rate of 60 %. However, only one retailer was willing to share useful information on costs and volumes sold, so that in effect the retailer data for the simulation models was based on only one respondent. As was the case with the meat processing plant, a sample of one is very small and tentative at best. However, it is repeated that the main purpose of this

study was to develop a method to compare separate supply chains for profitability. As long as the values are used consistently in the models, it is deemed as acceptable for the purposes of this study.

The data was processed by entering the retailers' responses into a spreadsheet model (Microsoft Excel). The typical information required were either averaged values or percentages. Averaged values (for instance unit costs) were simply calculated by adding the values and dividing them by the total number of relevant units. Percentages (for instance cost component **x** as a percentage of total cost) were calculated by adding all the values for cost component **x** and dividing them by the sum of all the total costs. Due to the relatively small sample sizes obtained no data was filtered out – hence everything was used.

Step 5 – Development of conceptual naturally fed beef products

This step can be regarded as an explorative part of the research. It was deemed necessary because naturally fed beef is not sold on large scale in South Africa. The other (more important) problem was that the retailers of the existing naturally fed beef were not willing to share any relevant information with the author, claiming that the information is confidential. This lack of information and co-operation from the large retailer groups came as an unexpected obstacle. The author was faced with the dilemma of not having any relevant data on the market for naturally fed beef, thus to come up with a solution that, if not exactly correct, would at least be a reasonable approximation in the correct order of magnitude.

This led to the development of two conceptual types of beef:

- Type A natural beef, produced from irrigated pastures in the Waterberg region.
- Type B natural beef, produced from natural pastures in the arid parts of Limpopo.

This step may perhaps be criticised as not being completely scientific, but rather tentative or explorative.

(However, this step forced the author to really think deeply about what it is that consumers really want from beef and natural beef. In this way, more insight was gained

about the market than would have been the case if the sales volumes and prices were directly available.)

Step 6 – Structured questionnaires to consumers of beef

These questionnaires consisted of seven questions. The purpose of these questionnaires were to determine consumers' general opinion on beef, gross household monthly income, number of people in the household, average monthly expenditure on beef products and preferred location to buy beef from.

Furthermore, the consumer's willingness to pay a premium for the "Type A" and a "Type B" beef as mentioned in Step 5, was assessed. The attributes of the two types of natural beef were described to the consumers and they could select whether they would be willing to pay a premium for the two types of beef, and if so how much more they would be willing to pay.

These questionnaires were given to consumers at two shopping malls, over a period of two days. Consumers were requested to fill in the relatively short questionnaire in about 5 minutes, on the spot. A total of 56 questionnaires were completed, which is regarded as a reasonably high number.

The data was processed by entering the consumers' responses on a spreadsheet model (Microsoft Excel). The typical information required was either averaged values or percentages. Averaged values (for instance unit costs) were simply calculated by adding the values and dividing them by the total number of relevant units. Percentages (for instance cost component **x** as a percentage of total cost) were calculated by adding all the values for cost component **x** and dividing them by the sum of all the total costs. All data was used.

Step 7 – Estimation of the market size and requirements for naturally fed beef from Limpopo

This step was performed by taking existing data for (feedlot) beef and combining it with other population statistics as well as the information received from the questionnaires as discussed in step 6.

This step can also be seen as an explorative part of the research, as the exactness of the obtained results may rightfully be questioned.

However, once again the author's justification of this method is that it is better to estimate a potential market size, location and pricing that is at least reasonable and in the right order of magnitude than to not have any estimate at all.

As was mentioned before, the true value of this research lies in the way in which the different supply chain configurations are analysed as co-operative systems, and profitability between each configuration is compared.

Step 8 – Synthesis of insight to design supply chain configurations

The insight developed through steps 1 to 7 above were used to design sensible supply chain configurations that would likely be successful and profitable. Normal supply chain elements such as production, transport, warehousing and retailing were used in the models.

The most important parameters that would influence the profitability of the supply chain were also identified. These identified parameters were varied in different simulation cases. A total of nine simulation cases were constructed.

Step 9 – Simulation and evaluation of supply chain designs

In order to perform the simulations, numerical models were created using spreadsheet software (Microsoft Excel).

The numerical simulation consisted of two separate analyses, namely:

- A dynamic (time based) analysis.
- A static (process flow based) analysis.

The dynamic analysis considered weekly demand. Real life fluctuation in demand was simulated using the random function of the software. The fluctuating weekly demand for cattle, carcass quarters, sizing of inventory buffers, transportation and meat processing requirements were calculated by this analysis.

After the sizing and other important parameters of the supply chains were calculated through the dynamic analyses, static analyses were performed. The static analyses considered the supply chain as a process flow diagram, where total income, operational costs and investment costs are based upon process parameters. Only constant, annual values were used in the static models. The static models were used to compare different supply chain configurations with each other and assess the influence of varying important parameters such as sales volume, sales price and input costs on overall supply chain profit.

The supply chain configurations were evaluated in a relatively unique way, in the sense that the performance of the supply chain as a whole was evaluated. The total supply chain profit, as well as return on investment for the supply chain as a whole were calculated.

The supply chains were thus evaluated and ranked according to profitability and return on investment.

3.6 Summary

The research was performed using a nine step process. The nine steps in the process were:

Step 1: A literature survey.
Step 2: Unstructured interviews and discussions.
Step 3: Visits to farms, abattoirs and butcheries.
Step 4: Gathering, processing and interpretation of data through structured questionnaires to farmers, abattoirs, butcheries, meat processors and meat retailers.

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Step 7: Estimation of the market size and requirements for naturally fed beef from Limpopo.

Step 8: Synthesis of the insight gained through steps 1 to 7 above, to design supply chains for naturally fed beef that would likely be successful.

Step 9: Simulation and evaluation of the supply chain designs as were developed in step 8.

Two of the steps above (step 5 and step 7) may potentially be criticised for being explorative and tentative as opposed to scientifically rigorous. However, they served to "bridge a gap" in the overall research process, and the information obtained from these two steps are probably reasonably realistic. It is also stressed that the main value of this research is in the unique way that the supply chains were evaluated and compared as entities or teams.

Having thoroughly discussed the research method, the external business environment will be discussed in Chapter 4. The operational elements of the supply chain and the market for beef and naturally fed beef and the management of the supply chain will be discussed in Chapters 5 and 6 respectively. The design and simulation of suitable supply chain strategies will be discussed in Chapter 7.

Chapter 4: The external environment impacting on the supply chain

4.1 Introduction

The purpose of this chapter is to describe the external context in which the beef industry operates, locally and abroad. As was described in Chapter 2, the supply chain of naturally fed beef should be seen as a value delivery system, operating inside an ever-changing business environment (or competitive space) that is shaped by a number of external factors (refer to Figure 2. 1). The external factors considered in this chapter are the South African economy, globalization, technology, government and politics, the natural environment, the ethical environment, legislation and stakeholder expectations.

4.2 Economic factors

The amount that households spend on food and consequently beef, is likely to be influenced by the general economic climate in the country. In general, one would expect that the higher the disposable income of households, the more expensive cuts of meat they would buy. On the other hand, as purchasing power decreases, consumers will be more price sensitive and will be likely to buy less expensive cuts and shop with a fixed budget.

Three of the main indicators that give an idea of the overall health of the economy are:

- The Gross Domestic Product (GDP) of the country. This is an indication of the total expenditure of the country as a whole.
- The inflation rate.
- The interest rates in the country, normally based upon the REPO rate.

These three indicators will now be discussed briefly:

The total annual GDP of the South African economy, ranging from 1993 to 2007, is plotted in Figure 4. 1 (www.statssa.co.za) . The values are based on 2000 prices, and are adjusted for inflation. As can be seen, the GDP has grown continuously over this

period – increasing by 64 % over this period. This is an indication that general economic growth in South Africa has been steady and reasonably good over the past 15 years.

However, when one considers Figure 4. 2 (www.statssa.co.za), it becomes clear that not all sectors have benefited equally from the good overall economic growth. In Figure 4. 2, the annual GDP values for two sectors in the South African economy are shown. The agriculture, fishing and forestry sector shows the worst performance, with almost no growth over the past 15 years. This is in sharp contrast with the transport, storage and communication sector, that has seen 136 % growth over this period.

Ironically, the supply chain as described earlier in Figure 2. 3 of this report, constitutes elements from both the agricultural sector and the transportation and warehousing sector. This huge discrepancy between the two sectors is certainly not healthy. It is about time that the agricultural sector, which has probably been neglected for a long time in the South African economy, be restored to its rightful place.

The inflation rate in South Africa (monthly figures), from the year 2000 is shown in Figure 4. 3 (www.statssa.co.za). The philosophy of the South African Reserve Bank is to target inflation, and keep inflation steady between 3 and 6 %. For the period between 2003 and the end of 2006, the inflation rate was kept within the upper and lower limits. However, from 2007 the inflation rate started creeping up and has recently broken through the 10% level again, for the first time in 5 years. This would be a reason for concern, as it puts pressure on the consumer's purchasing power.

The third economic indicator that is considered is the repo rate, as set by the Reserve Bank. The repo rate is the "price" that the commercial banks pay to the Reserve Bank to borrow money and they then lend it on to their own clients at a higher price. As can be seen in Figure 4. 4 (www.reservebank.co.za), the repo rate has climbed steadily over the last two years, following the upward trend in the inflation rate. This also decreases spending power in the South African economy.

The economic trends as discussed above are certainly not good news when one considers the potential market for naturally fed beef. Naturally fed beef will most likely be positioned as a higher priced product, and with consumers already feeling the pressure

of higher prices and less disposable income, there is likely to be an increased resistance against paying a premium price for a commodity like meat.

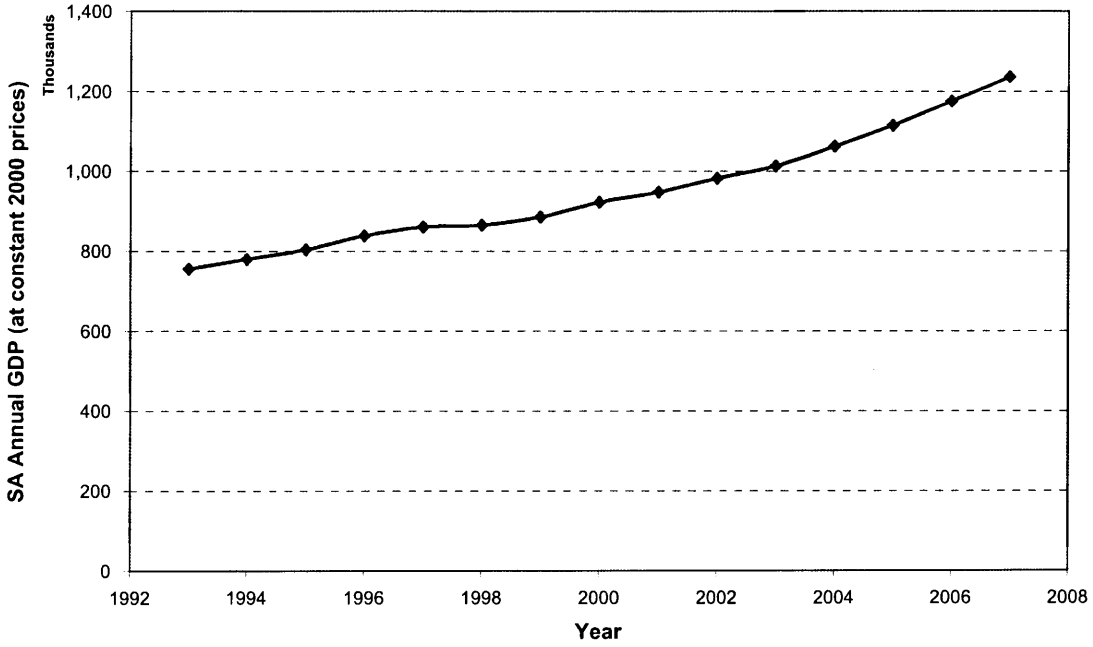


Figure 4. 1 - Total annual GDP of South Africa, from 1993 to 2007, at constant 2000 prices.
Source: Data from Statistics South Africa website (www.statssa.co.za)
Graph by the author

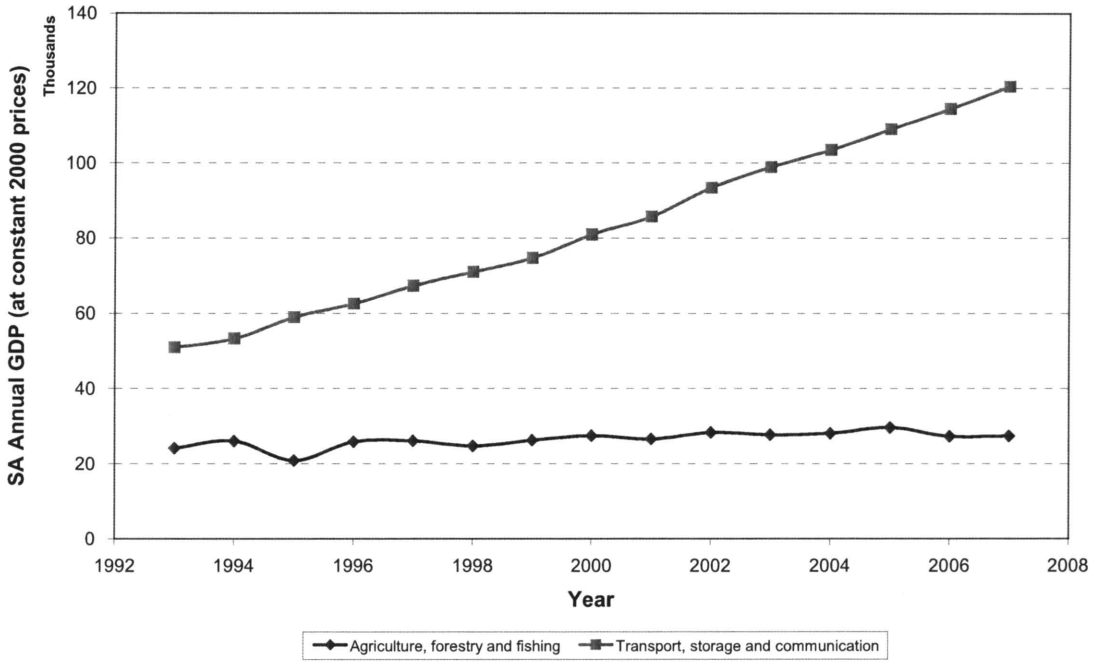


Figure 4. 2 - Comparison between the annual GDP values of the lowest growth sector (agriculture, forestry and fishing) and the highest growth sector (transport, storage and communication) from 1993 to 2007.
Source: Data from Statistics South Africa website (www.statssa.co.za)
Graph by the author

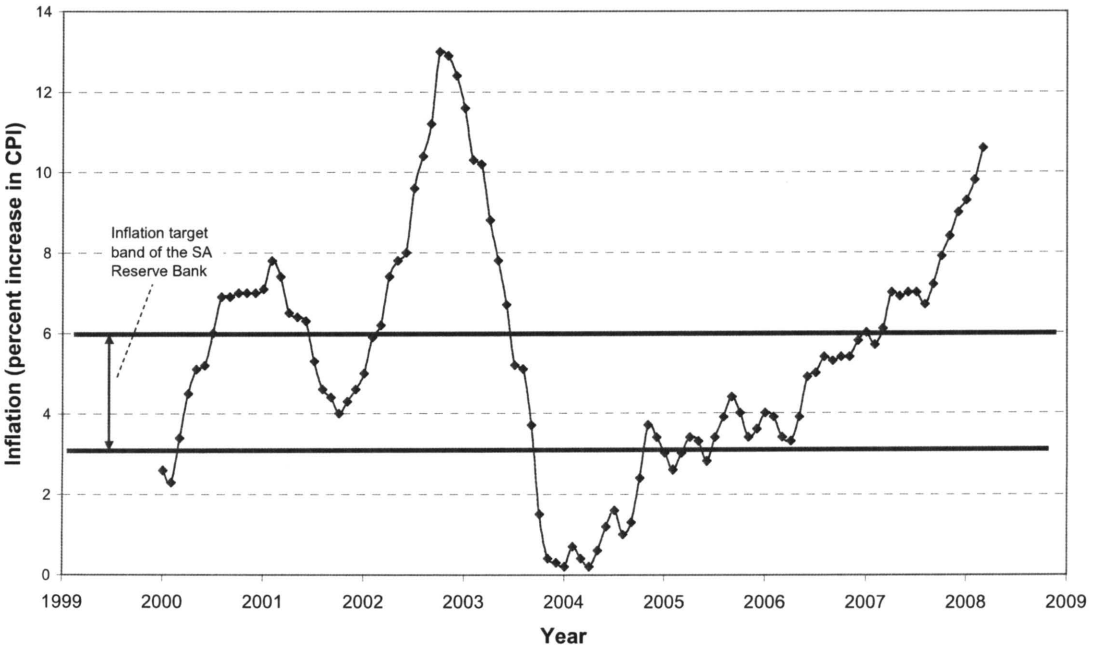


Figure 4. 3 - Inflation rate in South Africa from 2000 to current date.
Source: Data from Statistics South Africa website (www.statssa.co.za)
Graph by the author

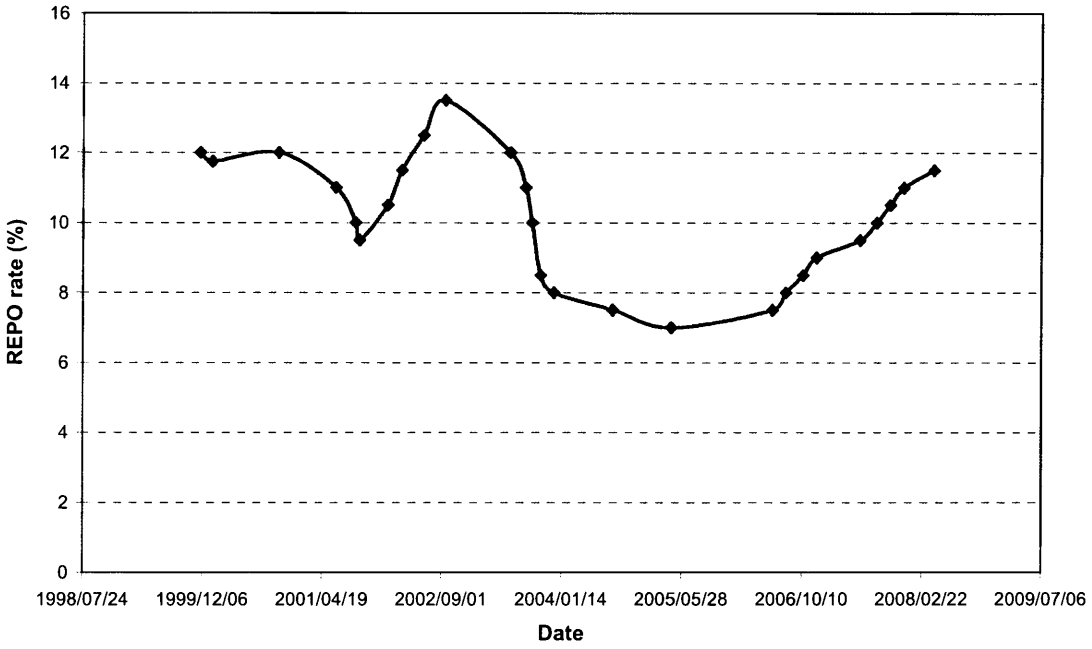


Figure 4. 4 - REPO rate as set by the SA Reserve bank, from 1999 to current date.
Source: Data from the South African Reserve Bank website (www.reservebank.co.za)
Graph by the author

4.3 The beef industry – a global perspective

The world as we know it today is a global village, where goods can be freely traded between most countries around the globe. The same is true for the beef industry, although strict regulations are usually in place for the international trade of beef. As an example, the European Union has a hormone ban in place, meaning that no meat or animals that have been fed growth hormones may be imported into the country. Most of the beef produced in South Africa comes from animals that have been given growth hormones in feedlots, hence for all practical purposes the European markets are closed for South African beef.

In order to gain some insight into the global trends of beef production, imports and exports, four important beef-producing countries are considered. These countries are:

- The United States of America – the largest producer and consumer of beef products in the world.
- Ireland – the largest exporter of beef in Europe.

- Brazil – the largest exporter of beef in the world by volume (second largest by value).
- Australia – the largest exporter of beef in the world by value (second largest by volume).

Overview of the United States of America beef market

In 2006, the USA produced a staggering 11 245 thousand tonnes (24.79 billion pounds) of beef. However, they have been a net importer of beef for more than 25 years, as can be seen in Figure 4. 5 (USDA, 2008).

The USA have imported most of their beef from Australia, Canada and New Zealand, as is shown in Figure 4. 6 (USDA, 2008).

Figure 4. 5 shows that exports started to equalize imports in the time period close to the year 2000, but then a dramatic drop in beef exports occurred in 2004.

The explanation for this huge fall in exports can be seen in Figure 4. 7 (USDA, 2008). Japan traditionally used to be the largest destination for beef exports from the USA. In 2004, following a BSE scare, Japan placed a ban on US beef, which caused the major drop in export volumes.

This highlights the importance of health and safety in food supply chains. A perception of unhealthy or unsafe food can wipe out an entire market in a matter of months.

Even though the US beef industry is very large, it does not have a huge impact on the beef industry in Southern Africa, since it neither imports nor exports significant amounts from these regions.

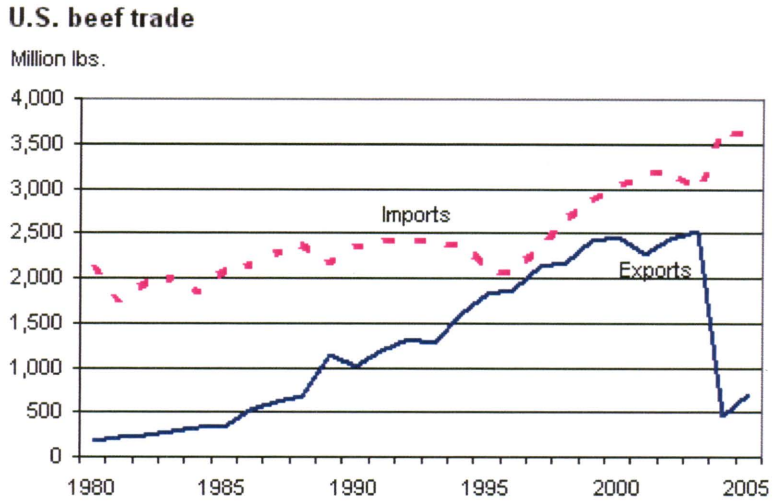


Figure 4. 5 - Beef trade in the USA, from 1980 to 2006.
Source: United States Department of Agriculture, Economic Research Service

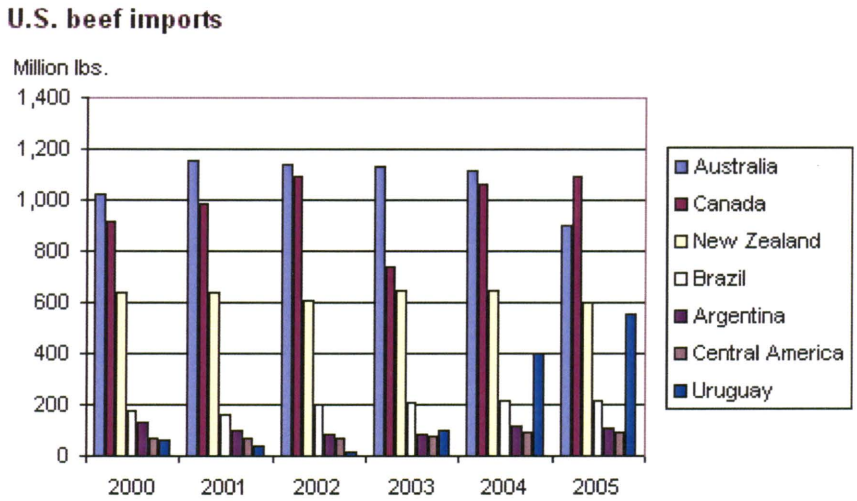


Figure 4. 6 - Beef imports to the USA, 2000 to 2005.
Source: United States Department of Agriculture, Economic Research Service

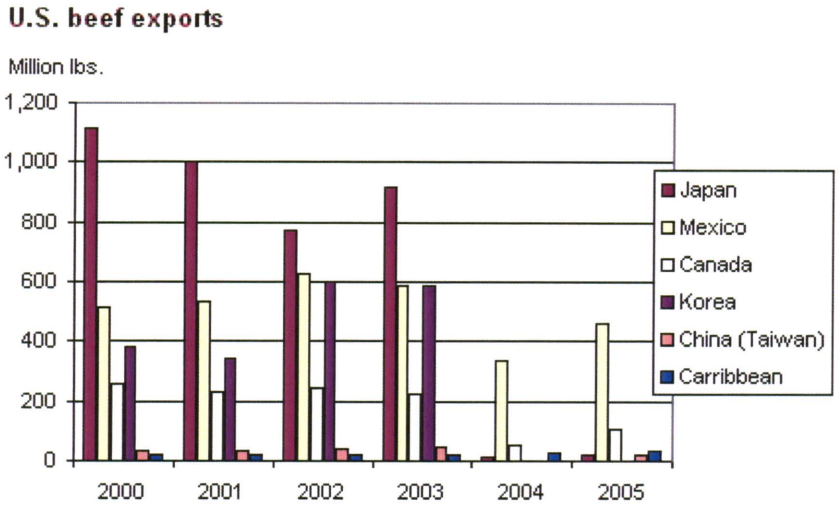


Figure 4. 7 - Beef exports from the USA, 2000 to 2005.
Source: United States Department of Agriculture, Economic Research Service website

Overview of the Irish beef market

As mentioned earlier, Ireland is the largest exporter of beef in Europe. This has much to do with the fact that there are 6.9 million cattle in Ireland, but only 4.2 million people. These 6.9 million cattle graze on natural pasture of about 3.4 million hectares, which equates to a carrying capacity of just over two large stock units (LSU's) per hectare. In comparison, in the drier regions of South Africa such as the Savanna veld in the Limpopo province, the average cattle carrying capacity is closer to 10 hectares required per LSU. Hence the Irish pasture has a carrying capacity that is about 20 times higher than the carrying capacity of the Bushveld.

Beef production and distribution are shown diagrammatically in Figure 4. 8 (Bord Bia, 2006/2007). It can be seen that about 569 thousand tons of beef were produced in 2006, of which 516 thousand tons were exported. This implies that about 90 % of Irish beef is exported.

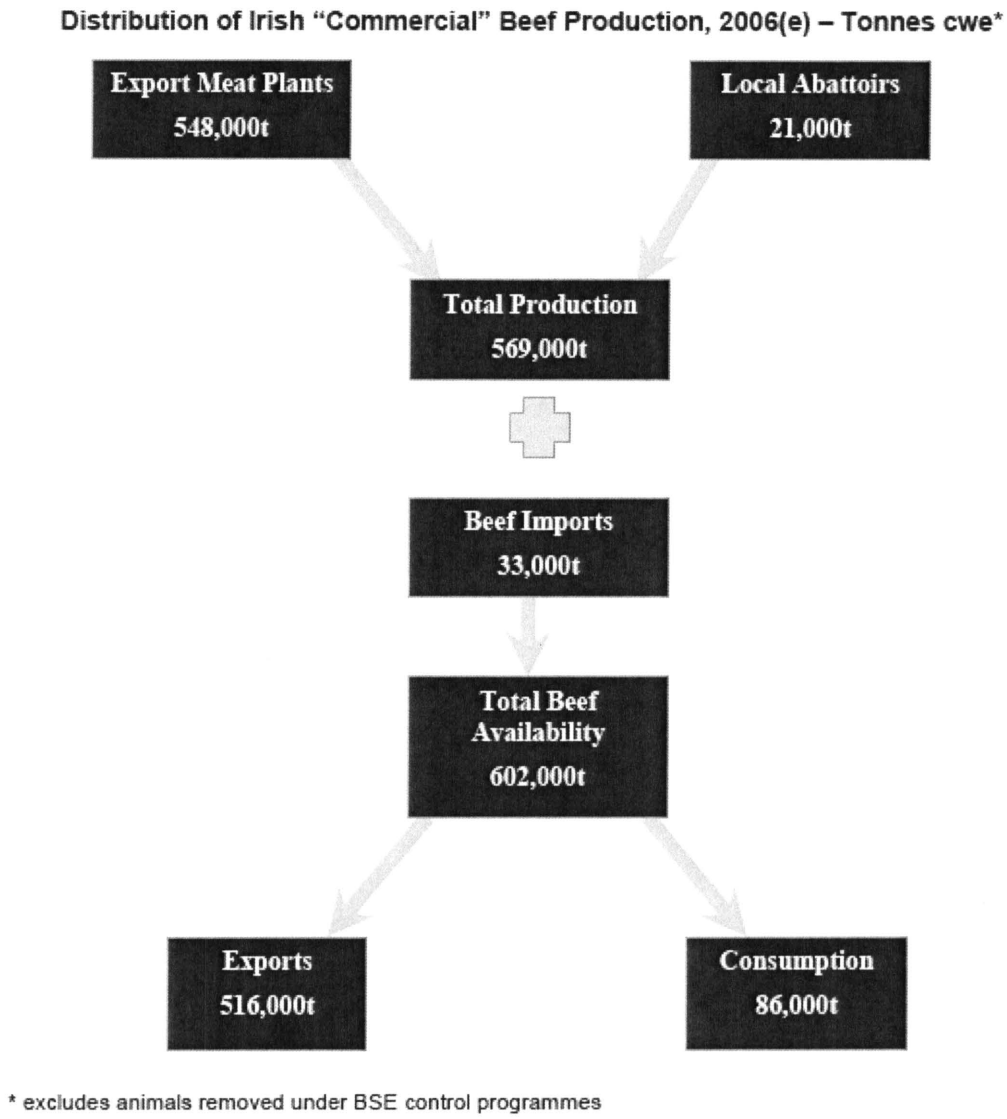


Figure 4. 8 - Irish beef production and distribution for 2006.
Source: Bord Bia (Irish Food Board) Meat and Livestock Review, 2006 / 2007

The major export markets for Irish beef are shown in Figure 4. 9 (Bord Bia, 2006/2007). As can be seen, the major export market is the UK, with the European Union being a close second. Only a relatively small portion is exported to the rest of the world.

The Irish beef industry export its beef mostly to the UK and Europe. Furthermore, backed by a very strong pound stirling and high costs of transportation, Irish beef would be very expensive in South Africa's market where many people are already feeling the pressure from increased food prices.

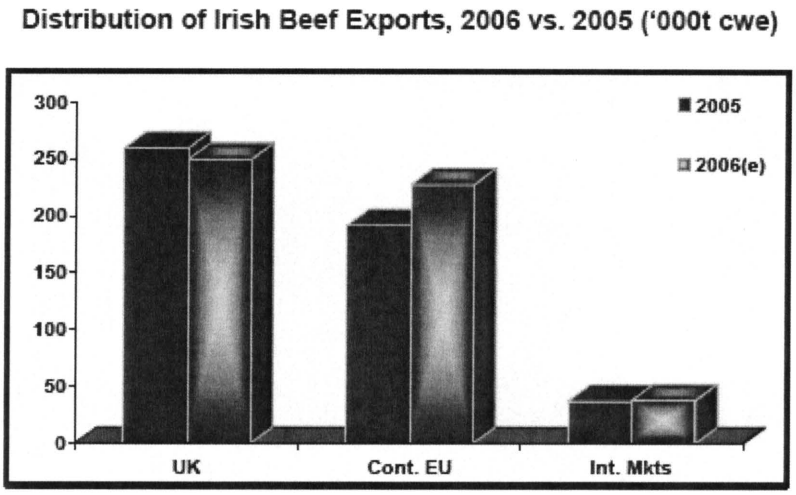


Figure 4. 9 - Market allocation of beef exports from Ireland.
Source: Bord Bia (Irish Food Board) Meat and Livestock Review, 2006 / 2007

Overview of the Brazilian beef market

Brazil is one of the fastest growing exporters of beef in the world. Since 2004, Brazil has been the largest exporter of beef in the world, by volume (Amber Waves, 2006). The reason that the value of exported Brazilian beef is lower per ton than the beef from North America and Oceania, has to do with the occurrence of foot-and-mouth disease, sanitary problems associated with cattle slaughter, and sales of lower value cuts.

Currently, the main markets for Brazilian beef are European countries, the USA, Middle Eastern countries, Japan, Russia and Hong Kong.

The fast growth in beef exports from Brazil is shown in Figure 4. 10 (USDA, 2008). As can be seen, since about 1998, the export figures for beef, chicken and pork have increased rapidly. It is reasoned that the following factors have contributed to Brazil's rapid rise in beef production capacity over the past decade:

- Macro-economic stability.
- High international commodity prices.
- Currency devaluations.
- Technological advancements.

- Expansion in arable land.
- Large capital inflows from domestic and direct foreign investment.
- Producer friendly domestic policies, such as credit and tax exemption programs.

Beef imports from Brazil could be a threat to the South African beef industry, especially since South Africa is already a net importer of beef. However, the South African industry may learn a lot from the Brazilian success over the past decade. It may be well worthwhile to study their model and implement some of their key success factors in the South African beef industry.

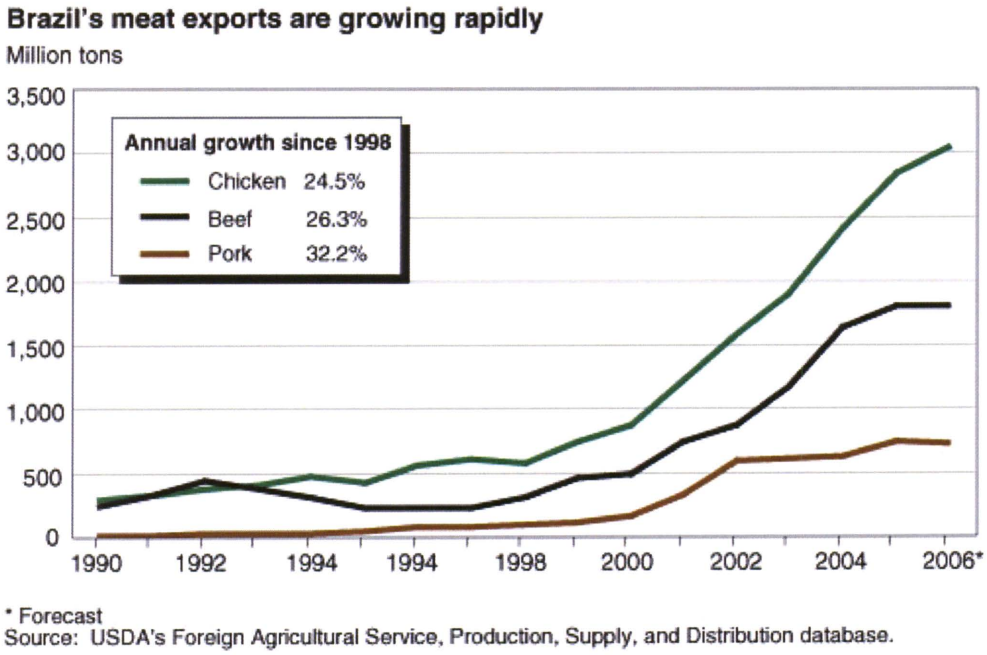


Figure 4. 10 - Increasing volumes of beef exported by Brazil.

Overview of the Australian beef market

The Australian beef industry is the second largest exporter of beef products (by volume) in the world, after Brazil. The total sales value for the exported beef is the highest in the world, though.

Even though the majority of the Australian landscape is quite arid, and more comparable to the drier regions in South Africa than the lush green pastures of Ireland, the Australian

continent is very large, with relatively few people living there. This gives the opportunity to keep large herds of cattle over extended pastures. Hence, the Australian beef industry is able to produce a surplus of beef and hence export most of their beef.

According to the Australian Department of Foreign Affairs and Trade, about 65 % of beef produced in Australia is exported. A graph with the beef exports from Australia between 1990 and 2007, in both volume and (Australian) dollar terms, is shown in Figure 4. 11 (Australian Government, DFAT, 2008).

Table 4. 1 shows the export markets for Australian beef. It can be seen that the United States and Japan are the two major markets for exported Australian beef.

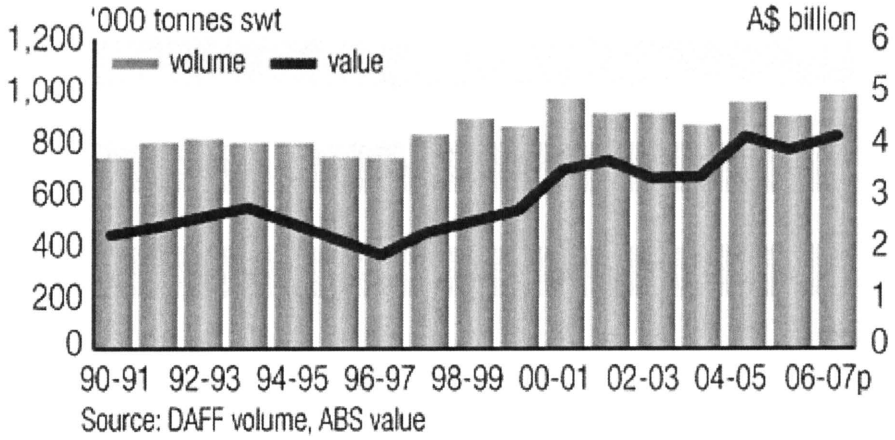


Figure 4. 11 - Australian beef exports – volumes and dollar values, from 1990 to 2007.
Source: Australian Government, Department of Foreign Affairs and Trade

Table 4. 1 - Annual Australian beef export volumes ('000 tonnes), from 1998 to 2003.

	1998	1999	2000	2001	2002	2003
Americas						
Canada	40.9	40.8	40.5	48.9	82.4	30.1
United States	290.8	299.1	362.8	401.3	387.2	374.7
Asia						
Taiwan	34.2	35.2	30.0	29.5	34.4	31.7
Hong Kong	7.2	4.0	5.1	4.5	4.1	2.1
Indonesia	2.0	12.7	15.4	13.0	19.4	13.0
Japan	327.8	319.9	321.7	320.8	238.0	280.1
Korea	36.3	80.8	80.6	64.0	84.8	67.6
Malaysia-Singapore	13.3	13.3	12.9	11.9	15.6	10.2
The Philippines	20.9	21.8	15.9	20.0	14.8	8.6
Other	5.7	4.4	3.3	3.5	4.7	na
Europe						
European Union	16.4	10.3	8.7	6.9	6.8	5.5
Other western Europe	0.1	0.1	0.0	0.1	na	na
CIS	23.6	9.7	3.1	8.2	5.2	0.3
Eastern Europe	16.8	2.1	2.0	0.4	3.0	1.4
Middle East						
Saudi Arabia	2.6	1.1	0.9	5.5	3.2	1.8
Other	12.4	7.8	3.5	6.0	4.9	3.7
Oceania						
New Zealand	2.0	1.8	4.2	4.0	9.9	3.5
Pacific Isles	3.5	2.5	2.8	2.4	3.0	2.1
Papua New Guinea	2.7	3.1	2.8	3.8	5.0	2.3
Other	23.0	13.1	13.4	18.6	n.a.	n.a.
Total	882.2	883.6	929.6	973.3	926.4	840.9

Note: n.a.= not available

4.4 Technology

Internet and information technology

The exponential rise of internet and communications technology over the past two decades has certainly changed the way that business is conducted. That also holds true for agricultural businesses. The potential for a farmer to market "farm-made" beef directly to consumers over the internet is suddenly a possibility.

Whether a farmer can currently be successful at marketing beef directly to consumers without the contributions of other specialized supply chain members such as abattoirs, butcheries and the likes, is a different question though. Nonetheless, the possibility for a group of farms to work together, own a small abattoir and a meat processing and packaging plant close to the source of production and market directly to consumers has become a clear reality.

Internet and communications technology is also very important within the supply chain. It enables all players to have direct and immediate access to information on all the important processes in the supply chain. The use of point-of-sale scanners in retail food is well-known (Salin, 1998). Meat packing and distribution companies use IT to automate delivery and billing, and retailers are striving to complete the implementation of scanner systems for fresh meat.

When considering an information system for a supply chain, it is important to first understand what the characteristics of the supply chain will have to be. It is also important to understand whether the product or service that is delivered is “functional” or “innovative”. Functional products are stable goods with predictable demand. Innovative products are differentiated, have more varieties and have shorter life cycles. Beef can generally be viewed as a staple or functional product, but when it is sold as “naturally fed” beef, it tends to lean a bit more towards the innovative side. Naturally fed beef is a differentiated form of beef, and will probably be targeted at a specific market segment, at a higher price. It may also be necessary to be more innovative in terms of packaging and product offerings, to keep the interest of a potentially fickle market.

Generally speaking, the focus of the supply chain for functional products should be on increasing production efficiency and reducing costs, while the focus in a supply chain for innovative products should be less on cost but more on delivering the attributes that customers require. A good understanding of consumer demand, as well as fast and flexible suppliers should form part of a supply chain for innovative products.

One of the challenges in the agri-food environment is that supply may be variable and weather related. At the same time, food quality and safety are of huge concern. To

complicate things further, food is perishable and a time-efficient supply chain is of critical importance, even though it may be more costly.

Consumers of naturally fed beef may require products to be traceable back to farm and animal level. IT systems that can be used to perform this tracking function should thus be implemented, even though it will be more expensive.

Inter-firm information networks allow companies to manage supply sources and distribution networks without owning them. It is also important that supply chain managers know what the most important information is that they need from the IT system, before installing a system.

Traceability in the supply chain

Modern technology also makes it possible to include full traceability of products in the supply chain – from farm and animal level to the final packaged product.

A good example of using technology as part of supply chain traceability comes from the VanDrie group, a manufacturer of hormone-free veal products in Holland (Buhr, 2003). Animals that enter the processing plant all have ear tags with a 12-digit barcode. This is the animal's identification number and remains with the carcass through sequential bar coding. The ID number contains information such as on which farm the calf was raised, who its "parents" were, what it weighed at delivery, health status (blood sampling) and other important parameters. As the carcass moves further down the process and is cut into more parts, barcode tags are created by printers and attached to the pieces as they move along the process. This continues until the case-ready package is labeled with a final barcode. As barcodes are printed out along the process, it gets updated electronically in the enterprise resource planning (ERP) system, hence the information is logged in the integrated inventory management system of the plant. In this way, when the end consumer buys the final product, he can actually log onto the internet and trace back the history of the meat – to farm and animal level, using the unique barcode number.

Supply chain simulation software

Specialised supply chain software exists that can be used to simulate different supply chain configurations. This is a powerful tool that should be utilized fully in order to evaluate and optimise supply chain configurations.

Simulations are also performed in this research report, chapter 7. These simulations were done on an Excel spreadsheet without using specialised supply chain software, as this is an academic study. However, it is recommended that specialised supply chain software be used in industry, as it is tailor-made for analysing supply chains.

Research and development – innovation across the entire supply chain

There will always be new developments that could improve processes along the beef supply chain.

One example is "pasture micro management", such as is currently being researched by the Agricultural Research Council (ARC) in Irene (Westfall, 2008). This implies that instead of farming with cattle on the ratio of around one LSU per 10 hectares for the Bushveld, the herd is managed to forage more intensely in smaller camps and make more fully use of the available grass. By moving the herd along in the correct fashion, this more intensive foraging method could be beneficial for the land, encouraging a higher percentage of grass growth. Hence the benefits are twofold.

Another example of an improvement in the supply chain process is the development of the so-called beef carcass steam pasteurization system (Golan et al., 2004). When microbiologists at Kansas State University studied various interventions to reduce pathogens on the surface of freshly slaughtered beef, they found that this innovation was superior to the other methods tested.

At this point, it may be appropriate to mention that People for the Ethical Treatment of Animals (PETA), has recently launched a $ 1 million prize for the person who develops an "in vitro chicken meat product" (Saletan, 2008). This would entail using starter cells from a chicken and grow it into chicken meat in a laboratory. Blood vessels, bladders, livers and hearts have already been grown successfully in laboratories.

4.5 Government and politics

There are two major political issues that currently have to be considered regarding farming in the Limpopo province.

Firstly, there is the issue of land claims. There are currently a large number of land claimed by black people on commercial farms. The settlement of these claims is progressing very slowly and it causes uncertainty which negatively influences agricultural production. There are also instances of land not being used productively after settlements, due to new tenants not having sufficient farming skills. It would be beneficial for government to speed up the land reform process and get it over and done with, while ensuring that new tenants are adequately skilled farmers. At all costs, a situation similar to what is currently happening in Zimbabwe must be avoided. Related to the issue of land claims, are the various cattle production systems that are used in the province. The commercial farming system is traditionally used by white farmers on allocated farmland, while communal farming is traditionally practised by the black community on communal land. At first glance it may look as if these two systems clash with each other, but there may be possibilities for synergy if the two systems become more integrated.

At the moment there are in the region of 5.3 million cattle in informal settlements in South Africa that are not part of the mainstream beef supply chain. If these cattle can however be incorporated into the chain, South Africa may become a net exporter of beef, as opposed to a net importer.

This leads to the second point of political contention, namely the current political instability in Zimbabwe. The Limpopo province is the only South African province that shares a border with Zimbabwe, and political instability in Zimbabwe translates into more refugees crossing the border from Zimbabwe to South Africa. However, there may be a silver lining to the dark cloud that is currently hanging over Zimbabwe. As part of the SADC community, Zimbabwe is a country with huge natural and agricultural potential, previously known as the “bread basket” of Africa. Once full democracy is returned to Zimbabwe, a whole new world of cross-border co-operation between Botswana, Zimbabwe, Limpopo and Mozambique may open up.

4.6 The natural environment

Except for the veld types and annual rainfall patterns (which will be discussed in more detail in chapter 5 as important parts of the cattle farming process), there are two other issues to consider regarding the natural environment of the Limpopo province:

Firstly, the debate on whether the Limpopo province should be used for cattle farming at all. Should it not be used for game farming instead? This is not an easy question to answer and it falls outside of the scope of this research. However, it is an important issue to keep in mind. On the one hand it is a fact that the Limpopo province is ideally suited for game farming – after all the game lived there long before cattle farming was established in the region. Game farming could also produce potentially higher income, especially if the correct types of game are kept and the purses of rich hunters are tapped. The question though is: How big is the market for game farming and will it be sustainable to turn the whole province into one big hunting farm?

The flip side of the coin is that South Africa is already a net importer of beef. Can it be afforded to reduce the beef production even more at the expense of game farms?

One of the problems with a combination of game and cattle farming is that certain game species bring in health problems such as foot-and-mouth disease. Perhaps it should be proposed that farmland in Limpopo be divided into game farming and cattle farming zones. This would give game farmers the opportunity to co-operate with other game farmers, and the same would be true for cattle farmers.

The second issue to keep in mind is the issue of global warming. Global warming is also a messy debate at this stage, but it would seem that more scientists believe that global warming does exist. The predicted effects of global warming for the Limpopo province is that it will reduce the rainfall even more for the province that is already dry. This makes optimal pasture management and buffer systems even more crucial.

4.7 The ethical environment

The consumption of meat brings with it somewhat of a moral dilemma, since in order to eat meat an animal must be slaughtered and processed. However, this process is part of nature and man is not the only being on the planet that kills other animals for food. Man is the only species that has domesticated animals though, and have set up industrial processes for this purpose.

On the one hand of the scale there are organisations such as People for the Ethical Treatment of Animals (PETA), who reason that eating meat is completely unethical and should in fact be outlawed. They claim that humans don't need to eat meat and can survive on a vegetarian diet. However, it is unlikely that the production of meat will stop just because PETA wants it to. Meat is just too important a part of the diet. Until we can "grow meat" in labs or production plants, and consumers are willing to actually buy and eat it, animals will be used for meat production.

However, when one steps one level from the basic question of whether or not the consumption of meat should be allowed at all, the debate really gets interesting. This is where issues of animal welfare, the use of growth hormones and antibiotics, and the debate on genetically modified foods kick in.

It would seem that the attitude of many people is that they would eat meat, but they would prefer if the animal "lived a good and natural life" before being converted into food. It was found that Swedish consumers were willing to pay more for beef that was slaughtered by a "mobile abattoir" (Carlsson, Frykblom and Lagerkvist, 2007) . A mobile abattoir can drive to the farm, kill the unsuspecting and peaceful animals, and perform the slaughtering process at the farm, inside the unit. From here the carcasses are transported to a cooling chamber. This method is obviously more expensive than the normal process of transporting cattle to the abattoir – hence the required premium. It is however also far more humane towards the animal.

Some studies claim that a high consumption of red meat increases the risk of cancer in humans. In a study done on the Swedish population it was found that a significant correlation exists between colon cancer and high consumption of red meat (Larsson et

al., 2004). The question then arises: If it is true that excessive levels of red meat can cause cancer and heart disease, what is the recommended maximum consumption of red meat for a human? Should this information be communicated to the consumer, even though there may be a risk of losing sales by doing so?

Another question that may be raised is whether it is ethical to put cattle through the feedlot process. In the feedlot process, cattle are typically kept in confined camps for about four months. They are fed a protein rich diet, which may include chicken dung, and are also given growth stimulants and antibiotics to artificially increase the growth rate. Ultimately, it is the final consumer that will determine whether or not he is satisfied with the treatment that cattle receives, and he will spend his money accordingly. In Europe, there is a ban on the importation of products from animals that have been given growth hormones.

The example described visually through the photos below illustrates the point of cattle welfare in the beef supply chain:

The photo in Figure 4. 12 shows a young, skinny bull that has recently arrived at the feedlot. Until now it has been raised on communal land under the communal farming system. The feedlot will now be the home of a herd of cattle for the next four months, as shown in Figure 4. 13. Four months later, the cattle that had gone through the process are almost unrecognizable. They seem to be in very good physical condition courtesy of the protein rich diet and growth hormones, as can be seen in Figure 4. 14. These cattle can now be slaughtered and the carcasses sold as “grade A beef”.

This process may make practical sense, but the question to ask is: If the end consumer really knew how the feedlot process worked, would he still be willing to buy beef, or would he develop resistance to the product and demand beef from cattle that have lived more natural lives?

Figure 4. 12 - Young, skinny bull that has recently arrived at the feedlot.
Source: Own photograph

Figure 4. 13 - Cattle living in the feedlot camps for a period of 4 months.
Source: Own photograph

Figure 4. 14 - Four months later and the cattle appear to be in a good condition – ready for slaughter.
Source: Own photograph

According to Compassion in World Farming Trust (Lymbery, 2001):

"The welfare of farm animals is recognised as an important public and political issue in the UK and Europe. The past decade has seen some welcome legislation introduced to counter some of the worst excesses of factory farming.

Narrow veal crates for calves and sow stall cages for pregnant pigs have both been banned in the UK. Yet the vast majority of farm animals are still kept indoors in highly intensive systems. Consumers are increasingly concerned about the way in which farm animals are treated."

4.8 Legislation

Legislation that has to be complied with regarding the processing and sales of natural beef includes:

- The Meat Safety Act (Act No. 40 of 2000) regarding Red Meat Regulations.
- The Code of Practice regarding handling and transport of livestock (in conjunction with Act 71 of 1962)
- For beef to be branded as "naturally fed", an audit is required from SAMIC, four times a year, to ensure that all processes are adhered to (Booysen, 2007).

4.9 Stakeholder expectations

The main stakeholders in the supply chain are:

- The shareholders of farms, abattoirs, logistic services, butcheries and retailers.
- The employees along the supply chain.
- The final consumers of beef.

The shareholders do expect good profitability and return on investment from their businesses. The employees would expect to be paid well and work under good employment conditions. The final consumers of beef expect good quality, safe beef at reasonable prices.

4.10 Summary

The external environment was scanned in this chapter. The following conclusions can be made:

- South Africa has enjoyed good economic growth over the past 15 years. However, some economic indicators such as the inflation rate and repo rate indicate that tougher times may be ahead. This will put pressure on consumers' spending power and will likely reduce the willingness to pay more for branded, naturally fed beef at this stage.
- In terms of globalization, two players in particular may have an impact on the South African beef industry namely Brazil and Australia. However, the success that Brazil's beef industry has experienced over the past decade can be studied by the South African beef industry.

- In terms of technology, it is expected that internet and communications technology, supply chain simulation software and continuing research and development into processes along the supply chain will play an ever increasing role in the future.
- In terms of government and politics, there are two pressing issues. Firstly, the land claims process must be completed as soon as possible to reduce uncertainty in the province. Secondly, the issue of political unrest in Zimbabwe should be taken into account. It causes risk but at the same time future opportunities for co-operation.
- In terms of the natural environment, it is very important to clearly determine what the respective roles of the beef and game farming industries are in Limpopo. A strategic framework should be developed to ensure that the "optimum mix" of game and cattle farming be implemented in Limpopo. The effects of climate change, that may reduce rainfall over the Limpopo even more in the future, must also be kept in mind.
- In terms of the ethical environment, one of the important issues that is surfacing is the treatment and welfare of animals, before they are slaughtered and converted to meat. It would also be necessary to take into consideration any possible health and safety threats, and communicate them clearly to the consumer.
- In terms of legislation, SAMIC would be required to perform audits 4 times a year, to ensure that the branded beef complies with the criteria of "naturally fed beef". This would be in addition to the normal regulations on the processing of beef that must adhere to.
- In terms of stakeholder expectations, the difficult balancing act of increasing business profitability, providing higher wages and better working conditions for employees while at the same time increasing customer value, will have to be performed.

Now that a general overview of the external environment surrounding the supply chain has been developed, the internal elements of the supply chain can be considered. The operational elements of the supply chain are considered in chapter 4.

Chapter 5: The operational elements of the supply chain

5.1 Introduction

The external environment in which the supply chain operates, was discussed in Chapter 4. This chapter discusses the operational elements of the supply chain for naturally fed beef from Limpopo. Referring back to Figure 2. 3 of this report, this chapter includes five out of the seven elements that were identified for a supply chain for naturally fed beef from Limpopo. The five elements considered in this chapter are beef cattle farming in Limpopo, abattoirs, meat processing and packing, logistics and sales channels. The remaining element, namely the market for beef, is considered in Chapter 6.

This chapter serves to discuss the operational inputs, processes, costs and other important aspects regarding production and sales of beef through the supply chain.

5.2 Beef cattle farming in the Limpopo province

Veld types in Limpopo

One of the most important factors to take into consideration for cattle farming, is the type of pasture on which cattle are raised.

A map indicating the biomes in South Africa are shown in Figure 5.1 (Calflora, 2008, online). Limpopo consists mostly of the "Savanna" or "Bushveld" biome, which is a combination of trees (bush) and grassland (veld). A more detailed veld map of Limpopo, as described by Acocks (1988), is shown in Figure 5.2. The veld types can be classified into three main groups, namely sweet veld, sour veld and mixed veld.

Sweet veld is found on the drier planes of Limpopo. The carrying capacity of this type of veld is not very high – typically in the region of 10 to 20 hectares required per live stock unit (LSU). In addition, rainfall is not very high nor consistent in these regions and droughts do occur here from time to time. The advantage of this type of veld is that it has a higher nutritional value during winter times than sour veld.

Sour veld is found mainly in the Waterberg region, with small strips on the slopes of the Soutpansberg, Blouberg and the eastern escarpment. However, cattle farming on the higher regions of the Soutpansberg and Blouberg would be impractical. Most of the higher rainfall regions on the eastern escarpment have long been converted into plantations and farmland. The only sour veld region left for cattle farming is therefore the Waterberg region. Because the Waterberg region enjoys higher rainfall there are more dams and water available, which means that cattle farming can be undertaken on irrigated pasture. If sour veld is not irrigated during winter times, its nutritional value is much lower and cattle lose weight. This is not an acceptable situation when beef cattle are fed naturally on the pastures, since the carcasses will have a low quality and will probably not be marketable during winter (Beef Cattle Farming, 1965). It is thus a prerequisite that sour veld needs to be irrigated (especially during winter) if naturally fed beef are to be produced from this type of pasture.

Mixed veld is simply a transitional region between sour and sweet veld pastures and consists of a mixture between the two veld types.

The grazing capacity for large stock units in the Limpopo province is shown in Figure 5.3 (AGIS, 2008, online). The clear difference between grazing potential in the arid bushveld and the Waterberg region can be seen in the photos in Figure 5.4 and Figure 5.5. (The photos were taken by the author, only one day apart from each other). In Figure 5.4 (arid sweet veld) it can be seen that there are many thorn trees in the veld. The grass is also distributed relatively sparsely along the ground, hence the grazing capacity is low.

However, it can be seen that the pasture in Figure 5.5 is much denser and the grass also grows stronger and higher. This pasture was planted specifically for cattle to graze on and trees were also removed from the area. During low rainfall periods (typically winter times) the pasture is irrigated to keep the nutritional value more or less constant throughout the year.

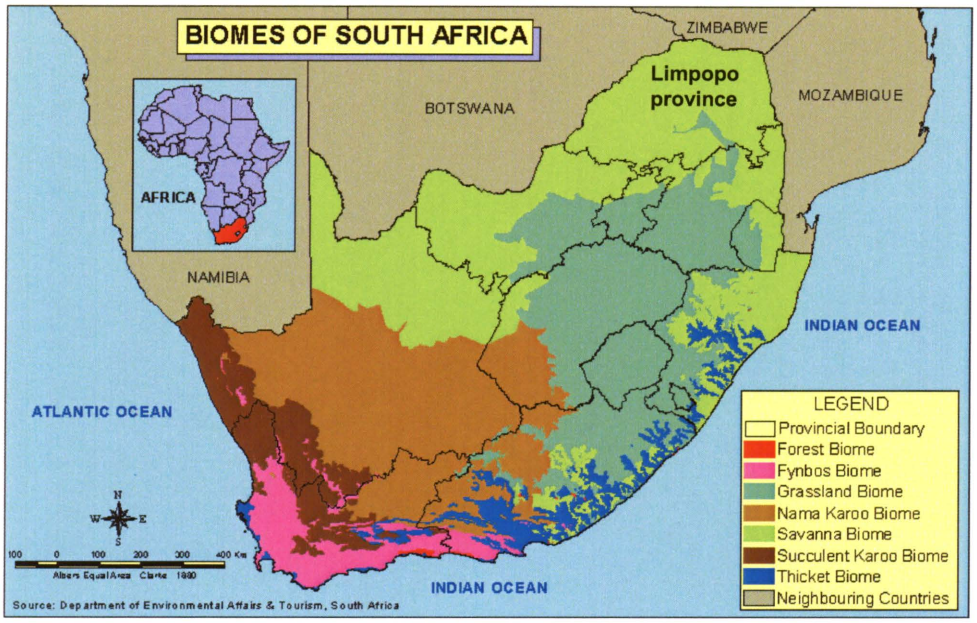


Figure 5.1 - Biomes of South Africa.
Source: Calflora, 2008 (Online)

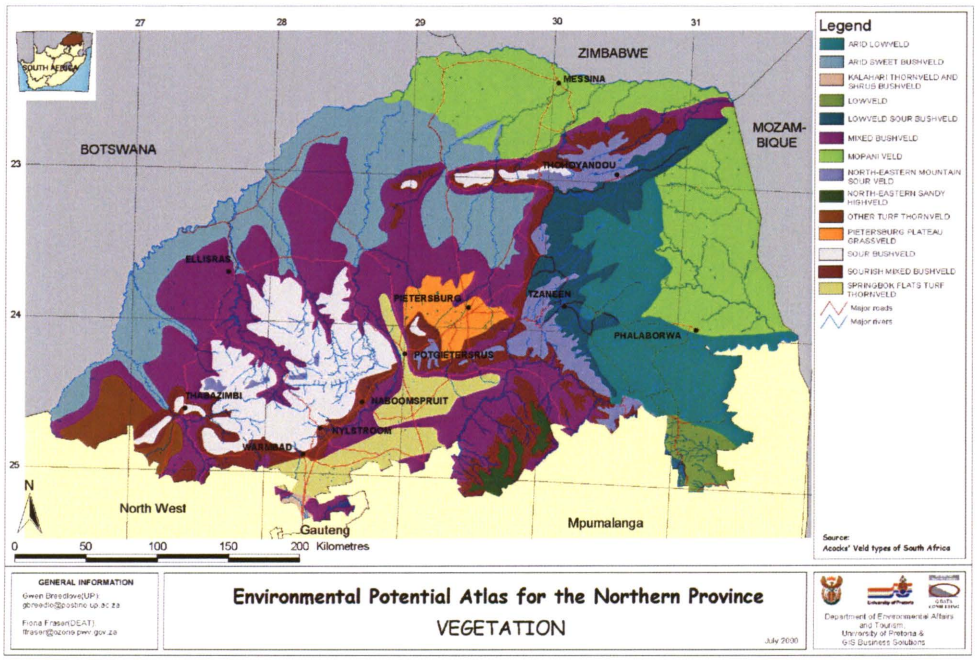


Figure 5.2 - Veld types in the Limpopo province.
(Source: Acocks, 1988)

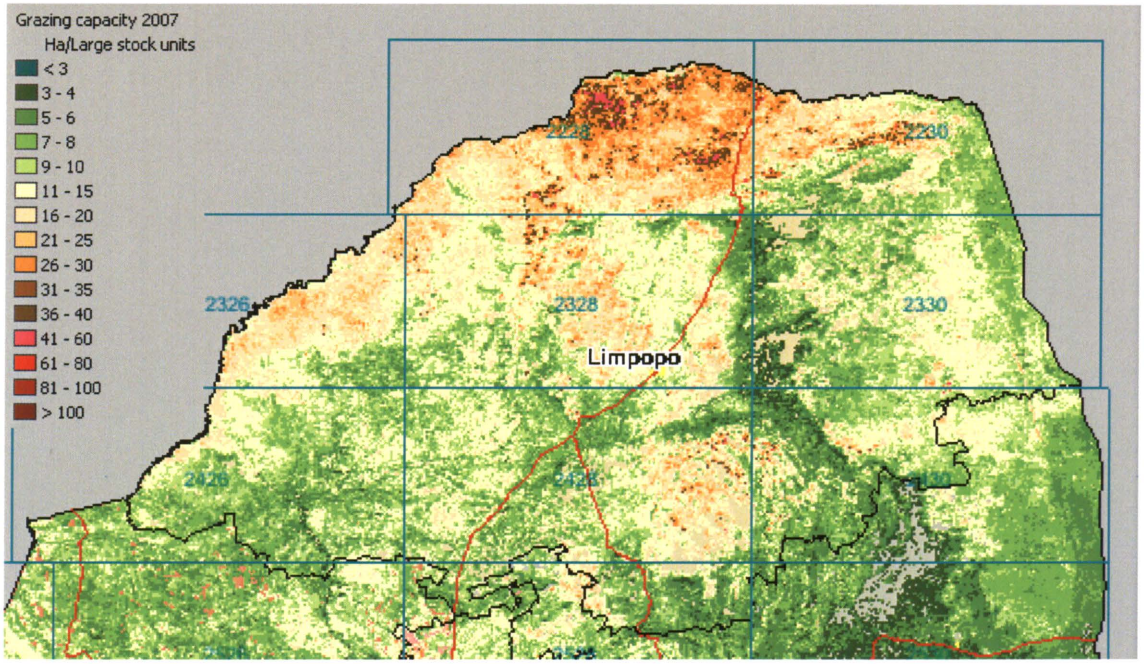


Figure 5.3 - Grazing capacity for LSU's in the Limpopo province.
Source: AGIS, 2008 (online)

Figure 5.4 - Cattle grazing in the arid sweet bushveld, near Vivo.
Source: Own photograph

Figure 5.5 – Cattle grazing on planted pasture in the Waterberg region.
Source: Own photograph

Typical rainfall patterns in Limpopo

Rainfall data was requested and obtained electronically from the South African National Weather Service in Pretoria (SANWS, 2008). Annual rainfall figures for a number of rainfall measurement stations were collated and averaged. The results for rainfall patterns on the sweet veld and sour veld are shown in Figure 5.6 and Figure 5.7 (SANWS, 2008).

It is clear that the rainfall patterns are somewhat erratic. As can be seen from Figure 5.6, the averaged rainfall over the arid sweet veld fluctuates randomly, with a minimum average rainfall of less than 200 mm in 1994 and a maximum of over 900 mm in 2000, only six years later. It can also be seen that the average rainfall is about 400 mm per year over the arid sweet bushveld. The low and erratic rainfall in the arid region makes it more difficult to plan. In the Waterberg region, with its higher rainfall (an average of

about 570 mm over a 30 year period, hence 43% higher than the arid regions – refer to Figure 5.7) and more dams this problem is less serious, especially if irrigated pasture is used for cattle farming.

Rainfall is a bigger problem in the arid sweet veld. The cattle carrying capacity in any year is directly correlated to the amount of rainfall in that particular year. From Figure 5.8 it can be seen that about 68 % of respondent farmers sell excess cattle during dry years. Only 22 % of respondents harvest from their own farms to provide for drier years. (Refer to Table A. 1, Appendix A for source data). Given the unpredictability of the weather, it is argued that the statistic should probably be turned around, hence that the majority of farmers should harvest in good years and store the harvested grass as a buffer for dry years. The dumping of cattle into the market during a drought only serves to reduce prices due to the oversupply.

However, according to Westfall (2008), a better strategy may be to make more optimal use of grazing, using a “precision grazing” system. With such a system, the veld can be micro managed and the grazing potential can be increased significantly. This involves the use of fencing that can be moved around across the farm, as cattle are kept in smaller camps at any one time. This is more expensive but may be justifiable due to the increased production capacity that results from this system.

Westfall (2008) also suggests that instead of harvesting grass, it may be more cost efficient to save less accessible pasture on the farmland for emergencies such as during a drought. It is also important that farm workers be given better training, as that will also result in better utilization of the pasture.

According to Archer (2008), the Northern parts of Limpopo are likely to be affected by climate change in the sense that average rainfall may decrease by as much as 10 % over the next 50 years. Ironically, the regions with a higher rainfall may experience an increase in rainfall. It has to be noted that the weather is a very complex phenomenon and nobody can predict exactly what future weather patterns will look like.

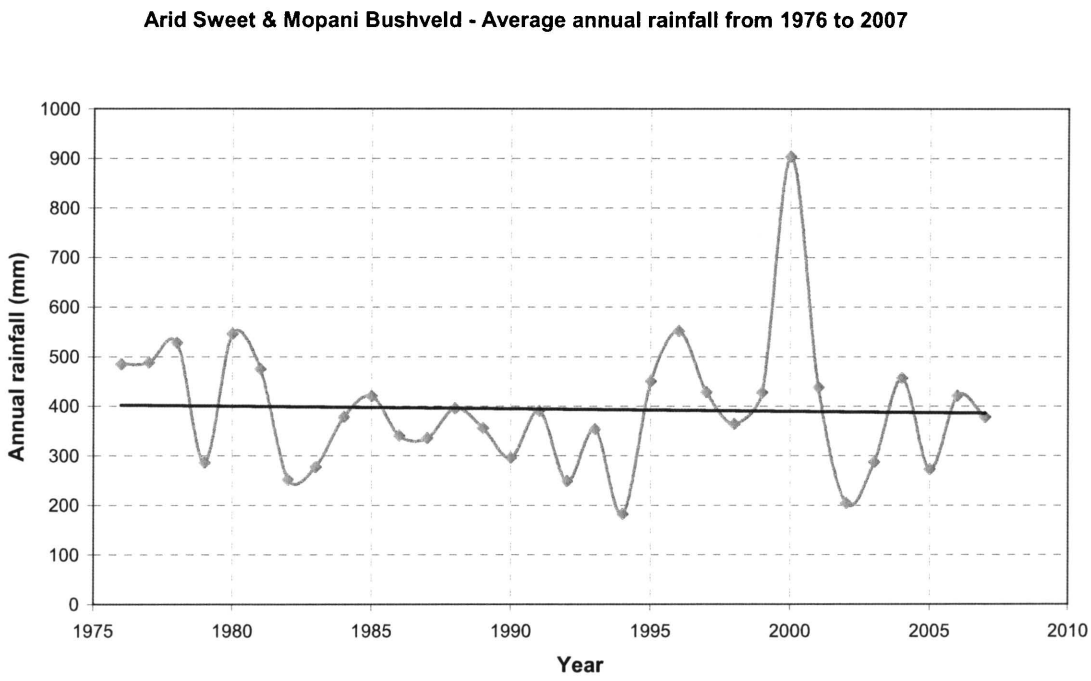


Figure 5.6 - Annual rainfall (averaged) in the arid sweet veld regions of Limpopo.
Source: Data obtained from the South African National Weather Service – graph created by author

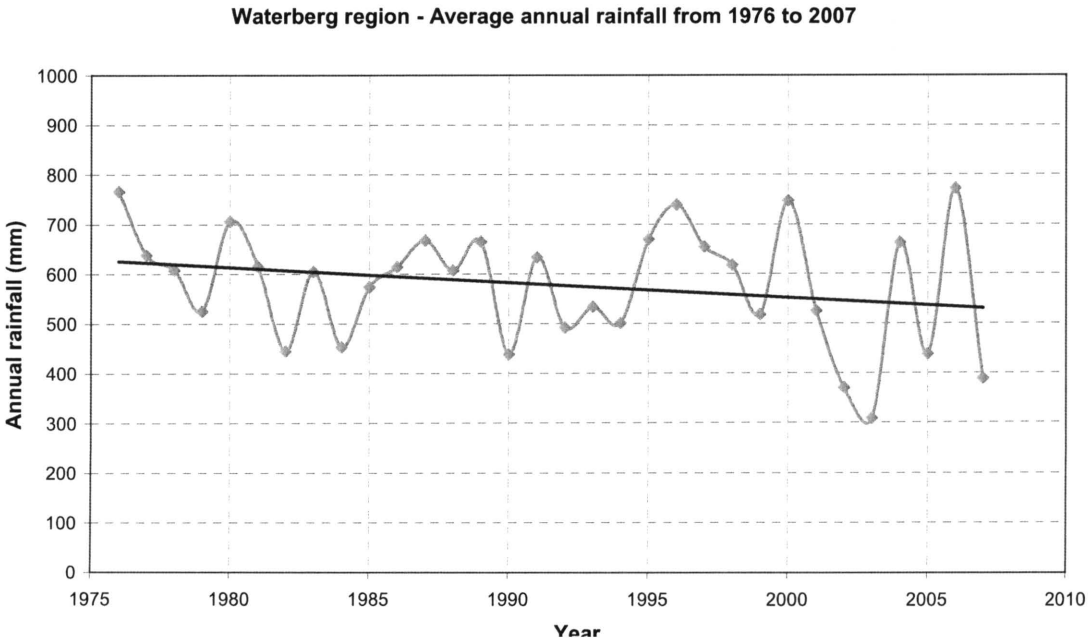


Figure 5.7 - Annual rainfall (averaged) in the sour veld (Waterberg) region of Limpopo.
Source: Data obtained from the South African National Weather Service – graph created by author

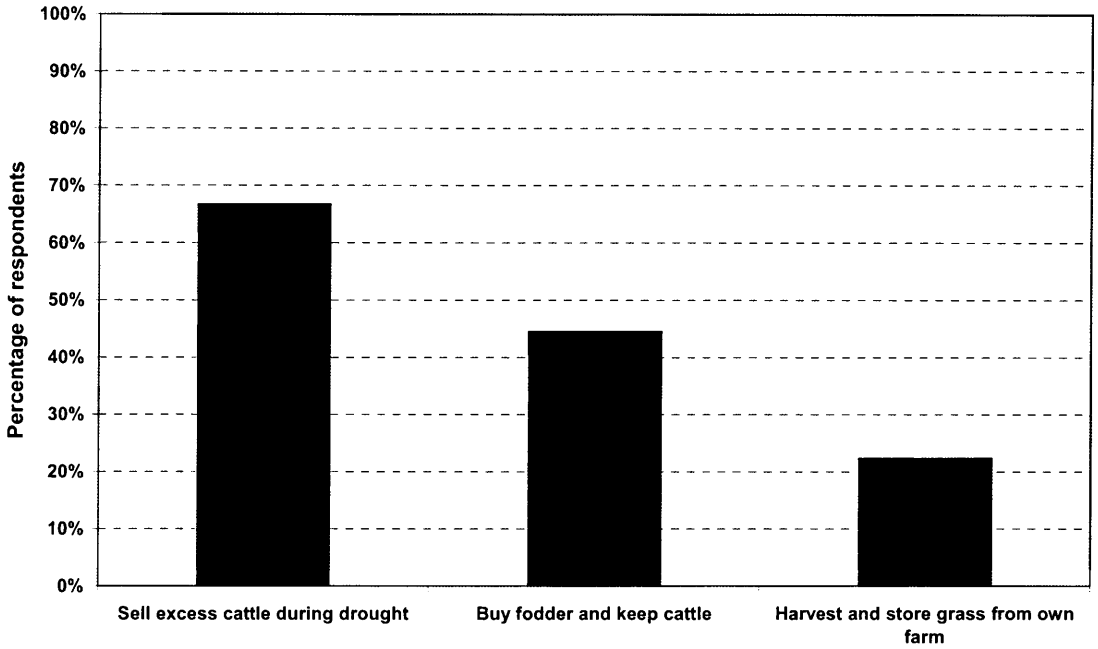


Figure 5.8 – Farmers' survival strategies during droughts.
Source: Table A.1, Appendix A

The cattle farming process

In principle, there are two types of cattle farming systems that can be used. The first is the more traditional weaner system. A representation of this production system is shown in Figure 5.9 (discussions with Limpopo farmers). In the weaner system, a core breeding stock is kept. Calves from the breeding stock are then sold at around six months of age. Some of the young cows (heifers) are kept back and used as replacement stock for older cows that are being replaced and sold out of the system.

The second system, known as the speculation system, is relatively simple and is shown in Figure 5.10 (discussions with Limpopo farmers). As can be seen - lean, young cattle are bought and placed on good quality pasture. The cattle are then sold again a few months later, when they have gained enough weight.

For a naturally fed beef production system, it is suggested that these two processes follow on each other. In other words, the weaner system remains the main production

system. Instead of selling calves to feedlots, the calves are sold to "finishing farms" where they are fed on natural pasture for a time period of about six months.

Two other important aspects of cattle farming in Limpopo are the type of cattle used as well as the main risks associated with cattle farming.

According to the questionnaires received from farmers (refer to Table A. 1, Appendix A), it is clear that the Bonsmara breed is the most popular choice for cattle farming in the province. As can be seen from Figure 5.11, a hundred percent of participants do have Bonsmaras. This is followed by Hugenots (44 %) and Brahmans (33 %), with Ngunis and Simmentalers (22 % each) used to a lesser extent.

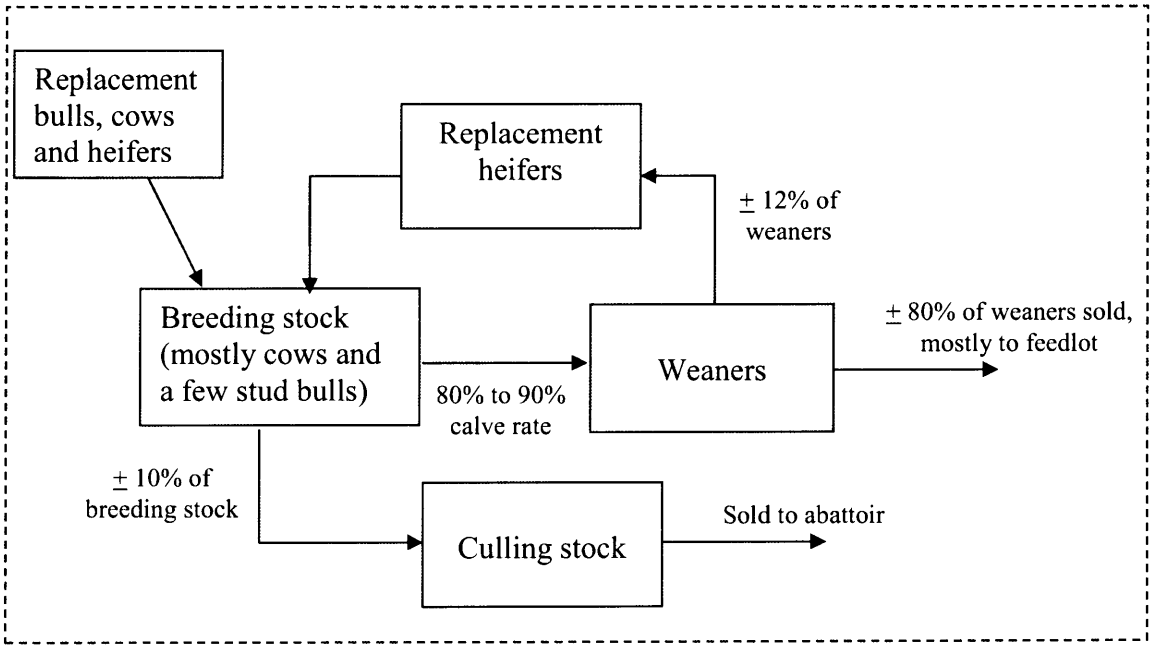


Figure 5.9 - Simplified beef cattle farming production system – the weaner model.
Source: Discussions with beef cattle farmers in Limpopo

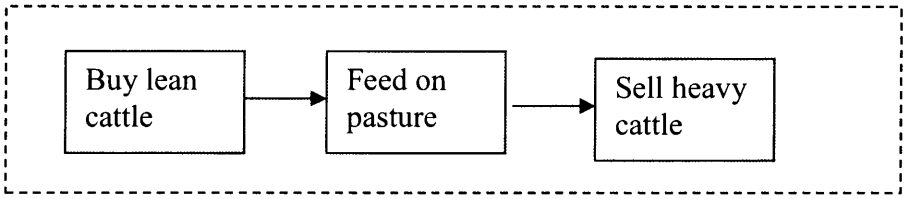


Figure 5.10 - Simplified beef cattle farm production system – the speculation model.
Source: Discussions with beef cattle farmers in Limpopo

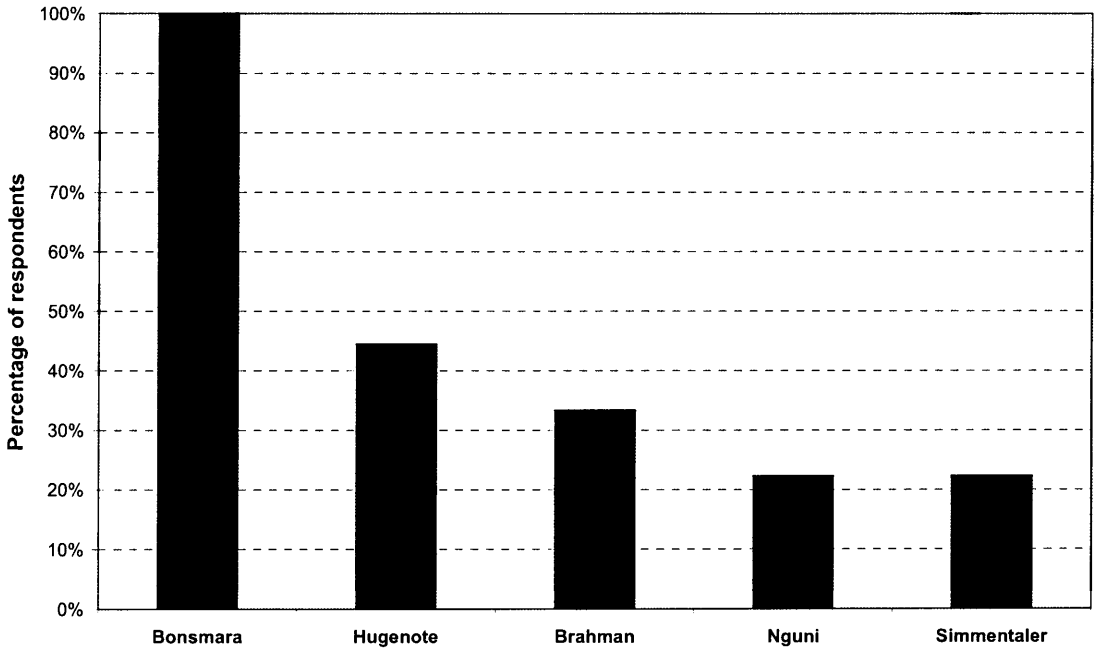


Figure 5.11 - Cattle types used in the Limpopo province.
Source: Table A.1, Appendix A

Important farming process parameters

The typical costs and other process parameters associated with beef cattle farming in Limpopo were obtained through the structured questionnaire, located in Appendix A.

The most important parameters that were obtained are shown in Table 5. 1. (Refer to Table A. 1, Appendix A). These values were used in the simulation model. (refer to Table 7. 2)

A detailed breakdown of the operational costs are shown in Figure 5.12 (Refer to Table A. 1, Appendix A). As can be seen, salaries, fodder, fuel and transport and disease control contributes to about 70 % of the total cost.

Table 5. 1 – Important cattle farming parameters
Source: Table A.1, Appendix A

Parameter	Weaner farming system	Speculation farming system (on irrigated farmland)
Hectare per breeding stock LSU	13.1 hectare / LSU	0.5 hectare / LSU
Cattle sold as percentage of breeding stock	76 %	N/A
Unit operational costs	R 1519 per LSU	R 3750 per LSU
Unit capital costs (buildings and equipment)	R 3053 per hectare	R 4143 per hectare

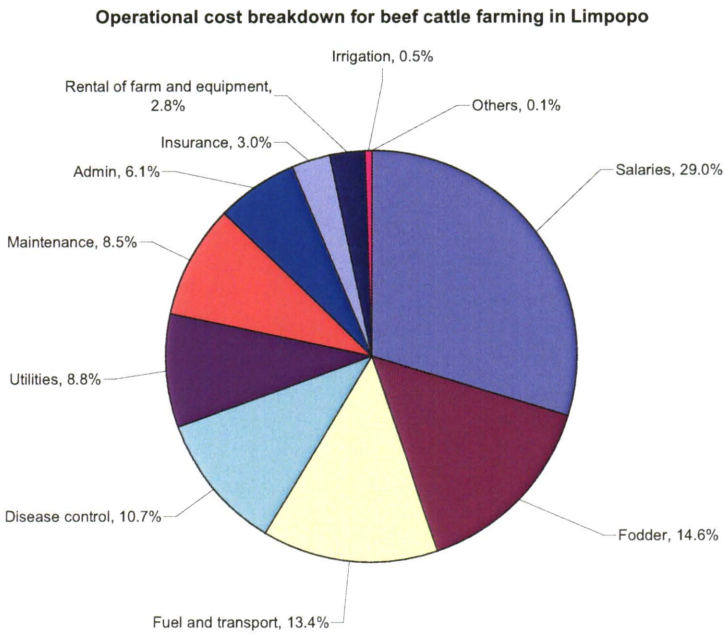


Figure 5.12 - Average cost structure for farming with beef cattle in the Limpopo province.
Source: Table A.1, Appendix A

Other statistics regarding cattle farming in Limpopo

Two other interesting observations are shown in Figure 5.13 and Figure 5.14 (refer to Table A. 1, Appendix A). In Figure 5.13 it is clear that there are far more cattle farmers who have been farming for 20 years or more than there are new farmers that have farmed for less than five years. This indicates a declining interest in farming, probably due to conditions that have become increasingly unfavourable for farmers during the past decade or two.

An alarming statistic is also shown in Figure 5.14, which indicates that almost 80 % of farmers don't expect good growth of the cattle industry in the future. Clearly, this is an important issue that needs to be taken up by the government and farming associations alike, to secure a better cattle farming future for South Africa.

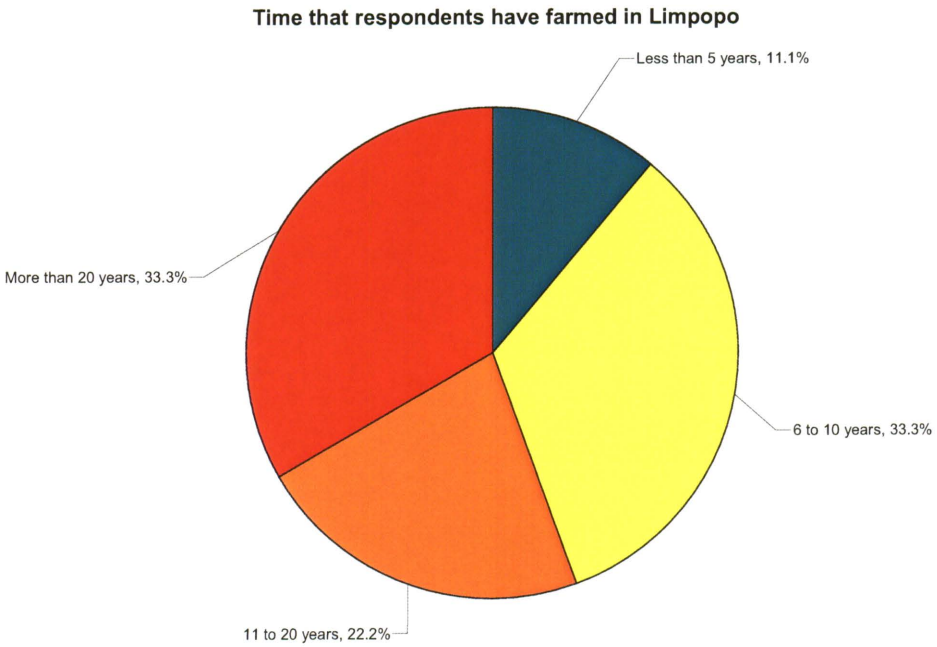


Figure 5.13 – Indication of time that farmers have been farming with cattle in Limpopo.
Source: Table A.1, Appendix A

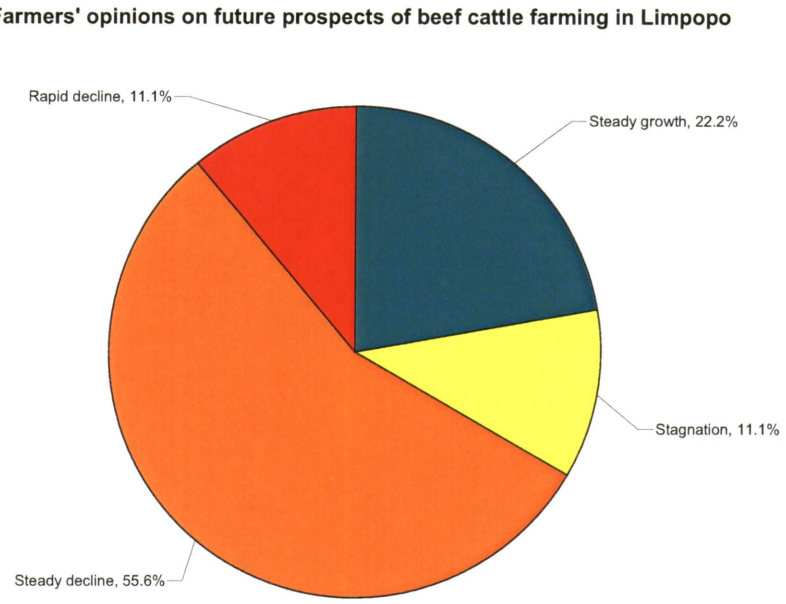


Figure 5.14 – Farmers' opinions about the future prospects of beef cattle farming in Limpopo.
Source: Table A.1, Appendix A

5.3 The abattoir function

The abattoir process is responsible for converting livestock into carcasses, which can then be further processed into meat. It is critical that the abattoir process be operated in a very hygienic way, so as to ensure meat safety. Therefore, abattoirs have to comply with The Meat Safety Act, 2000 (Act 40 of 2000).

Abattoir capacities range from low throughput (four to 20 units per day) to high throughput abattoirs that can handle up to 250 or more cattle per day.

The abattoir process is quite a complex process, in which the animal needs to be stunned, hoisted, bled, slaughtered, split into quarters and stored in a chilled environment (below seven degrees Celsius), for about two to three days. Furthermore, the head, skin and offal need to be stored separately and sold to other markets. It is not within the scope of this research to focus on the operational details of the abattoir. However, Figure 5.15 (Olivier, 2004) shows a detailed description of the typical South African abattoir, indicating that it is a reasonably complex process.

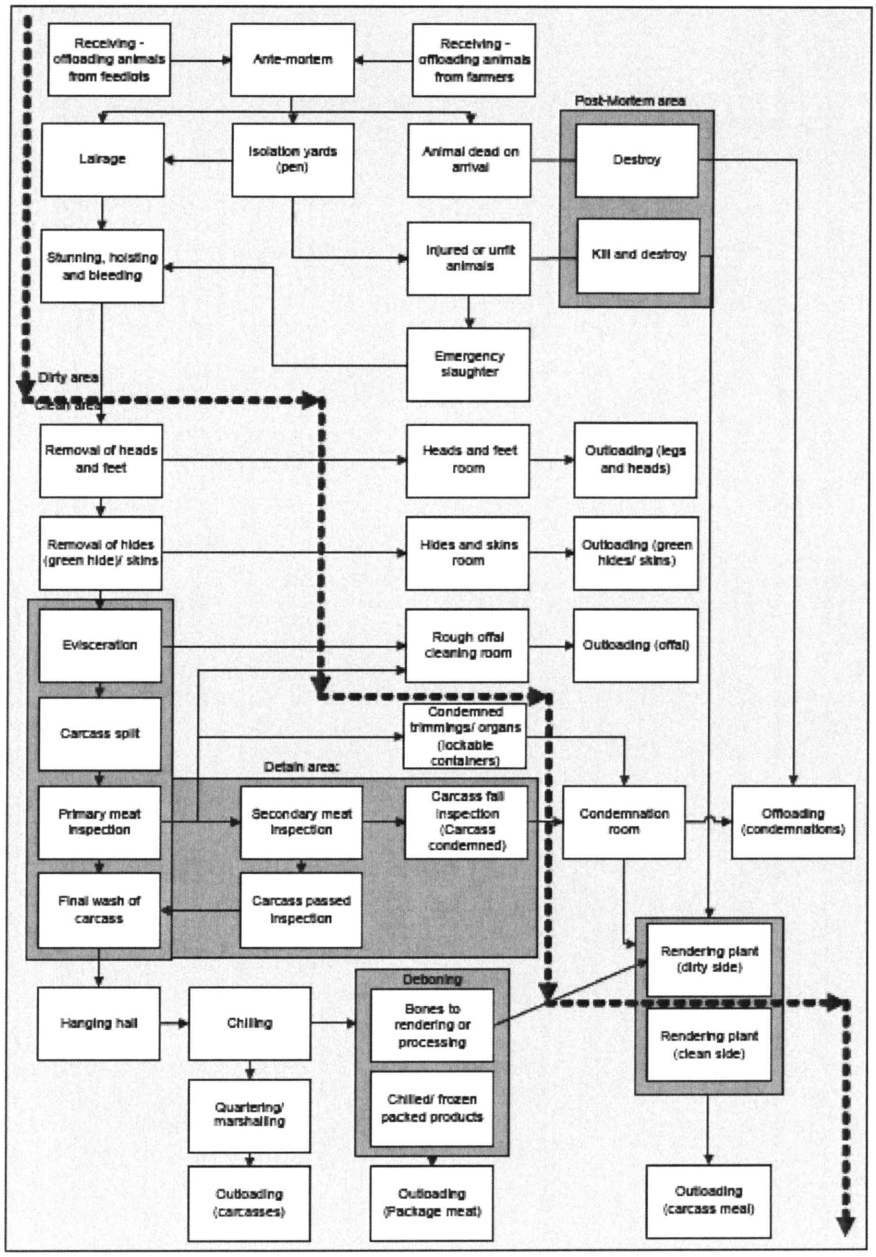


Figure 5.15 - Abattoir production system.
Source: Olivier, 2004

Important abattoir process parameters

The typical costs and other process parameters associated with abattoir operations in Limpopo were obtained through the structured questionnaire, located in Appendix A.

A detailed breakdown of the cost structure is shown in Figure 5.16. (Refer to Table A.3, Appendix A). As can be seen, salaries, fuel and transport and administration costs account for about 70 % of total operational costs.

The most important parameters for abattoirs are listed in Table 5. 2. (Refer to Table A.3, Appendix A). These values were used in the simulation model (refer to Table 7. 2).

Table 5. 2 – Important abattoir parameters.
Source: Table A.3, Appendix A

Parameter	Value
Percentage of income received from beef cattle slaughter	72.1 %
Average process time	2.7 days
Unit operational costs	R 300 per beef carcass processed
Unit capital costs (buildings and equipment)	R 560 per beef carcass processed

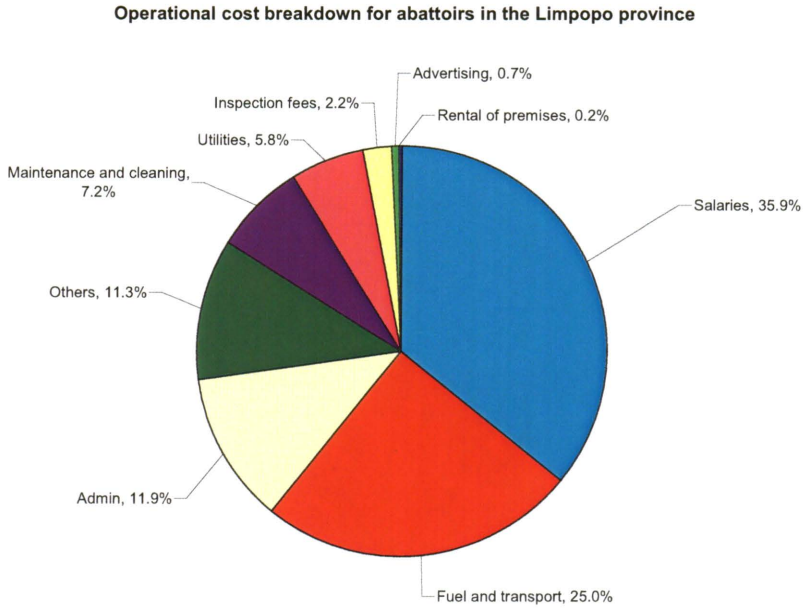


Figure 5.16 – Cost breakdown structure for abattoirs in Limpopo.
Source: Table A.3, Appendix A

5.4 Processing, packing and sales

Processing and packing of meat can take many forms (USDA, 2008, Online). It starts with the carcasses being received from abattoirs or wholesalers (shown in Figure 5.17) and ends with a huge variety of cuts or products made for the consumer.

Processing of the meat can be done either by hand (Figure 5.18) or through advanced automated systems (Figure 5.19). A large variety of packaging options are available, with vacuum packing rising in popularity in recent times.

An interesting trend (in the USA) in terms of the growing importance of pre-processed meat can be seen in Figure 5.20. It can be seen that the percentage of boxed and cut-up meat shipments have grown steadily and quite significantly from 1963 to 1997. Considering the supply chain of the future, it is important to take note of this trend. The implication of such a trend could be that more meat will be processed and packaged close to the source, as opposed to carcasses being transported to butcheries for processing close to the market.

Figure 5.17 – Carcasses hanging on rail, ready for further processing.
Source: USDA, 2008 (Online)

Figure 5.18 – Production line workers busy processing meat.
Source: USDA, 2008 (Online)

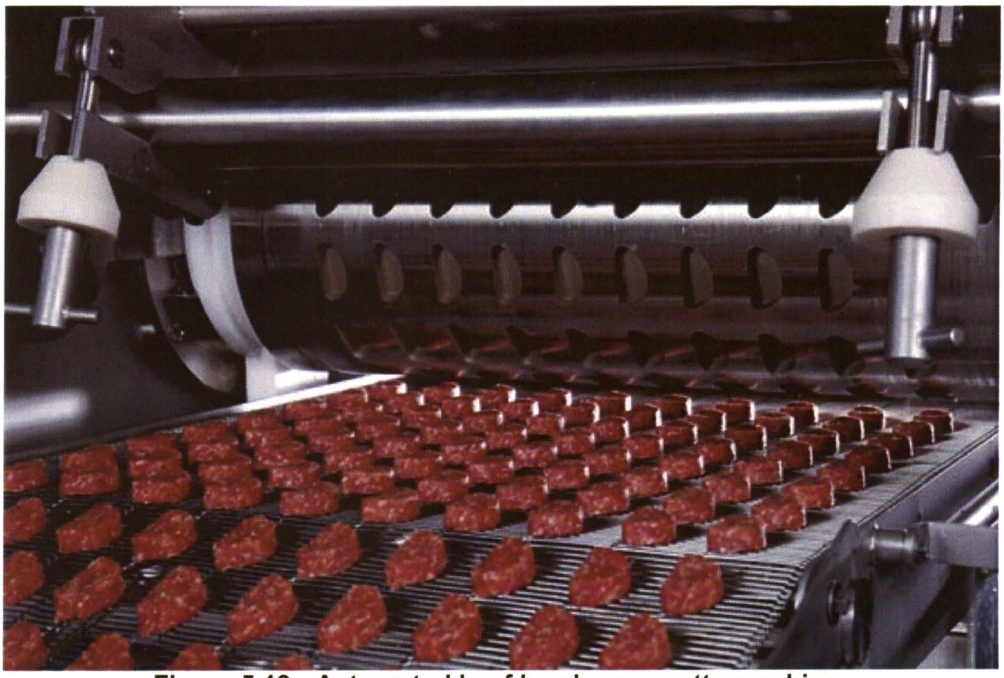


Figure 5.19 - Automated beef hamburger patty machine.
Source: USDA, 2008 (Online)

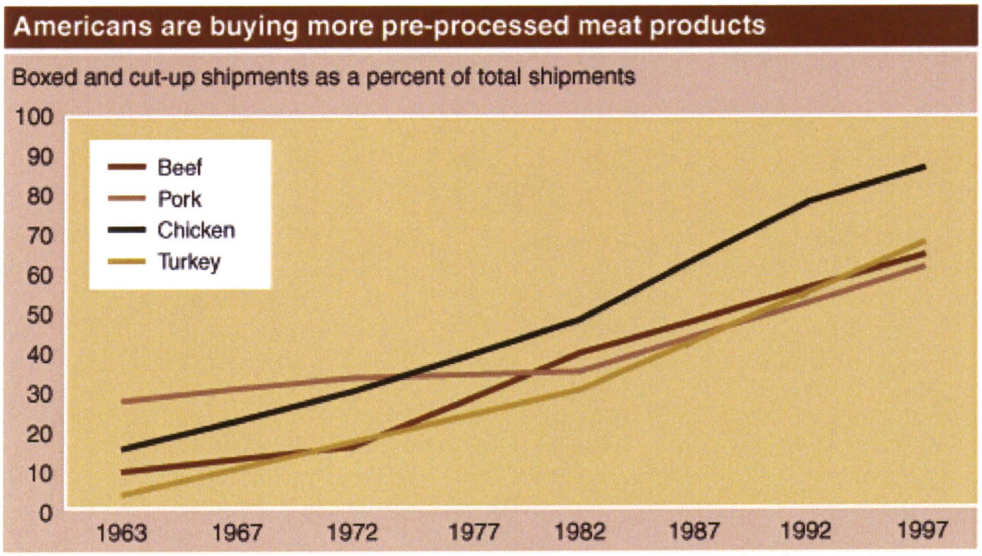


Figure 5.20 – Growing trend in boxed and cut-up sales in meat.
Source: USDA, 2008 (Online)

There are two main channels through which beef can be sold (Olivier, 2004):

The first option is the butchery, where meat is processed and sold from the same premises. In this case, the butchery buys carcasses from either a wholesaler or directly from an abattoir.

The second option is pure retailing of meat, where meat packages are processed beforehand in a remote plant, and the final products are displayed and sold. The largest retailers of meat are the large chain stores such as Pick and Pay, Woolworths, Checkers and Spar. These groups typically have very strong buying power which should enable them to sell larger quantities of beef at lower prices.

Two factors influence the retail price of meat in trade outlets. The first factor is the location of the outlet. If it is located in a higher income region, retail prices will typically be higher than in a lower income region. The second factor is that some consumers buy meat on face value and are willing to pay a premium for good looking meat, whereas others with less disposable income focus on maximum value for money – hence they buy mostly according to price.

Important processing, packing and sales process parameters

The typical costs and other process parameters associated with processing, packing and sales of beef were obtained through the structured questionnaire, located in Appendix A. Information was obtained regarding three different types of meat processing and sales businesses, namely:

- Centralised processing plants (typically for distribution to retailers, not to the general public).
- Retailers of meat (typically receives processed meat and could possibly also sell other groceries).
- Butcheries, where the processing and sales take place at the same venue.

The important process parameters for meat processing and retailing are shown in Table 5. 3. (Refer to Table A.2, Appendix A). These values were used in the simulation model (refer to Table 7. 2).

Table 5. 3 – Important meat processing and sales parameters.
Source: Table A.2, Appendix A

Parameter	Centralised meat processing plant	Retailer of meat (no processing)	Butchery (processing and sales at same location)
Average process time	3 days	6 days	6.3 days
Income from beef processing and / or sales	100 %	60 %	65 %
Beef from hind quarter / fore quarter	50 % hind 50% fore	43 % hind 57 % fore	80 % hind 20 % fore
Unit operational costs	R1.59 / kg	R 2.11 / kg	R 3.00 / kg
Unit capital costs (buildings and equipment)	R 6.15 / kg	R 4.14 / kg	R 6.06 / kg

The operational cost structure for butcheries is shown in Figure 5.21. (Refer to Table A.2, Appendix A). As can be seen salaries, rental of premises, utilities and fuel and transport comprise about 85 % of the total cost.

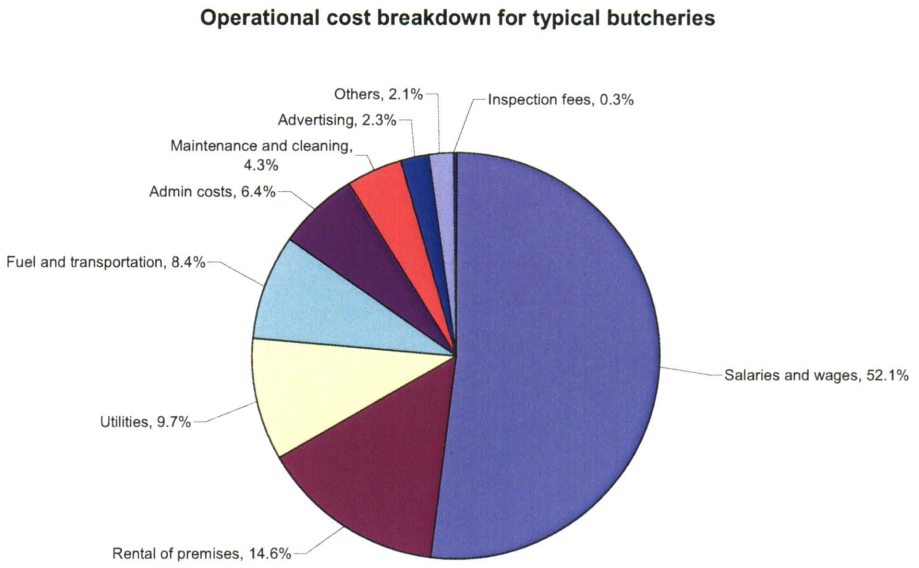


Figure 5.21 – Operational cost structure for butcheries.
Source: Table A.2, Appendix A

5.5 Logistics

Logistics in the supply chain of beef comprise of four main components, namely:

- Transport of live cattle.
- Transport of refrigerated carcasses.
- Transport of case-packed meat.
- Refrigerated storage of carcasses.

A typical live cattle transportation truck is shown in Figure 5.22. An example of a refrigerated truck is shown in Figure 5.23. Storage of carcasses in a cooling room is shown in Figure 5.24. (Author's own photographs). The difference between the two types of trucks gives a visual example of the "shift in mindset" before and after the abattoir process. The cattle transportation truck is "big, rugged and dirty". Since live animals are transported with the truck, it needs to have adequate volume, be strong enough to contain the cattle and will typically be dirtied by dung and soil.

However, from the moment that the carcasses are stored in the cooling rooms of the abattoir, they enter into the so-called “cold chain”, which may not be broken until the meat is sold to the final consumer. The cold chain implies that the meat must be kept below seven degrees Celsius. From here on the process must be completely hygienic as well. The truck shown in Figure 5.23 personifies this mindset. It is compact, clean and refrigerated. Since the meat will already have been cut up into parts once in the refrigerated truck, it will require much less volume.

It is more economical to transport packaged meat in a smaller truck than to transport live cattle over a long distance. However, the meat requires refrigeration which offsets some of the savings caused by the smaller volume.

Figure 5.22 – Live cattle transport truck.
Source: Own photograph

Figure 5.23 – Refrigerated delivery truck (with rail hangers), inside view.
Source: Own photograph

Figure 5.24 – Beef carcasses inside cooling chambers.
Source: Own photograph

Important logistics parameters

The typical costs for transportation and storage were obtained from logistics companies and a farmer who also transports live cattle. The relevant costs are given below:

Transportation cost		
Live cattle (Source: Van Heerden, 2008)		
For an average of 100 km radius		
Cattle transported	34	
Cost	2300	Rand
Unit cost	**67.65**	**R / LSU**

Transportation cost		
Carcasses (Source: Liebentrans, 2008)		
Within a 400 km radius		
Cost	7650	Rand
Capacity	12500	kg
Unit cost	**0.612**	**R / kg**

Transportation cost		
Case packed meat (Source: The Cold Chain, 2008)		
Average of 120km / day		
Unit cost	**0.56**	**R/kg**

The average costs for a cooling chamber (The Cold Chain, 2008) are given below:

Operational cost per beef quarter: R 2155 per quarter

Capital costs per beef quarter: R 4500 per quarter

These costs were used in the simulation model (refer to Table 7. 2).

5.6 Summary

The operational supply chain elements for naturally fed beef from Limpopo were discussed in this chapter. These elements include beef cattle farming, the abattoir function, processing and packing, logistics and sales channels.

The processes were briefly described, and the main process parameters and costs were obtained through structured questionnaires. This information were used in the simulations performed in Chapter 7. Some of the important aspects that featured in this chapter, are the following:

- Salaries and fuel makes a significant contribution to the operational costs of the supply chain.
- The carrying capacity of veld in the drier regions of Limpopo is better suited for naturally fed beef during the winter time, however carrying capacity is lower.
- The higher rainfall region in Limpopo (Waterberg region) has to be irrigated in order to consistently feed cattle through the winter.
- Rainfall in a large part of the Limpopo province is low and inconsistent. Improved farming and pasture buffering strategies have to be adopted.
- In general, beef cattle farmers in the Limpopo province are pessimistic about the future prospects of cattle farming.
- Bonsmara is the most popular choice of cattle used in Limpopo, and it is thus suggested that this breed be used for production.
- In the USA, there has been a significant increase in the volume of pre-processed and packaged beef since the 1960's, indicating the importance of beef processing facilities.

Chapter 6 will now discuss the market for beef and naturally fed beef.

Chapter 6: The market for beef and naturally fed beef

6.1 Introduction

The operational elements of the supply chain for naturally fed beef were discussed in Chapter 5. The objectives of this chapter are to gain insight into the market for beef and naturally fed beef, and determine what possible products could be offered to the market and estimate what the market demand for these products is likely to be. Understanding the market requirements and customer preferences is one of the most important steps in designing and operating the supply chain. The traditional sequence (Kotler and Keller, 2006) of marketing was to first make the product and then to try and find a market for the product and sell it. The modern approach is to do it the other way around - hence firstly determine what the market wants, and then find a way to make the required product in a profitable way. In order to design the supply chain for naturally fed beef from Limpopo, it is crucial to have a good idea of the market size, location, buying power, opinion on naturally fed beef versus feedlot beef and willingness to pay a premium for natural beef. The remainder of this chapter serves to gain an understanding of these factors. Importantly, the validity for the market estimate is discussed in section 6.5.

6.2 Trends in the beef industry

Meat has been part of man's diet for a very long time, dating back to prehistoric times. It has become a symbol of survival and dominance over nature. It seems to have symbolic, as well as nutritional value. The remainder of section 6.2 will discuss the market trends in the USA, the market trends in South Africa and then briefly consider the nutritional value of beef as a source of protein. The likely implications for the future of naturally fed beef in South Africa will then be extracted from these observations.

Market trends in the USA

According to Allen and Hung (2002): "Some anthropologists and sociologists claim that meat is the most highly prized and culturally significant of foods in Western society. In fact, meat is so crucial that its absence is described as a 'meat hunger' but not in the physiological sense, rather as a food habit that is a ***feature of society and is integrated into a structure of social values that may have nothing to do with the principles of nutrition***. "

However, during the last two or three decades, per capita demand for meat and especially beef has declined. Figure 6. 1 and Figure 6. 2 below (Schroeder, Marsh and Mintert, 2000) show a clear downward trend in the per capita expenditure on beef in the United States. The per capita expenditure on poultry has increased slightly though.

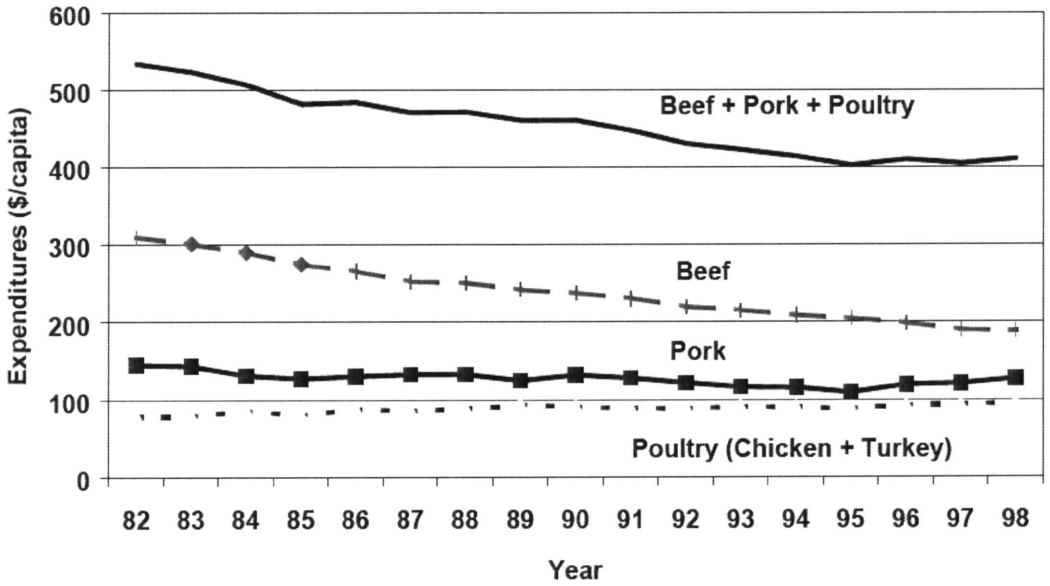


Figure 6. 1 - Declining expenditure per capita on meat and beef in the USA.
Source: Schroeder et al., 2000

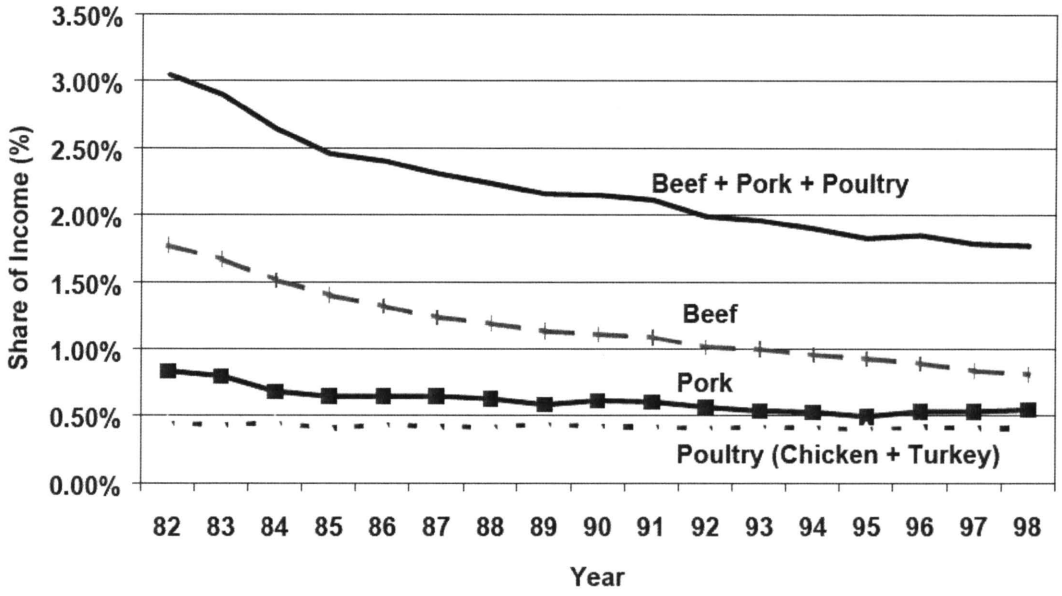


Figure 6. 2 - Declining expenditure as percentage of income on meat and beef in the USA.
Source: Schroeder et al., 2000

Some of the proposed reasons for the decline in beef expenditure in the USA are as follows (Schroeder et al., 2000):

- Beef in general does not live up to the **quality** expectations of the consumers.
- Outbreaks of diseases such as BSE has lowered confidence in the **safety** of beef.
- **Health information** linking the consumption of beef with cholesterol, heart disease and cancer worries consumers.
- Increasing participation of females in the work force has lowered the demand for beef. Families have less time to prepare food and the preparation of beef is seen as laborious. **Convenient and easy to prepare** meals are favoured instead.
- **Ethical issues** in terms of feedlot produced animals and also pressure from groups like PETA who believe it is unethical to kill animals for food.
- In general, consumers are becoming more **brand** conscious. Branding in the beef industry is not commonly used at the moment.
- Consumers in general are requiring higher levels of **mass customisation**.

In the early 20th century (Martinez and Stewart, 2003), most types of farm products in the USA were sold as commodities on the open market. These standarised products were pushed through the supply chain to keep costs down. This system was adequate for consumers who needed basic staple foods and prepared the food mainly at home.

However, changing consumer demographics, such as larger incomes and less time available, has increased the demand for further processed food. An example of this trend can be seen in Figure 6. 3, which clearly shows the changing consumer preferences towards variety and convenience. From this graph it can be seen that between 1962 and 2003, the demand in terms of mass for whole chickens in the USA dropped from about 83 % to only about 10 % - a significant drop indeed. On the other hand, further processed products have increased from only about 2 % in 1962 to almost 50 % in 2003.

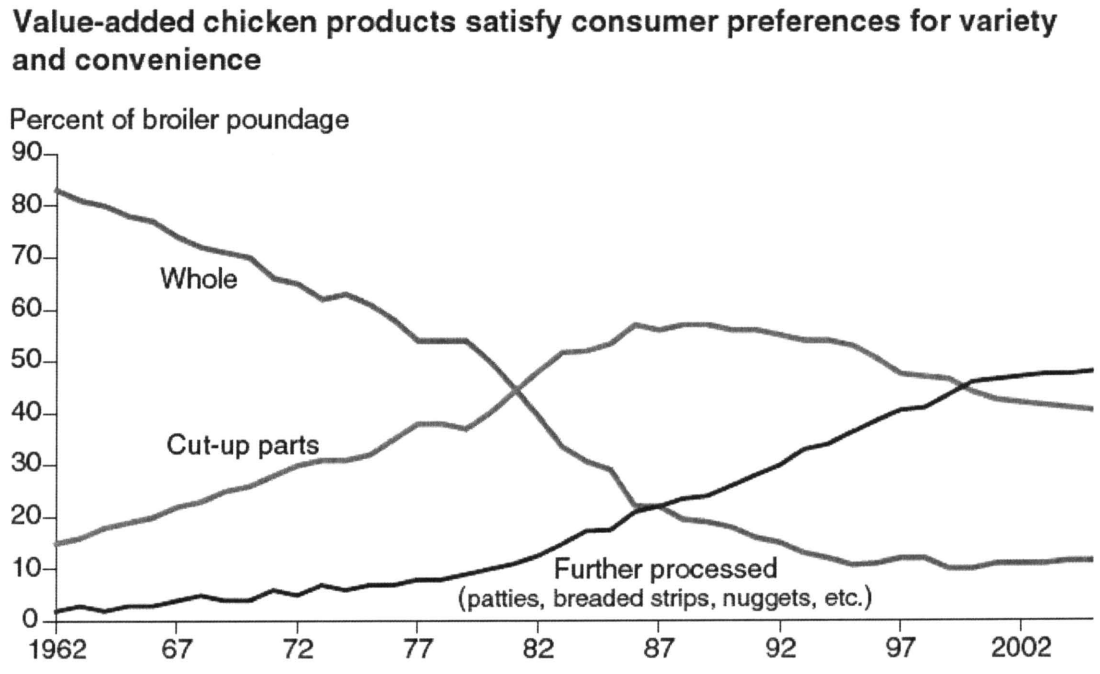


Figure 6. 3 - Consumer shift towards variety and convenience in the chicken industry.
Source: Martinez and Stewart, 2003

The challenge today is for farms to produce livestock that will best be in line to effectively serve their market requirements. For instance, in the USA, farms may specialise in producing specific breeds in the right quantities and of the right quality to suit the market.

An example is the production of "Smithfield's Lean Generation Pork", which only uses hogs of a specific genetic line – specially bred to be the leanest pork in the USA.

In developed countries, the demand for red meat has decreased over the past decade (Williamson et al., 2005). The variation in demand for lamb and mutton has been small, while the demand for pork has actually increased. The drop in demand for red meat can thus primarily be attributed to a drop in demand for beef.

The market for organic, or "grass fed" beef in the USA has definitely taken off recently:

"When the restaurant Harry Caray's in Chicago put steaks from grass-fed cattle on the menu, the effect was dramatic: The restaurant had its best month of sales in nearly 20 years." (Berta, 2006)

The number of American producers of "grass-fed" beef has grown from 40 to about one thousand over the last six years. Grass-fed beef has more nutritional value and less fat than feedlot produced beef (Berta, 2006). It is also free from growth hormones and antibiotics that is fed to feedlot animals.

However, because it is leaner one must be careful to not overcook it because it will taste too dry. Furthermore, because the meat is leaner it has to be matured for 18 to 28 days before it is butchered. One of the drawbacks of grass-fed beef is that it also does not necessarily have the best taste that beef has to offer. Unfortunately, fat makes beef taste better. Ways to improve the taste of this type of beef will thus remain a challenge.

Laura's Lean Beef (founded by Laura Freeman) is a natural brand, but it is still mainstream enough to be sold in most of the large chains in America.

According to Freeman: "The thing that probably stands out most about the look of the product in the meat case is that I'm on the label. There aren't many other women in this industry, and having my face, for better or worse, on the label really connects with the core grocery shoppers — women." (Gazdziak, 2007)

This is probably a very important observation to take cognisance of – the fact that it is women who are the major shoppers and one should take their needs and shopping behaviour very carefully into consideration.

Market trends in South Africa

The same downward trend in per capita beef consumption is evident in the SA beef industry, as can be seen from Figure 6. 4 (Taljaard, 2003). It can be seen that the per capita consumption of beef has nearly halved from around 24 kg per capita in 1973 to around 12 kg per capita in 2003. This has happened while the average disposable income has remained relatively constant. This indicates that beef has become less popular as a source of protein, even though consumers had the same amount of money to spend on it.

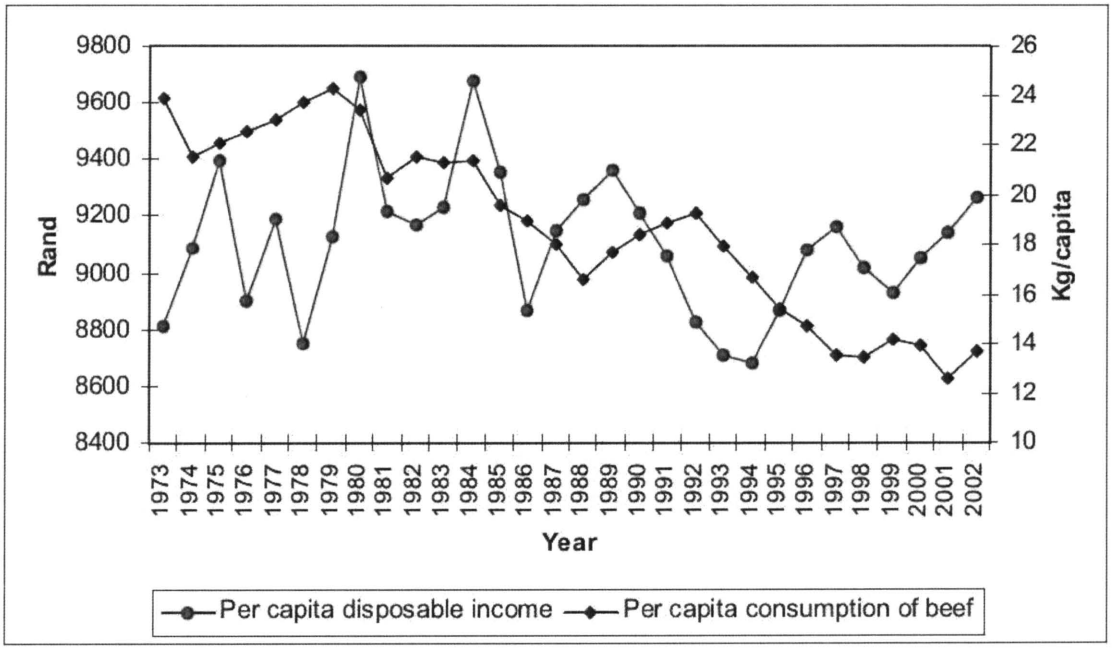


Figure 6. 4 - South African beef consumption from 1973 to 2002.
Source: Taljaard, 2003

However, according to Booysen (2007), the problem in South Africa is not simply one of declining demand, but rather of production capacity. Even though it is true that beef consumption per capita has declined, one must keep in mind that the country's population has grown faster than the cattle population. South Africa is a net importer of

beef, which indicates that the production capacity inside the country is lower than the demand for beef.

According to Louw (2008), the meat industry is a very competitive environment. White meat is perceived to be cheaper and healthier. South Africans have also become much more accustomed to white meat through fast food outlets, for instance Kentucky Fried Chicken.

In a system-wide demand study (Taljaard, Alemu, van Schalkwyk, 2004) on the demand for meat in South Africa, the expenditure elasticity results indicated that beef and mutton must be considered luxury products. Pork is close to being a luxury product. Chicken was the only product to be classified as a necessity.

The demographics of South Africa are changing. The nation is becoming more urbanised and cosmopolitan, and the consumption patterns have changed. One implication is that per capita consumption of red meats, especially beef, has decreased whereas consumption of pork and poultry has increased. This can be seen in Table 6. 1 below (Poonyth, Hassan & Kirsten, 2001):

Table 6. 1 - Per capita consumption of meat in South Africa in kg (ten year average)
Source: Poonyth et al., 2001

Period	White Meat	Red Meat
1971-1980	10	32
1981-1990	15	28
1991-1999	22	26

From the results it is clear that the red meat industry will have to develop innovative, consumer friendly, easy to prepare, fast, healthy and safe products. It is also very important to take cognisance of how changes in prices of white meat influence the demand of red meat, as a substitution product.

The nutritional value of beef

According to Williamson, Foster, Stanner and Buttriss (2005), red meat contains high biological value protein and important micronutrients, all of which are essential for good health throughout life. Most healthy balanced diets will include lean meat in moderate

portions, together with starchy carbohydrates (including wholegrain foods), plenty of fruit and vegetables, and moderate amounts of milk and dairy foods.

Dietary protein is needed for growth, maintenance and repair of the body, and can also provide energy. Protein from foods consists of chains of hundreds to thousands of amino acids. Some amino acids can be synthesised in the body, while others cannot, and therefore essential amino acids need to be consumed in the diet to maintain good health. Red meat is a good provider of these amino acids.

Eating different plant foods, in combination, can provide the right balance of essential amino acids, although far less efficiently than meat.

Meat and animal-derived foods are the only foods that naturally provide vitamin B12, some individuals who exclude such foods from their diet are at risk of inadequate intakes. Dietary intakes of vitamin B12 are consistently reported as being lower in vegetarian diets.

Likely implications for the market of naturally fed beef from Limpopo

As was discussed above, it is clear that beef has lost a lot of ground over the last three decades in terms of per capita consumption, at the expense of white meat like chicken. This trend is applicable to the USA as well as South Africa. According to Louw (2008), this trend may continue into the future.

However, beef eaten in the right quantities is still a valuable source of protein. Furthermore, the market for naturally fed beef is likely to grow in South Africa, for the following reasons:

- Naturally fed beef addresses many of the problems that caused the decline of beef sales in the first place. For instance, naturally fed beef has a much improved status regarding quality, safety and health issues when compared to feedlot beef. It can be considered a more ethical and humane way of treating animals. It also lends itself to the establishment of a premium branded product.
- The market in the USA has grown strongly over the past decade (40 producers to about 1000 in 6 years' time). According to Louw (2008), trends in the South African market are typically 10 to 15 years behind trends in the USA. It is thus an

indication that the South African market could also start growing rapidly in the foreseeable future.

The trend in the beef industry has been a move towards convenience and fast and easy-to-prepare meals. The market for pre-processed meat has grown significantly. It will thus become more important to produce pre-packaged beef products that are convenient and also appeal to women, who typically do the monthly shopping.

6.3 *The development of two differentiated natural beef concepts from Limpopo*

At this point of the research enough insight had been gained to come up with a proposal for a conceptual differentiation and positioning of natural beef in the Limpopo province. Since there are mainly two regions in the Bushveld suitable for beef cattle production, namely the Waterberg and arid sweet veld regions, it was decided to investigate the possibility of matching two brands of naturally fed beef with the production regions.

Hence, a “type A” and a “type B” beef was conceptually developed. Type A natural beef is produced from cattle in the Waterberg region, having grazed on natural pasture. Type B natural beef is produced from cattle in the drier regions of the bushveld (sweet veld), on totally natural land without any irrigation of pastures.

However, when developing a product, one must keep in mind that the core product is not the only aspect that consumers will consider when they buy. The total product offering, also known as the “augmented” product (Kotler and Keller, 2006) consists of a number features such as branding, packaging, availability, flexibility and customer service.

In order to develop realistic market offerings, an expert in the technical aspects of beef was also interviewed (Du Bruyn, 2008). Following the discussion, two differentiated beef brands were developed. The attributes of these two brands, types A and B beef, are compared with the attributes of normal feedlot beef in Table 6. 2. (Du Bruyn and own compilation, 2008)

Table 6. 2 - Comparison between the attributes of feedlot beef and two conceptual naturally fed offerings (types A and B beef)
Source: Du Bruyn, 2008 and own compilation

Feedlot beef	Type A beef: Naturally fed beef (grazed on irrigated sourveld pasture in Waterberg region)	Type B beef: Totally free ranging beef (grazed on natural mixed and sweet veld pastures)
Lowest price	Price positioning between feedlot and type B beef	Highest price
Safe to use	Safe to use	Safe to use
Standard taste	Better taste than feedlot beef	Better taste than feedlot beef
Fat content about 13 %	Fat content can be trimmed to make leaner cuts.	Fat content can be trimmed to make leaner cuts.
Tender	Meat has to be matured longer to obtain the same tenderness as feedlot beef	Meat has to be matured longer to obtain the same tenderness as feedlot beef
High availability across South Africa	Availability probably determined by production capacity in Waterberg region	Availability probably determined by market demand - only available in very selected, high affluence regions
Cattle were confined in feedlot for 4 months	Semi – free ranging. Cattle are kept in smaller camps, as they are moved along the irrigated pastures	Completely free ranging
Growth stimulants and antibiotics were added to diets to artificially increase growth rate	No growth stimulants added – hence healthier than feedlot beef	No growth stimulants added – hence healthier than feedlot beef
	Colour a bit darker and fat a bit yellower (yellow fat have omega 3 and 6 acids which is good for health)	Colour a bit darker and fat a bit yellower (yellow fat have omega 3 and 6 acids which is good for health)
	Meat is pre-packaged and branded	Meat is pre-packaged and branded. Attractive packaging is part of the marketing effort.
		Highest variety of cuts and packages available
		Beef is completely traceable – back to farm level

A questionnaire was developed and given to consumers of beef to complete. The objective of the questionnaire was to gain insight into consumers' general attitude towards beef and naturally fed beef, and their opinions regarding the offerings of types A and B beef. This questionnaire is located in Appendix A of this report.

The results obtained through this questionnaire will now be discussed with the aid of Table A.4 and Table A.5, which are also located in Appendix A.

In Figure 6. 5 (refer to Table A.4, Appendix A) the opinion of consumers regarding the essentiality of beef is shown. As can be seen, about 71 % indicated that beef is still essential to them, which indicates that the market for beef should still be strong.

In Figure 6. 6 (refer to Table A.4, Appendix A) it can be seen that the majority of clients are also happy with the variety of beef products that are available on the market. Hence, differentiation through a greater variety of beef products is unlikely to have a significant impact on sales.

Figure 6. 7 (refer to Table A.4, Appendix A) shows that almost 60 % of consumers are concerned about the treatment of cattle. This indicates that naturally fed beef, where cattle are not artificially grown in feedlots, should appeal to consumer preferences.

In Figure 6. 8 (refer to Table A.4, Appendix A) more figures are shown. About 48 % of respondents would prefer full traceability in the supply chain. Roughly 45 % of respondents are concerned about the use of growth stimulants in cattle. This should support the sales of natural beef.

On the other hand, almost 40 % of respondents is of the opinion that beef is too expensive as a source of protein. This should impact negatively on the sales of naturally fed beef, which would be sold at a premium. About 37 % of respondents prefer chicken or pork, which is considered quite a high percentage. This is an indication of the pressure that is put onto the sales of beef by substitute products and highlights the fact that differentiation needs to be considered to increase the competitiveness of beef in the market.

Figure 6. 9 (refer to Table A.5, Appendix A) indicates that the average expenditure on beef products varies from an average of about R 200 per month for a single person to an average of around R 400 per month for a household of six people.

An interesting observation can be made from Figure 6. 10 (refer to Table A.5, Appendix A) namely that the expenditure on beef is relatively unrelated to the monthly household income of the household. The average expenditure remains relatively constant at around R 300 per month per household. This is an indication of how essential beef is as part of the diet – even poorer households have to buy a minimum amount of beef. This also indicates the potential that lies in marketing differentiated, higher priced beef to higher income households.

In Figure 6. 11 (refer to Table A.4, Appendix A) it can be seen that almost 70 % of respondents still prefer to buy their beef at a butchery. This is somewhat contradictory to the trend in the USA of more pre-packed meat (refer to Figure 6. 3). A butchery is specifically geared towards cutting meat to the requirements of the customer, as opposed to pre-packed meat. This could indicate that the South African market is still lagging some way behind the USA market.

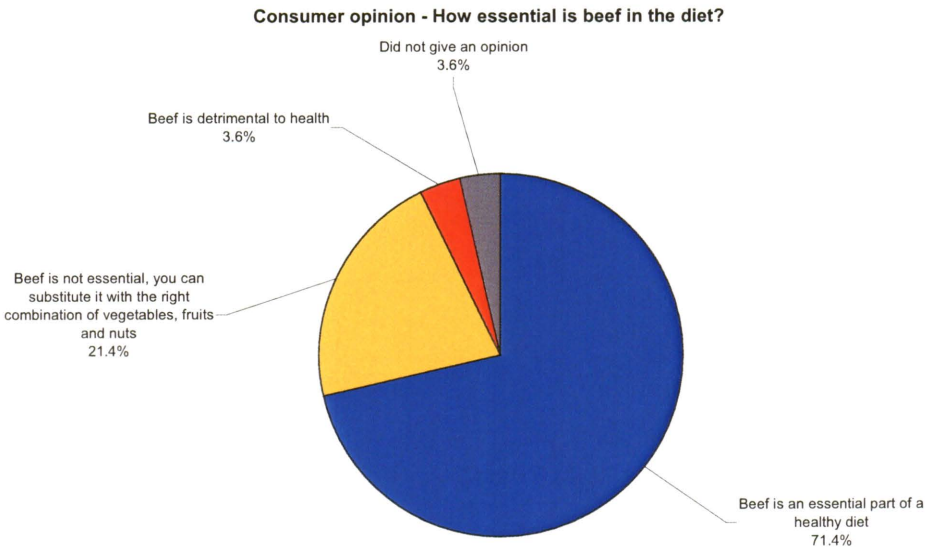


Figure 6. 5 – Essentiality of beef as part of the diet.
Source: Table A.4, Appendix A

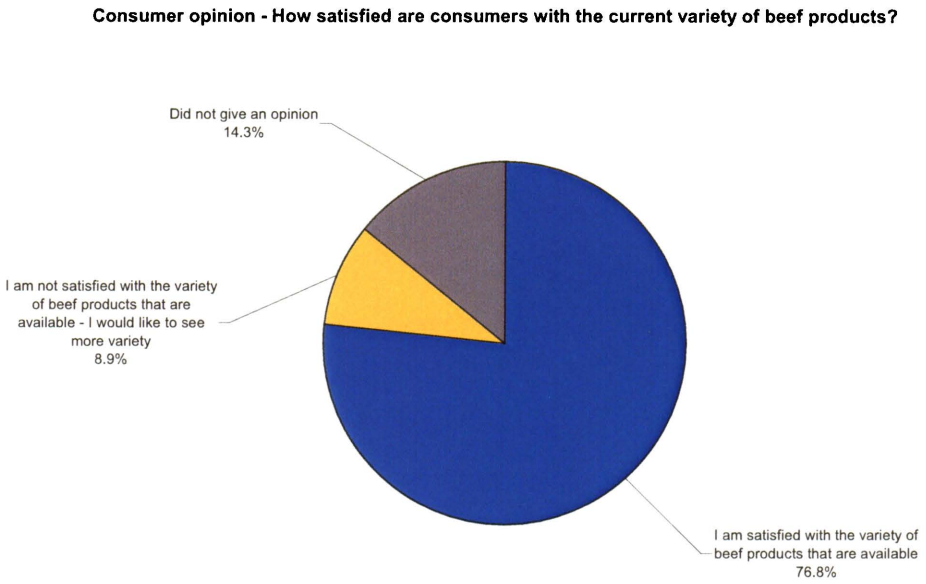


Figure 6. 6 – Customer satisfaction with the variety of beef products available.
Source: Table A.4, Appendix A

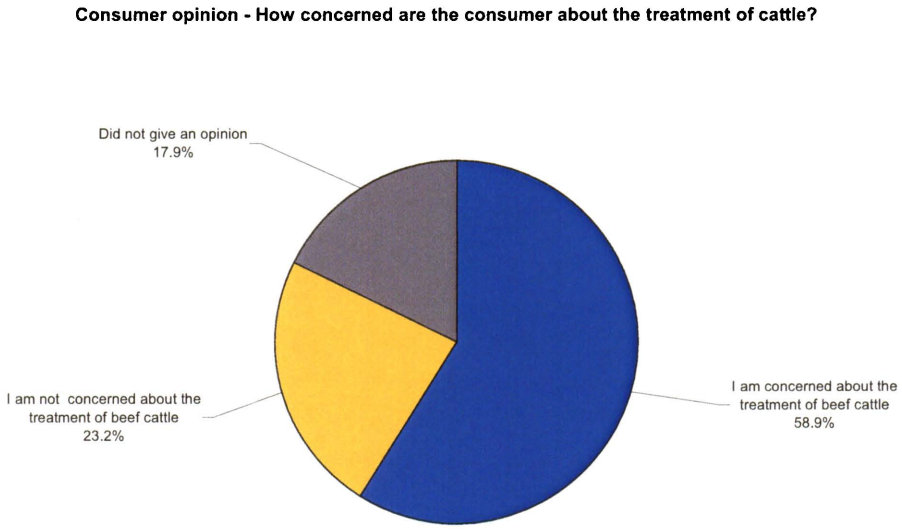


Figure 6. 7 - Consumer concern about the treatment of beef cattle.
Source: Table A.4, Appendix A

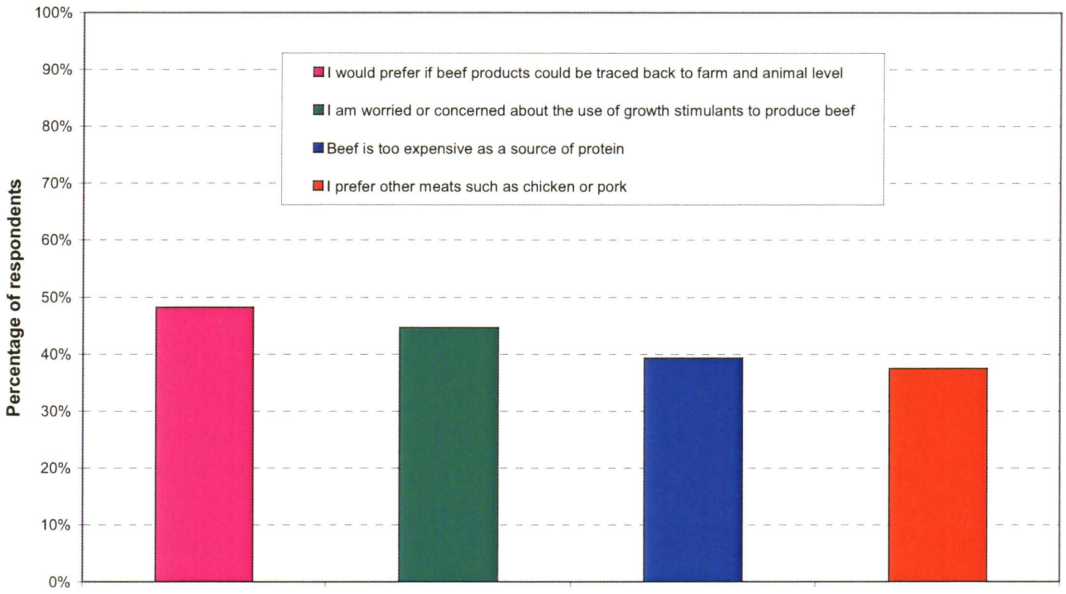


Figure 6. 8 – Other consumer preferences.
Source: Table A.4, Appendix A

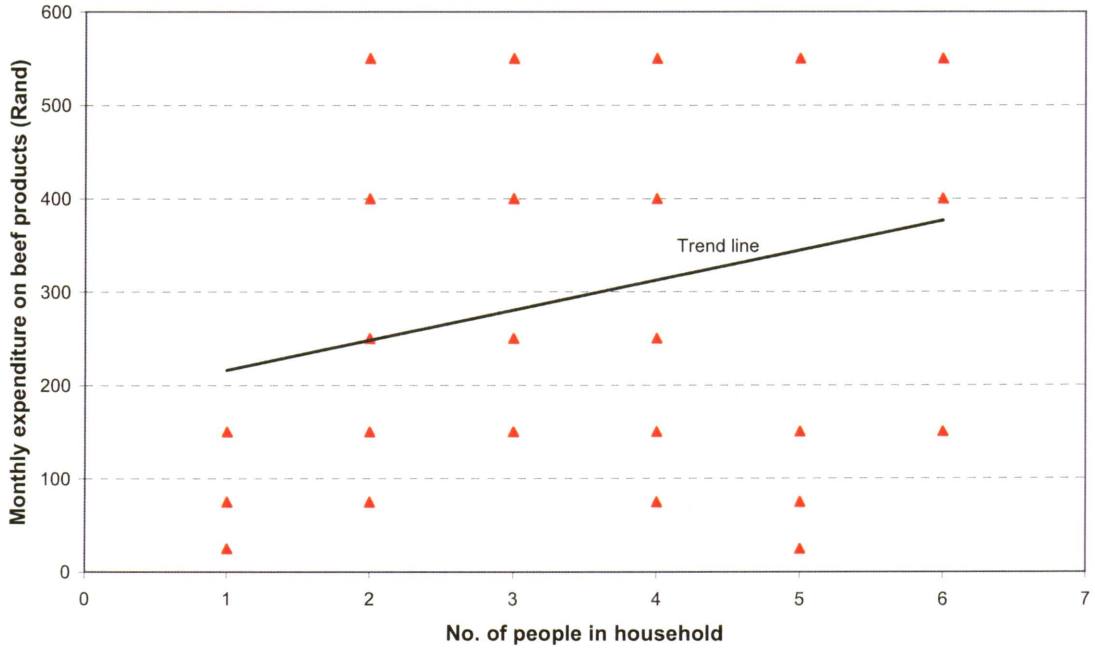


Figure 6. 9 – Monthly spending on beef products, as a function of number of people in the household.
Source: Table A.5, Appendix A

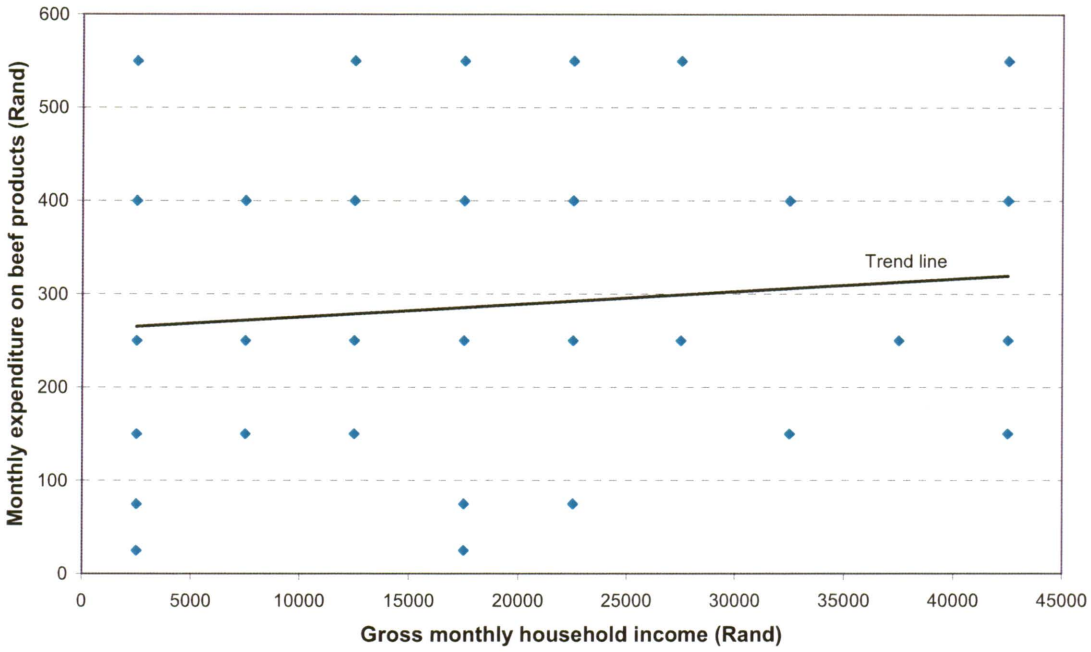


Figure 6. 10 – Monthly expenditure on beef products, as a function of gross household income.
Source: Table A.5, Appendix A

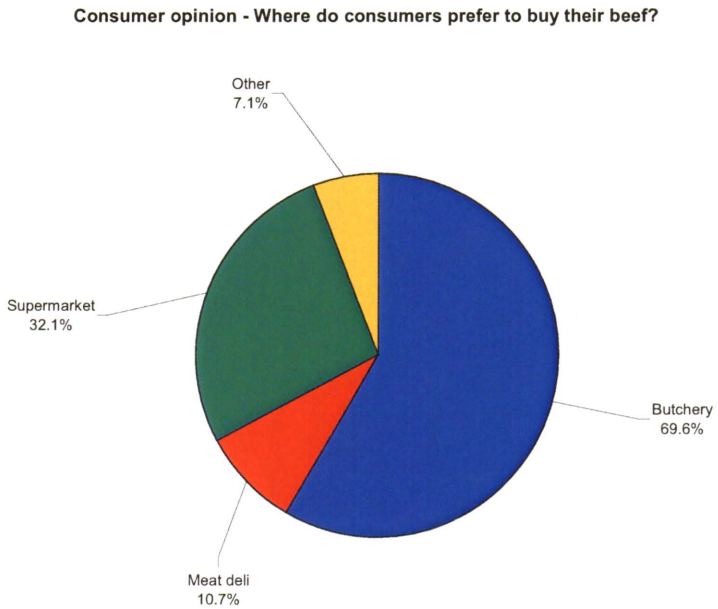


Figure 6. 11 – Consumer preferences in terms of where beef is bought.
Source: Table A.4, Appendix A

6.4 *Estimate of market demand for naturally fed beef, types A and B*

In this section, an estimation of the market demand for naturally fed beef from Limpopo is made, by combining the results from the questionnaires with information for current beef consumption in South Africa. The total number of beef cattle slaughters across South Africa is shown in Figure 6. 12. As can be seen, the average slaughter value for beef cattle is around 165 000 cattle per month. Assuming that about 2 % of the cattle do not reach the market as carcasses, the total amount of carcasses sold to market then becomes about 161 700. The reasons why not all cattle are converted into marketable carcasses would include factors such as diseases, not complying with all requirements and other inefficiencies in the system.

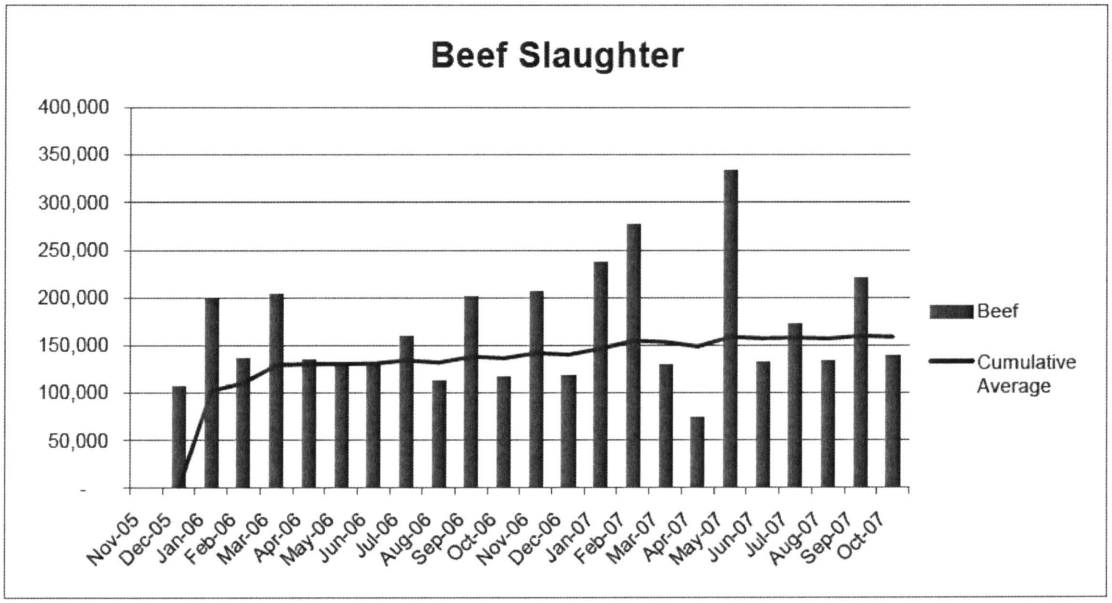


Figure 6. 12 - Total cattle slaughter numbers in South Africa, 2005 to 2007.
Source: The Red Meat Abattoir Association

Due to the location of the Limpopo province, the most likely markets (based on distance) for beef from this province would probably be:

- Gauteng (Pretoria and Johannesburg specifically)
- The eastern part of North West (where the largest percentage of the population of North West is concentrated)
- Polokwane
- Nelspruit

To justify the above decision – the market in Cape Town could be served from farms in the Western Cape, and the market in Durban can be served from farms in Kwazulu-Natal.

It was also decided that the higher priced type B beef would only be sold in Gauteng, where the highest purchasing power is concentrated. This was decided because the percentage of high income households in the other three markets are so small that it would most probably not be worthwhile to pursue these markets.

The next step was to estimate the current market size for beef in each of these regions. Data was obtained from Statistics South Africa (2008, online) regarding the concentration of the population but also regarding wealth distribution across the different provinces. From Figure 6. 10 it can be seen that the expenditure on beef products per household remains relatively constant as a function of household income. However, there is a slight increase in expenditure as income increases. Based on this observation, for the purposes of this study it was decided to give a 20 % weight factor to the income and 80 % to the population in any province.

The reason why these weight factors are used is the following: When considering Figure 6. 9, the trend line for the monthly expenditure on beef products varies from about R 220 per month for 1 person to R380 for 6 people, thus an increase of about 73 % (hence the 80 % weight factor for population). When considering Figure 6. 10, it can be seen that the expenditure trend line varies from about R270 at low income to R320 at high income, thus an increase of 18.5 % (hence the 20 % weight factor for income).

Using these weight factors together with the beef slaughter values, the estimated sales of beef carcasses are calculated in Table 6. 3 (Statistics South Africa, 2008 [online] and own compilation).

However, the provinces will not be targeted completely as markets for the naturally fed beef, hence the sizes for the four chosen markets have to be further refined. This is done by calculating the population of the market as a percentage of the population of the province, and then multiplying this by the estimated demand in the province. The

estimated annual market for beef carcasses is shown in Table 6. 4 (refer to several sources listed below Table 6. 4).

Table 6. 3 – Estimate of beef carcasses sold in four provinces (weighted average)
Source: Statistics South Africa (2008, online) and own compilation

Sold in market:	Percentage of income	Percentage of population	No. of carcasses sold		
			Based on income	Based on population size	Weighted averaged
Gauteng	39.2%	20.2%	63386	32663	38808
North West	5.6%	7.1%	9055	11481	10996
Limpopo	5.1%	11.3%	8247	18272	16267
Mpumalanga	4.5%	7.4%	7277	11966	11028

Table 6. 4 – Estimate of beef carcasses sold annually in the four target markets

Markets	Population of province (millions)	Population of market (millions)	Market size as percentage of province population	Carcasses sold in this market (per month)	Annual carcasses sold in this market
Pta and Jhb	9.67	7.73	80%	31046	372552
North West (East region only)	3.40	1.1	32%	3560	42720
Polokwane	5.41	0.51	9%	1534	18408
Nelspruit	3.54	0.56	16%	1744	20928

Sources:

www.polokwane.org.za/welcome/demographics.htm

www.sa2010.gov.za/southafrica/hostcities.php

www.pptpilot.org.za/North_West_Province.pdf

Data was also obtained regarding the number of households per province. This data was used to calculate the "average number of carcasses consumed per household" in a year. This is shown in Table 6. 5 (Statistics South Africa, 2008 [online] and own compilation).

Table 6. 5 - Calculation of average annual beef carcasses consumed per household, in the four target markets
Source: Statistics South Africa (2008, online) and own compilation

Province	No. of households in province	Market population as % of province population	No.of households in market	Average annual carcasses consumed per household
Gauteng	1964168	80%	1571334	0.237
North West	720644	32%	233331	0.183
Limpopo	982457	9%	92667	0.199
Mpumalanga	604010	16%	95525	0.219

The market estimation done up to this point, was for normal feedlot produced beef. The market demand for the type A and type B natural beef offerings, as developed earlier in Table 6. 2, had to be estimated. The way in which the market demand was estimated will now be described:

The willingness of consumers to pay premiums for the two types of natural beef considered in this study were measured. This is shown in Figure 6. 13 (refer to Table A.5, Appendix A). As can be seen, consumers with a household income of R 5000 per month seem to be willing to pay a premium of 5 % for type A beef and 10% for type B beef. Consumers with a household income of around R40 000 per month are willing to pay a premium of around 15 % for type A beef and 20 % for type B beef.

Using this information, estimated premiums of 10 % for the type A beef and 20 % for the type B beef are regarded as reasonably realistic for the purposes of this research. As a rough estimate, the conclusion is then made that households with a total monthly income of R22 500 or higher, will buy type A beef if it costs 10 % more than feedlot beef. Using the same approach it is deduced that only households with a monthly income of R40 000 per month or higher would be willing to pay 20 % more for type A beef.

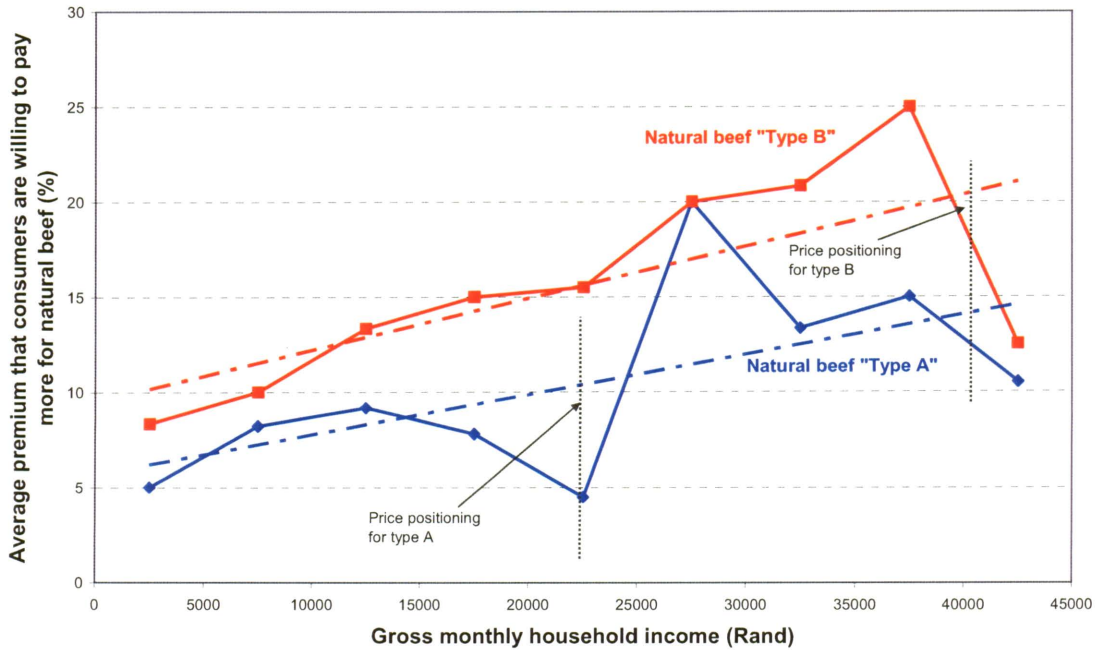


Figure 6. 13 - Consumers' willingness to pay a premium for naturally fed beef.
Source: Table A.5, Appendix A

Data was also obtained regarding the income distribution per household for each of the four provinces considered. These distributions per province are shown in Figure 6. 14 (Statistics South Africa, 2008 [online]). The conclusions that can be made from these graphs are:

- 5 % of households in Gauteng earn R22 500 or more per month.
- The distributions for Limpopo, Mpumalanga and North West are very similar. About 1 % of the households in these provinces earns R22 500 or more per month.
- About 2 % of households in Gauteng earn R40 000 or more per month.

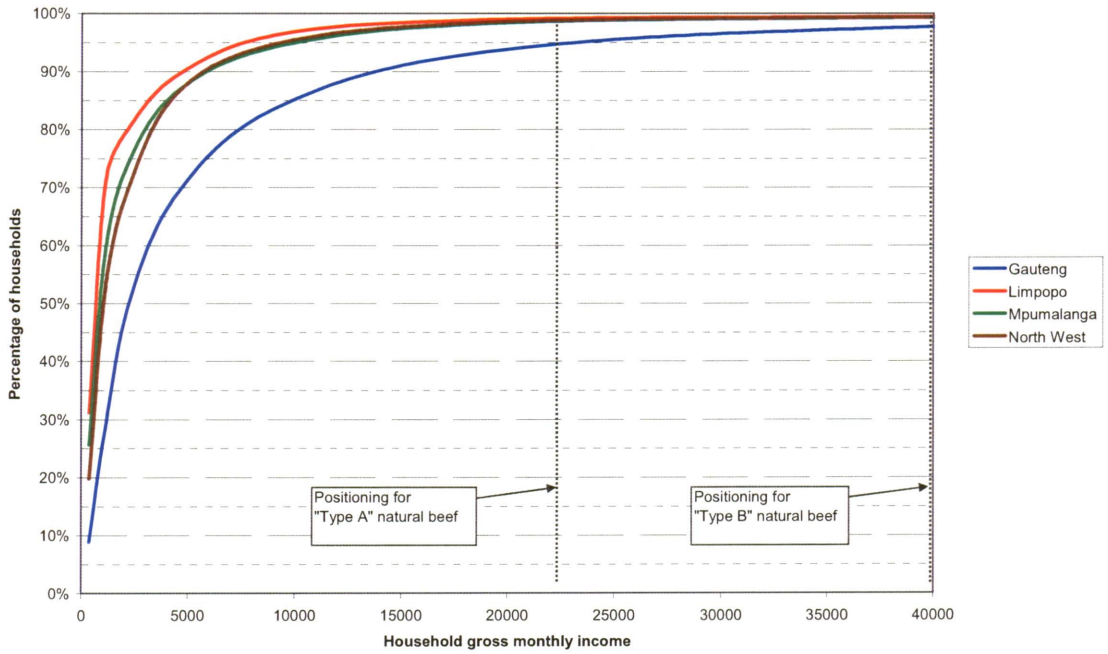


Figure 6. 14 – Distribution of household income in four provinces.
Source: Statistics South Africa (2008, online)

Referring back to Figure 6. 7 and Figure 6. 8, there are three important values available:

- About 60 % of people who participated in the consumer survey are concerned about cattle welfare.
- About 48 % of people who participated in the consumer survey would prefer to have full traceability in the supply chain

- About 45 % of people who participated in the consumer survey are worried about the use of growth stimulants used to produce beef.

For the purposes of this study, it is therefore regarded as a reasonable assumption that only about 50% of the market sizes derived from Figure 6. 14 would in fact be willing to buy naturally fed beef. The final estimated market sizes for types A and B beef can now be calculated, and are displayed in Table 6. 6. These estimated market sizes were used as the baseline values in the simulations, as performed in Chapter 8.

Table 6. 6 - Estimation of market size for types A and B beef in the target markets.
Source: Author's own calculations

Markets	Percentage of households willing to buy type A (at 10% premium)	Percentage of households willing to buy type B (at 20% premium)	Estimated annual carcasses of type A sold	Estimated annual carcasses of type B sold
Pta and Jhb	2.50%	1.00%	9314	3726
North West (East region only)	0.50%	0	214	0
Polokwane	0.50%	0	92	0
Nelspruit	0.50%	0	105	0

6.5 *Discussion of the validity of the market estimate*

Two aspects of the market research are discussed in order to assess the validity of the results as presented in sections 6.3 and 6.4 of this report. The first is a discussion of the sample size, and the second is a discussion of the estimation procedure for the size of the market.

Validity of the sample

A total of 56 questionnaires were completed by the general public. This is considered a reasonable sample. The income profile for the respondents is shown in Figure 6. 15 (refer to Table A.4, Appendix A). This shows that more of the lower income households are represented, which is in line with the reality in South Africa.

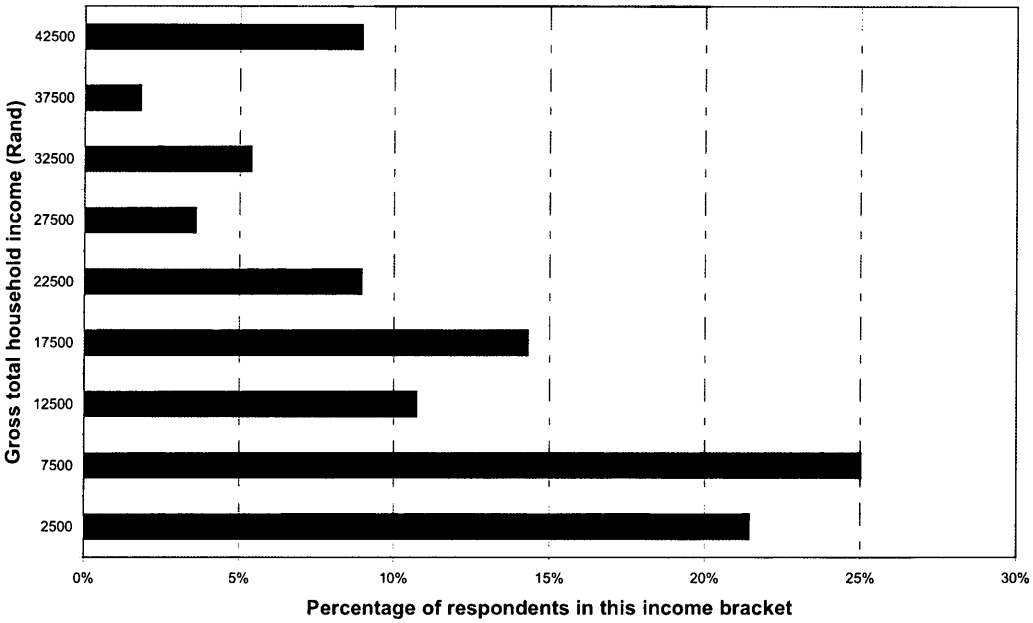


Figure 6. 15 – Distribution of gross household income of participants.
Source: Table A.4, Appendix A

Validity of the market size estimate

The estimation of potential market sizes for the natural beef products was problematic, particularly due to the fact that the type A and type B beef offerings are conceptual and no real sales exist for these products.

However, since this study is regarded to be partly explorative it was considered adequate to make an estimate, based on research data, that is in the right order of magnitude. It is difficult to say exactly how scientifically correct the determination of the market size, as determined by Figure 6. 13, really is. The other values that can be questioned are the 20 % and 80 % weight factors assigned to the income and population densities.

In order to mitigate the possible inaccuracy of the method, the estimated markets was halved in order to be conservative rather than to over estimate the market potential. Furthermore, sensitivity analyses are performed in the simulations of Chapter 8 where both sales volumes and prices are varied.

According to Gordon (2008), the sales of Woolworths' naturally fed beef is roughly between 2% and 5% of their total beef sales. The estimates for the markets for type A beef are 2.5 % of the market in Gauteng, and 0.5 % of the markets in North West, Nelspruit and Polokwane. The estimate for type B beef is 1% of the market in Gauteng. These estimates compare well with the values as given by Woolworths. Nevertheless, the market sizes as estimated in this study are to be considered as tentative and with some degree of skepticism.

6.6 Calculation of the average retail carcass price for beef

When a carcass is cut into different parts such as steaks, stewing meat and mince, there are different retail prices per kilogram for these products. It is quite possible that on the same day, fillet steak is sold at R 120 per kg at an upmarket venue, while mince is sold at R 30 per kg on a bulk special at another venue. The question arises – what exactly is the average retail price of the whole carcass? The precise answer to this question can only be known if all retailers in a region are willing to share exactly how many sales they have made at what prices. Unfortunately these figures are usually confidential and not conveyed to the beef industry.

The only way to estimate the average carcass price of beef, is to make use of the so-called "block test" (SAMIC, 2008, online). In fact, most butcheries and meat retailers make use of this test as a guideline for their pricing structures – although prices are also adjusted according to supply and demand. The full block test is shown in Figure 6. 16.

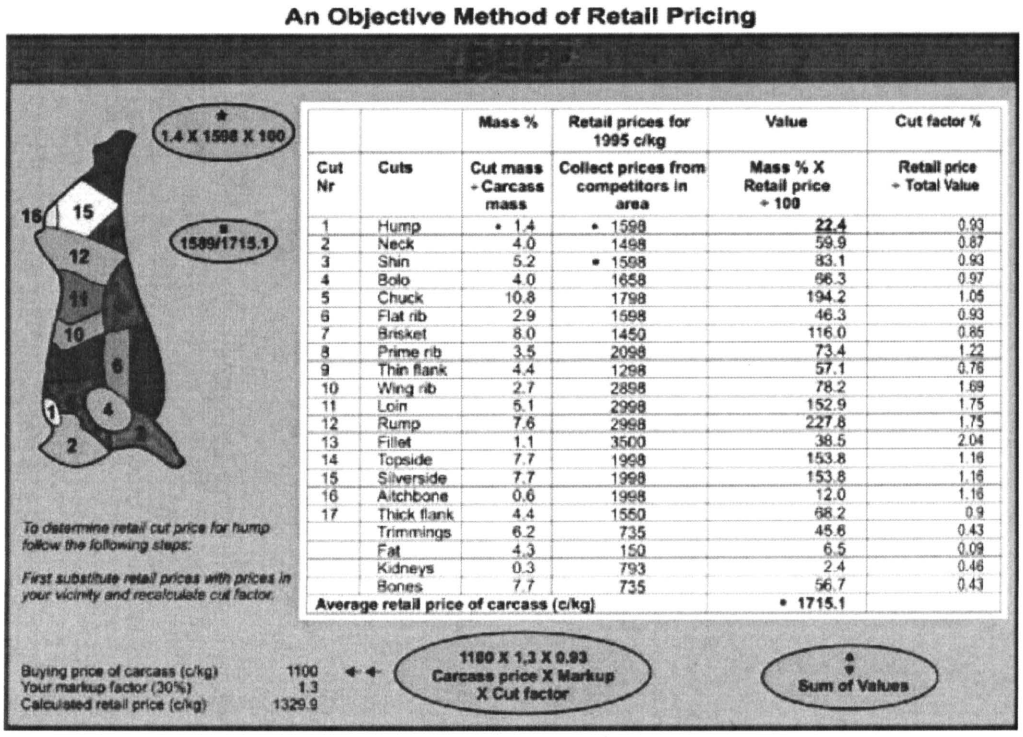
The block test works on the following principle: The production price of the carcass (as sold from the abattoir) is currently at around R 22 per kilogram (RMAA, 2008, online). The mass percentage of each cut can then be used to calculate the production price value of the cut. The retail value of the cuts, divided by the production price contribution, gives the retail markup for a specific cut at a specific shop.

Five meat shops were visited on the 19th of April 2008, and the prices for different cuts of beef were obtained. The five shops visited are:

- King' Meat Deli, Erasmuskloof.
- BOMA butchery, Moreletta Park.
- Meat World, Elardus Park.
- Checkers, Moreletta Park.
- Pick and Pay, Moreletta Park.

The prices for the beef cuts obtained from the survey conducted at the above shops, are shown in Figure 6. 17. As can be seen, the average retail markup is calculated as 112.3 %, implying that the average retail price for the carcass is 2.123 x 22 = **R46.72** per kg. This price is exclusive of VAT.

This price is used as the average retail price for a whole carcass, in the simulations of Chapter 7 (refer to Table 7. 2).



Cut Nr	Cuts	Mass % Cut mass ÷ Carcass mass	Retail prices for 1995 c/kg Collect prices from competitors in area	Value Mass % X Retail price ÷ 100	Cut factor % Retail price ÷ Total Value
1	Hump	• 1.4	• 1598	22.4	0.93
2	Neck	4.0	1498	59.9	0.87
3	Shin	5.2	• 1598	83.1	0.93
4	Bolo	4.0	1658	66.3	0.97
5	Chuck	10.8	1798	194.2	1.05
6	Flat rib	2.9	1598	46.3	0.93
7	Brisket	8.0	1450	116.0	0.85
8	Prime rib	3.5	2098	73.4	1.22
9	Thin flank	4.4	1298	57.1	0.76
10	Wing rib	2.7	2898	78.2	1.69
11	Loin	5.1	2998	152.9	1.75
12	Rump	7.6	2998	227.8	1.75
13	Fillet	1.1	3500	38.5	2.04
14	Topside	7.7	1998	153.8	1.16
15	Silverside	7.7	1998	153.8	1.16
16	Aitchbone	0.6	1998	12.0	1.16
17	Thick flank	4.4	1550	68.2	0.9
	Trimmings	6.2	735	45.6	0.43
	Fat	4.3	150	6.5	0.09
	Kidneys	0.3	793	2.4	0.46
	Bones	7.7	735	56.7	0.43
Average retail price of carcass (c/kg)				• 1715.1	

Figure 6. 16 – The block test, a method to determine average carcass price.
Source: SAMIC website, www.samic.co.za

Date: Saturday, 19 April 2008
Average carcass purchase price 2200 c/kg
Carcass weight 212 kg

Fore quarter as price % carcass price 49.10%
Hind quarter as price % carcass price 50.90%

Fq calculated carcass price 2160.4
Hq calculated carcass price 2239.6

				Retail price (c/kg) (VAT included)					Average retail price	Av. Retail price,	Retail price	Area retail
Cut name	Cut mass %	Cut weight	Cost price	Shop 1	Shop 2	Shop 3	Shop 4	Shop 5	(c/kg)	less VAT (c/kg)	benchmark	markup %
Shin	5.2%	11.024	23816.2496	4200	3300	3900		4300	3925	3442.98	37955.44	59.4%
Chuck	10.8%	22.896	49464.5184	4600	4200	3800	4300	5000	4380	3842.11	87968.84	77.8%
Neck	4.0%	8.48	18320.192	4100	3400		4000	3900	3850	3377.19	28638.60	56.3%
Brisket	8.0%	16.96	36640.384	4500	3300	3700		4900	4100	3596.49	60996.49	66.5%
Rump	7.6%	16.112	36084.4352	5800	6500	7000	7500	6200	6600	5789.47	93280.00	158.5%
Fillet	1.1%	2.332	5222.7472		10000	11000	11600	9000	10400	9122.81	21274.39	307.3%
Trimmings	6.2%	13.144	29437.3024	3800	3700	4200	4900	3900	4100	3596.49	47272.28	60.6%
Silverside	7.7%	16.324	36559.2304		4700				4700	4122.81	67300.70	84.1%
										Average retail markup		112.3%

Cost of carcass 22 R/kg
Retail sales price of carcass 46.72 R/kg

Figure 6. 17 – Estimation of average retail sales price of a beef carcass, 19 April 2008.
Source: Author's own calculations

6.7 Summary

The markets for beef and naturally fed beef were discussed in this chapter. Potential market offerings were developed, and consumers' opinions on beef, naturally fed beef and the potential products were obtained through questionnaires. Some of the important aspects discussed in this chapter are the following:

- There has been a general decline in per capita consumption of beef over the past three decades, both in South Africa and the United States of America.
- Consumer preferences have shifted towards further processed products as opposed to whole products.
- White meat consumption has grown significantly while red meat consumption has declined.
- There seems to be a growing market for organic and naturally fed beef. Sales in the USA of these products have increased significantly over the past decade.
- A structured questionnaire was developed to assess a number of market preferences regarding beef (refer to Appendix A).
- For the purposes of this analysis two natural beef concepts, "Type A" and "Type B" naturally fed beef, were developed. (Type A beef is produced on irrigated farms in the Waterberg, while type B beef is produced on totally natural farms in

the drier regions of Limpopo). The consumers' willingness to pay a premium for these two types of beef were also tested in the research questionnaire.

- The potential market demand for types A and B beef were estimated. It was determined that a premium of 10 % above normal meat prices should be asked for type A beef, and a premium of 20 % above normal prices for type B beef.
- Using the above stated premiums, the estimated market sizes for type A beef are 2.5 % of the Gauteng market for beef and 0.5 % of the North West (Eastern part), Nelspruit and Polokane markets for beef. The estimated market size for type B beef is 1 % of the Gauteng market for beef.
- The estimated average retail price for a carcass was about R 46.72, based on a block test using a limited sample.
- The research and calculations performed in this chapter gave extremely important parameters in terms of market location, market sizes and pricing of the products. These three parameters form the "core" of the market, and without them the supply chain configurations cannot be designed or analysed. For this reason, it was deemed more important to have at least reasonably realistic values as opposed to exactly correct values. The simulation of different supply chain configurations with reasonably realistic values should give adequate insight into the economic potential of the supply chain, especially if the correct parameters such as market size and price are varied in the simulations to cater for uncertainty.

The design and analyses of suitable supply chain configurations will now be discussed in Chapter 7.

Chapter 7: Design and analysis of supply chain configurations for naturally fed beef from Limpopo

7.1 Introduction

All the previous chapters have served to develop an adequate understanding of the supply chain for naturally fed beef from Limpopo. The purpose of this chapter is to integrate and synthesise the insight that has been gained up to this point. This was done by developing supply chain designs that should likely be successful, and performing simulations on these supply chains, in order to evaluate the economic potential of each design.

7.2 Design of supply chain configurations for naturally fed beef from Limpopo

In principle, it was decided that there are two main possibilities to process and deliver the beef to the market. Firstly, the more traditional approach of transporting carcasses to the market and processing them in butcheries was considered. Secondly, the approach of processing and pre-packaging meat closer to the source was considered.

The supply chain design for the first approach (configuration 1), is shown in Figure 7. 1. As can be seen, cattle from farms in the Waterberg region and the more arid regions of Limpopo are transported to local abattoirs. From these abattoirs, the carcasses are transported to a cooling chamber facility in Pretoria, with the exception of a small number of fore quarters that are delivered directly to the butcheries in Polokwane from the local abattoir.

The cooling chambers in Pretoria perform two functions: Firstly, an implicit requirement for naturally fed beef is that the hind quarter carcasses need to be hung in a cooling chamber for at least a week. This needs to be done to get the meat to more or less the same tenderness as feedlot beef. The meat from naturally fed cattle is tougher than that of the inactive cattle in a feedlot. The second function of the cooling chamber is that of

an “inventory warehouse”, where the carcass inventory also acts as a buffer mechanism against variable demand.

The carcasses are then distributed to butcheries in Gauteng, North West and Nelspruit from this facility, where they are processed and sold to the final consumer.

The second basic configuration that was considered is shown in Figure 7. 2. For this configuration the processing is performed close to the source, hence the cooling chambers and central meat processing plant are located closer to the farms in the Waterberg regions. Once again the cooling chamber performs the two functions of maturing and tenderising the meat but also the warehouse function of inventory holding.

In this case it was decided to reduce the market to Gauteng only. The reason for this decision is that the packaged meat is to be sold in meat stores without any meat processing equipment. The most likely locations for this type of pre-processed meat shops would be in or close to shopping malls in the higher income regions. For this configuration, the option of ordering meat over the internet is also included. It is reasoned that the supply chain will become more efficient as more people order over the internet. The reason for this is that when the meat is pre-ordered and consumers are willing to wait about seven days for their packages to arrive, the orders can be fed electronically to the meat processing plant in the Waterberg. Hence – production at the plant will take place according to real demand, not guessed demand (thus a pull approach as opposed to a push approach). This will assist in optimising productivity and minimising waste.

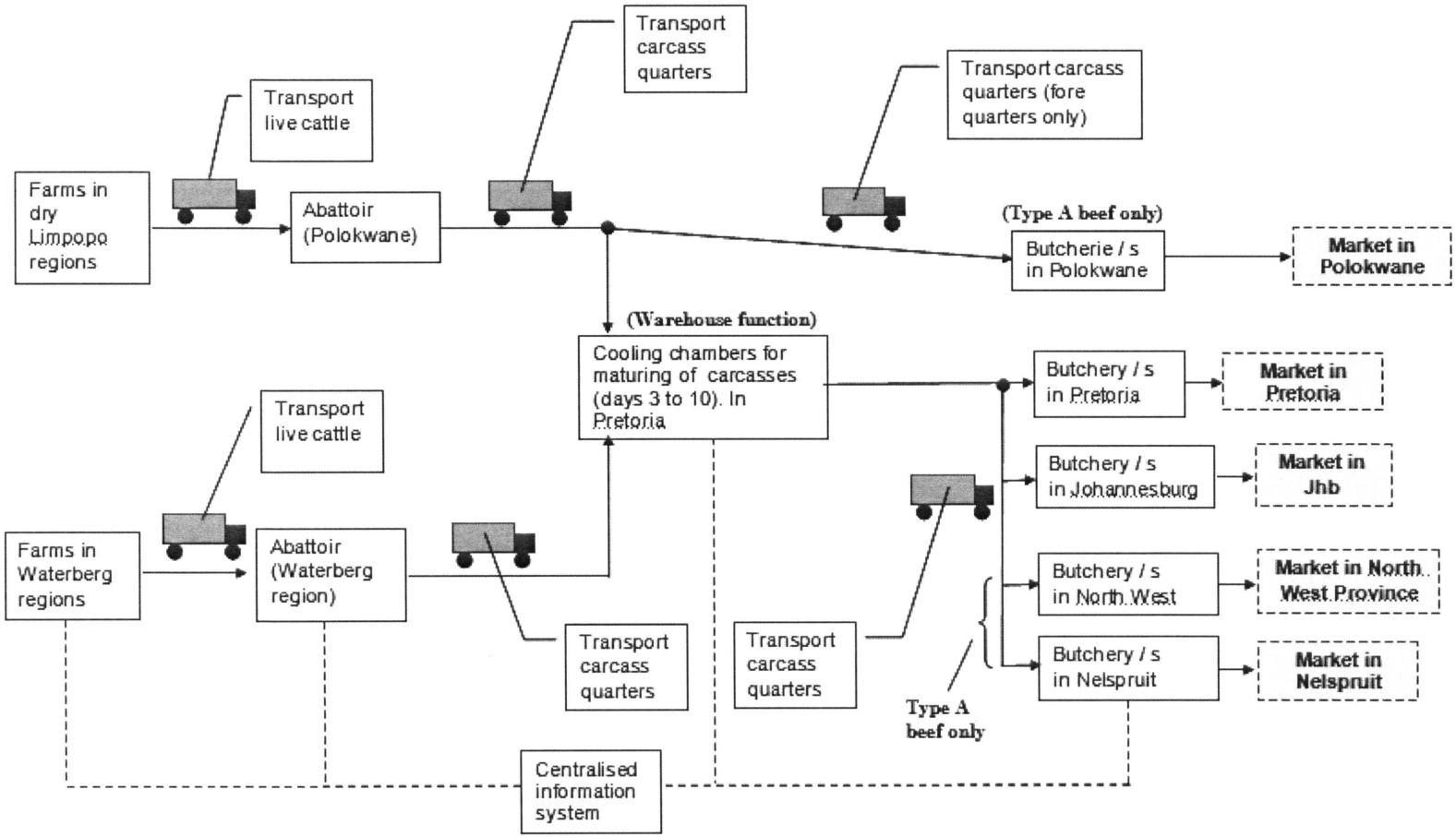


Figure 7. 1 – Supply chain design, configuration 1. Processing of beef close to market.
Source: Author's own design

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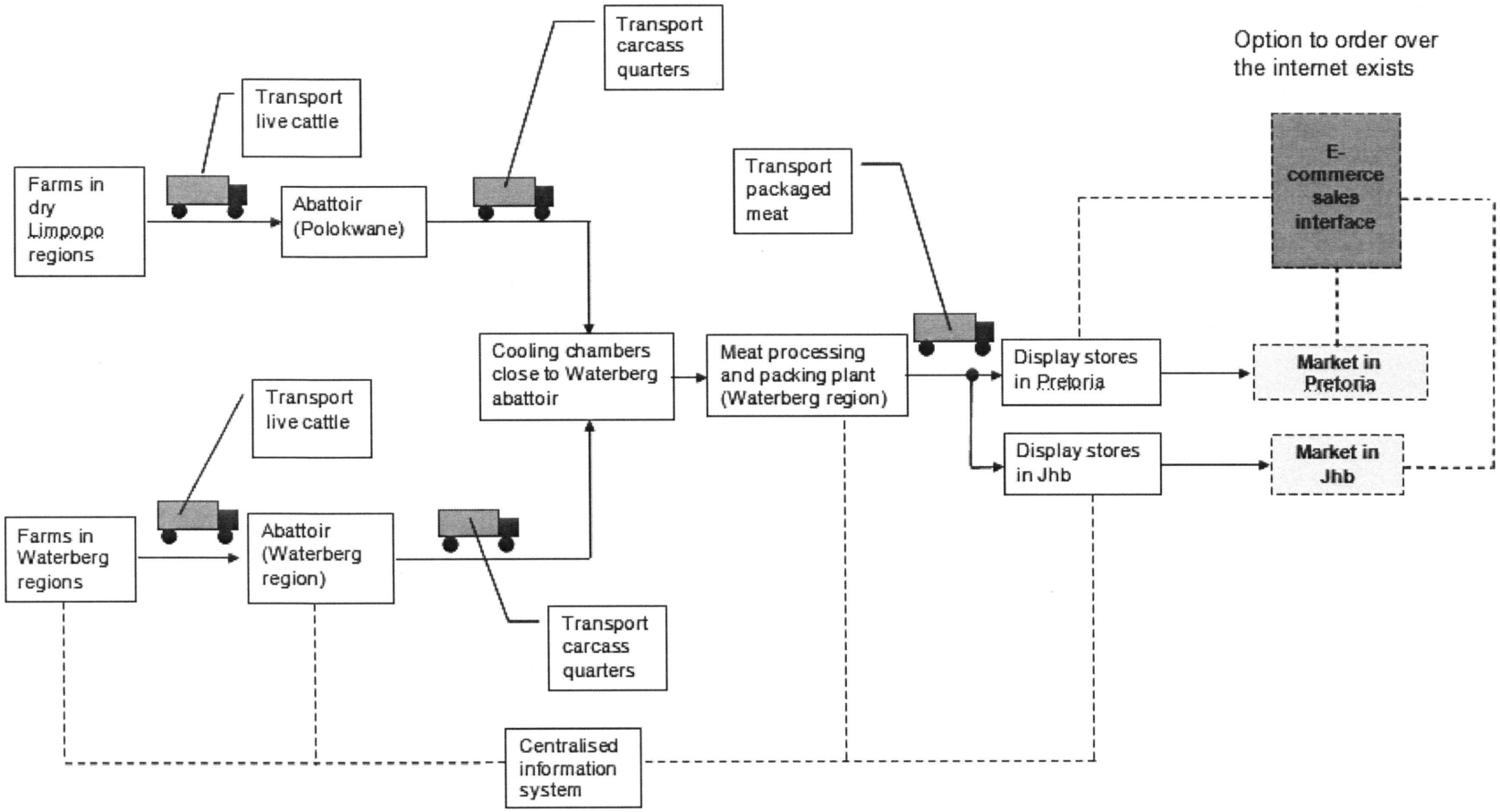

Figure 7. 2 – Supply chain design, configuration 2. Processing of meat close to source.
Source: Author's own design

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7.3 Simulation cases

Having developed the two basic supply chain design configurations in the previous section, it had to be decided what simulation cases could be performed on the supply chains.

It was argued that the six features that would have the greatest impact on supply chain profitability are:

- Supply chain configuration.
- Market size.
- Sales price of the beef.
- Input costs.
- Business to consumer (B2C) versus Business to Business (B2B) market.
- Type A versus Type B beef.

In order to asses the impact of these six features, the simulation cases were organised as shown in Table 7. 1.

Table 7. 1 – Description of simulation cases that were analysed
Source: Author's compilation

Simulation case no.	Analysed feature	Supply chain design	Notes
1	Base case	Configuration 1	Base case values used.
2	Market size	Configuration 1	Assumed that cooling warehouse in Pretoria doubles as a high volume sales outlet. Sales in Gauteng are increased by 30%, advertising costs rise to 3% of turnover.
3A	Input costs	Configuration 1	Input costs (operational) are raised by 10% throughout the supply chain.
3B	Input costs	Configuration 1	Input costs (operational) are raised by 20% throughout the supply chain.

4A	Sales price	Configuration 1	Sales premium on type A beef is lowered to 5% and on type B beef to 15%.
4B	Sales price	Configuration 1	Sales premium on type A beef is increased to 15% and on type B beef to 25%.
5	Supply chain configuration; smaller market	Configuration 2	Only market in Gauteng is served.
6	B2B versus B2C	Configuration 2	Beef is delivered on contract basis, directly to hotels, restaurants, hostels etc. in Gauteng. Advertising costs fall away.
7	Removal of type B beef from the supply chain	Configuration 2	Only type A beef is produced and delivered to market.

7.4 Simulation parameters

Simulation Case 1

The parameters used for simulation case 1 are tabulated in Table 7. 2.

Table 7. 2 – Parameters used for simulation case 1
Source: Numerous tables throughout the report

Parameter	Value
Beef cattle farming parameters	
Average time that cattle is kept on veld	1 year (365 days)
Average growth rate of cattle	1 kg / day
Average live mass of cattle when sold to abattoir	365 kg
Percentage of cattle breeding stock sold as weaners	76 %
Hectares / LSU required in natural arid bushveld	13

Parameter	Value
Hectares / LSU required on irrigated farmland in the Waterberg	0.5
Replacement cost per cow	R 4000
Replacement cost per calf	R 3000
Capital cost per hectare in natural arid Bushveld	R 3053 per hectare
Capital cost per hectare on irrigated pastures in the Waterberg	R 4143 per hectare
Operating cost per LSU on natural arid Bushveld	R 1519 per LSU
Operating cost per LSU on irrigated pasture in the Waterberg	R 3750 per LSU
Transportation parameters	
Transportation cost of live cattle (average 100 km radius)	R68 / LSU
Transportation cost of carcasses, within 400 km radius	R 0.612 / kg
Transportation cost of case packed meat, average of 120 km distance	R 0.56 / kg
Abattoir parameters	
Carcass mass as percentage of live mass	58 %
Average carcass mass	212 kg
Scrap rate	2 %
Cost / LSU processed	R 300 per LSU
Capital cost per LSU	R 560 per LSU
Average sales revenue for offal and hide	R 350 per LSU
Cooling chamber parameters	
Capital cost per beef quarter	R 4500 per q
Operating cost per beef quarter	R 2155 per q
Processing, packing and sales channel parameters	
Mass per quarter	53 kg
Processing mass loss factor	5%
Butchery operating cost	R 3.00 / kg
Butchery investment cost	R 6.06 / kg
Central processing plant operating cost	R 1.59 / kg
Central processing plant investment cost	R 6.15 / kg
Meat sales shop (no processing) operating cost	R 2.11 / kg

Parameter	Value
Meat sales shop (no processing) investment cost	R 4.14 / kg
Market parameters	
Average carcass retail price (based on the block test, prices end of April 2008, VAT excluded)	R46.72 /kg
Dip in sales in February	10 %
Peak in sales over December	30 %
Random variability of demand around forecast demand	30 %
Annual demand for type A beef in Gauteng	9314 carcasses + 7268 fore quarters from Polokwane
Number of butcheries in Gauteng selling type A beef	10
Annual demand for type B beef in Gauteng	7452 hind quarters
Number of butcheries in Gauteng selling type B beef	4
Annual demand for type A beef in North West	214 carcasses
Number of butcheries in North West selling type A beef	1
Annual demand for type A beef in Nelspruit	105 carcasses
Number of butcheries in North West selling type A beef	1
Annual demand for type A beef in Polokwane	184 fore quarters
Number of butcheries in North West selling type A beef	1
Overhead parameters	
Interest rate	13 %
Cost of vantage point manager	R 500 000 per year
Cost of integrated IT system	R 500 000 per year
Cost of auditing by SAMIC	R 500 000 per year
Costs of using registered brand name	R 250 000 per year
Cost of full traceability for type B supply chain	R 2 million per year
Advertising costs	1% of total annual revenue of supply chain

Simulation Case 2

The input parameters for simulation case 2 were the same as for case 1, except for the following two changes:

- Advertising expenditure was increased from 1 % to 3 % of the overall supply chain income as calculated in case 1.
- An additional processing and sales outlet was placed next to the cooling warehouse in Pretoria. This increased the sales of type A beef in Gauteng by 30%.

Simulation Case 3

The input parameters for cases 3A and 3B remained the same as for case 1. The only difference was that all **operational** costs were increased by 10 % for case 3A and by 20 % for case 3B.

Simulation Case 4

The input parameters for cases 4A and 4B remained the same as for case 1. The only difference was that, for Case 4A, premiums on types A and B beef were reduced to 5 % and 15 % respectively. For Case 4B, premiums for types A and B beef were increased to 15 % and 25 % respectively.

Simulation Case 5

The parameters for this simulation were the same as used for case 1, the only difference being that the markets for Polokwane, Nelspruit and North West were not considered. Hence beef was only marketed in Gauteng.

Simulation Case 6

Simulation case 6 was similar to case 5, except for the fact that this case considered the B2B model of selling directly, on a contract basis, to restaurants, hotels, hostels and the likes in Gauteng. This case was therefore different from case 5 in the following two ways:

- Advertising costs fall away completely.
- The beef will have to be sold at at least a 10 to 15 % discount. Hence, the 10 % premium asked for type B beef falls away completely to zero, while the 20 % premium for type B beef is reduced to only 5 %.

Simulation Case 7

Simulation case 7 was similar to case 5, the only difference being that the type B beef was completely removed from the supply chain. This also has the implication that the costs of full traceability for the type B beef falls away.

7.5 Simulation

The simulation was performed by considering two types of models – a "dynamic" model and a "static" model.

The objective of the dynamic model was to simulate real expected demand per week, which is more likely to be variable from week to week than constant. However, one would expect that the variability would be within certain limits. By performing this dynamic analysis, the variable inventory and production response through the whole supply chain, right back to the farm level, can be observed. The required production and inventory storage capacities can also be determined by this model.

The static model is performed after the dynamic model is performed. The static model is built in the form of a process diagram. It provides a map of the supply chain, indicating the flow of products, the expected costs for each process and the income that flows into the supply chain where applicable. The sum of all the incomes that flow into the supply chain as a whole, is subtracted from the sum of all the costs that flow out of the supply chain, to give the total **supply chain profit**. It is reasoned that the supply chain as a whole must be the most profitable. It is not within the scope of this research to analyse or prescribe the transaction prices between supply chain members. These prices should be negotiated by the members of the supply chain, but in such a way that the **constraint** in the supply chain be identified and that resources are focussed towarding removing the constraint and increasing profitability. The supply chain profit for each simulation case is calculated and the results can be compared.

The dynamic analyses

Dynamic analysis for simulation case 1 (the base case)

The dynamic simulation for case 1, the base case, will now be discussed:

The first step is to develop the "ideal" expected demand. Figure 7. 3 shows the forecast demand over a five year period. The graph is obtained in the following way:

The expected annual demand for type A beef in Gauteng is 9314 carcasses. The average carcass mass is 212 kg, hence the monthly demand is (9314 x 212)/12 = 164.5 tonnes. The hind quarter constitutes 51 %, and the fore quarter 49 % of the carcass mass. Hence, the mass of hind quarter meat sold is 0.51 x 164.5 = **83.9 tons**. The fore quarter mass is 0.49 x 164.5 = 80.6 tons.

However, the demand in Gauteng for type B beef (hind quarters only) is 7452 hind quarters per year. This means that there are also 7452 fore quarters produced in Polokwane. There is an expected demand for 184 fore quarters per year in Polokwane, hence there is a surplus of 7268 fore quarters from Polokwane. For the purposes of the simulation, it is assumed that this can be sold as type A beef in Gauteng. The additional mass of these fore quarters is (7268/2 x 0.49 x 212)/12 = 31.5 tons. The total demand for fore quarter beef is thus **112.1 tons** per month.

When the sales growth rate of 5 % per year, the sales dip of 10 % in February and the sales peak of 30 % in December are applied to the values as calculated above, the demand forecast appears as shown in Figure 7. 3. (dynamic model developed by author). The peak in December and dip in February is a typical trend observed in the retail sector, according to data from Statistics South Africa (www.statssa.co.za).

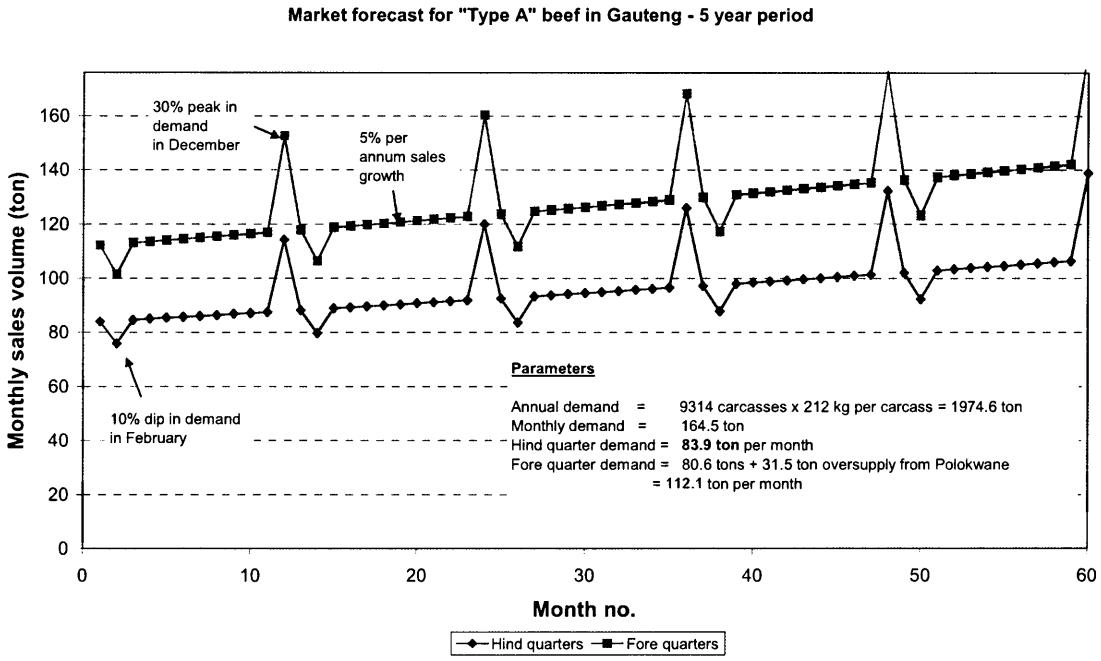

Figure 7. 3 – Market forecast for type A beef in Gauteng.
Source: Dynamic model developed by author

Once the ideal demand forecast is obtained, some steps need to be taken to make demand more realistic, hence variable from week to week. This is done in the following way:

It was assumed that there are 10 butcheries that sell the type A beef in Gauteng (divided into equal amounts per butchery for the purposes of this study). As an example, consider the demand for type A hind quarter beef in Gauteng. The forecast demand for each butchery would thus be one tenth of the overall demand. It follows that the weekly demand (starting value) for this type of beef would be (83.9 ton x 12) /52/10 = 1.94 tons per week. However, when modeling the demand in the spreadsheet, a function has been built in so that the "true" demand can vary randomly between 70 % and 130 % (hence plus or minus 30%) of the "ideal" demand as calculated above, for each week. The resulting demand for two selected butcheries is then shown in Figure 7. 4 (dynamic model developed by author).

When the demand for all 10 butcheries is added together, the weekly demand is typically such as shown in Figure 7. 5 (dynamic model developed by author), where the

aggregate demand for both fore and hind quarter beef in Gauteng is shown. As can be seen the "true" demand fluctuates randomly around the forecast demand.

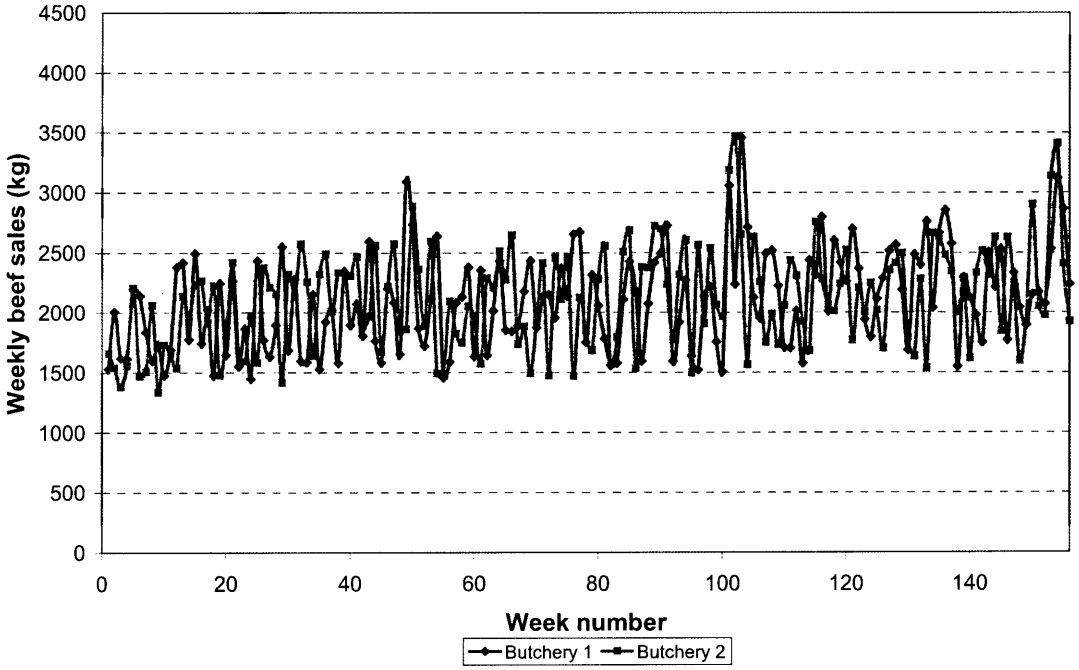

Figure 7. 4 – Weekly demand for hind quarter meat (type A) for two selected butcheries in Gauteng over a 3 year period.
Source: Dynamic model developed by author

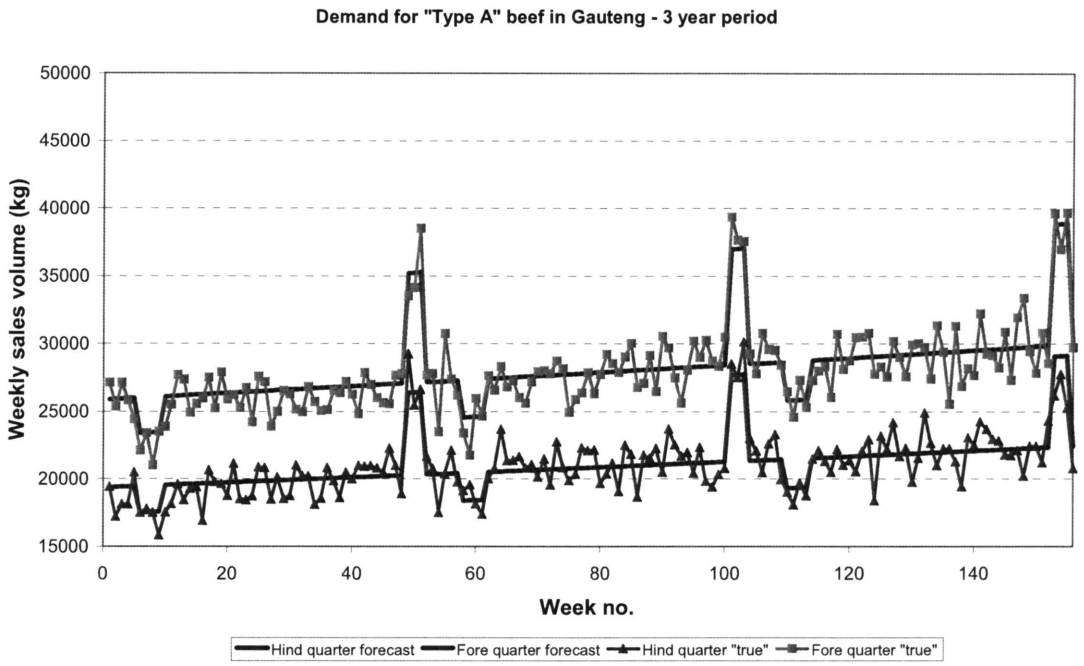

Figure 7. 5 – Aggregate weekly demand from 10 butcheries in Gauteng.
Source: Dynamic model developed by author

The aggregate weekly sales as shown in Figure 7. 5 can be translated back to the number of quarters required per week. For instance, it can be seen that the required mass of type A hind quarter beef is about 19 tons in week one. The average hind quarter mass is 54.06 kg, hence 19 000 / 54.06 = 352 hind quarters are needed.

The aggregate demand for types A and B beef in the markets for Gauteng, North West and Nelspruit can now be converted back to number of quarters required as shown above. When this is done, the aggregate demand for number of quarters required from the central warehouse (cooling chamber in Pretoria) is shown in Figure 7. 6 (dynamic model developed by author).

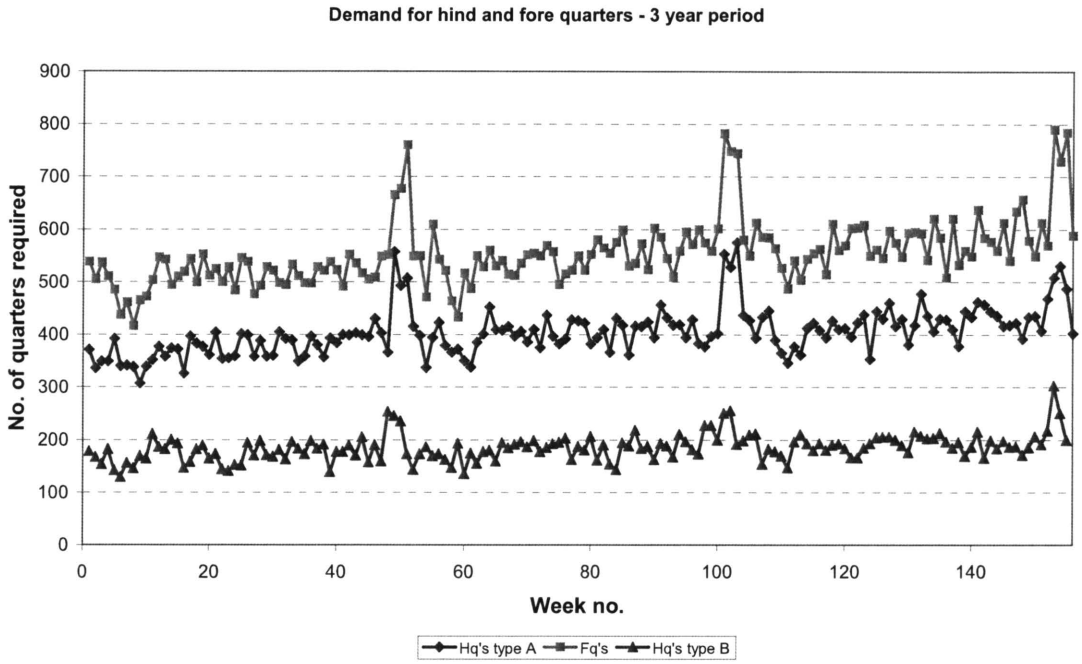

Figure 7. 6 – Aggregate weekly demand for fore and hind quarters over a three year period.
Source: Dynamic model developed by author

The next step is to calculate inventory flow and the required size of the cooling chamber in Pretoria. The cooling chamber is one of the most important elements in the supply chain. The reason for this is that it forms the link between production and demand, it fulfills the function of maturing the hind quarters for about a week to increase tenderness, and it must act as the inventory buffer to ensure that there is always stock available.

When dealing with inventory holding, there is a built-in contradiction involved. On the one hand, the larger the inventory buffer, the better one is protected against out-of-stock situations. However, it is also more costly and the movement of products through the warehouse will be slower. For a perishable product such as beef, this is not good. It is therefore crucial to find the minimum storage capacity that will still prevent stock outs.

In order to understand the inventory flow through the cooling chambers, both the demand for carcasses (shown in Figure 7. 6) and the production process upstream of the cooling chambers need to be understood.

At the end of any week, the abattoir places an order with the farms for a number of cattle. These cattle are slaughtered on the Monday and Tuesday of the week. The carcasses hang at the abattoir for about two more days, before they are transported to the cooling warehouse in Pretoria (and a small number of fore quarters to butcheries in Polokwane). Hence the carcasses arrive at around Thursday or Friday at the central cooling warehouse. The hind quarters are then stored for another week to mature, while the fore quarters can be directly transported to butcheries, according to demand.

The lead time between the order for cattle the abattoir and the arrival of the beef quarters at their destinations (butcheries) is thus:

- Approximately one week for fore quarters.
- Approximately two weeks for hind quarters.

Cattle is ordered in such a way that it is "pulled" through the supply chain by market demand, instead of being pushed through by the farmers, irrespective of demand. Since there is a lead time of up to two weeks between when cattle are ordered to when the carcasses are in the butcheries, the following must be done to regulate demand:

Assume that forecast demand two weeks in the future is for 105 carcasses, hence 210 fore and hind quarters respectively. Assume that forecast demand for the current week was for 100 carcasses. However, real demand in the current week was only for 93 carcasses, hence seven carcasses less than forecast demand. There is thus surplus stock of seven carcasses, and seven cattle less can be ordered for two weeks into the future. Instead of ordering 105 carcasses, only 98 cattle are ordered by the abattoir. (This synchronised system will almost completely eliminate the bullwhip effect).

When this approach is used in the model, the results are the following:

The fluctuation of hind quarter (types A and B) inventory in the cooling warehouse in Pretoria is shown in Figure 7. 7 (dynamic model developed by author). The stock at the beginning of the week consists of the new quarters received from the abattoirs, plus whatever stock remained after weekly orders for the butcheries were picked. The new carcasses must now remain in the cooling warehouse for at least a week to mature, before being ready for delivery to the butcheries. After the week is completed, new

weekly orders are collected (first in first out basis, to prevent quarters from hanging too long). New carcasses are then replenished from the abattoirs, and the cycle repeats itself in this fashion.

The fluctuation of forequarter inventory is shown in Figure 7. 8 (dynamic model developed by author). The fore quarter inventory works slightly differently to the hind quarter inventory: The fore quarters do not have to mature for seven days, since they will mostly be sold as stewing meat. The forequarters can thus be offloaded onto secondary distribution trucks, directly on arrival from the abattoirs.

The so-called "morning stock" is the stock that arrives in the morning from the abattoir, plus whatever surplus fore quarters were stored in the warehouse from the previous week. The "afternoon stock" is the stock that is left over after the orders for the week from the butcheries have been loaded onto the secondary delivery trucks. The afternoon stock is thus the left-over stock, and needs to be stored in the cooling warehouse until it is demanded by the market.

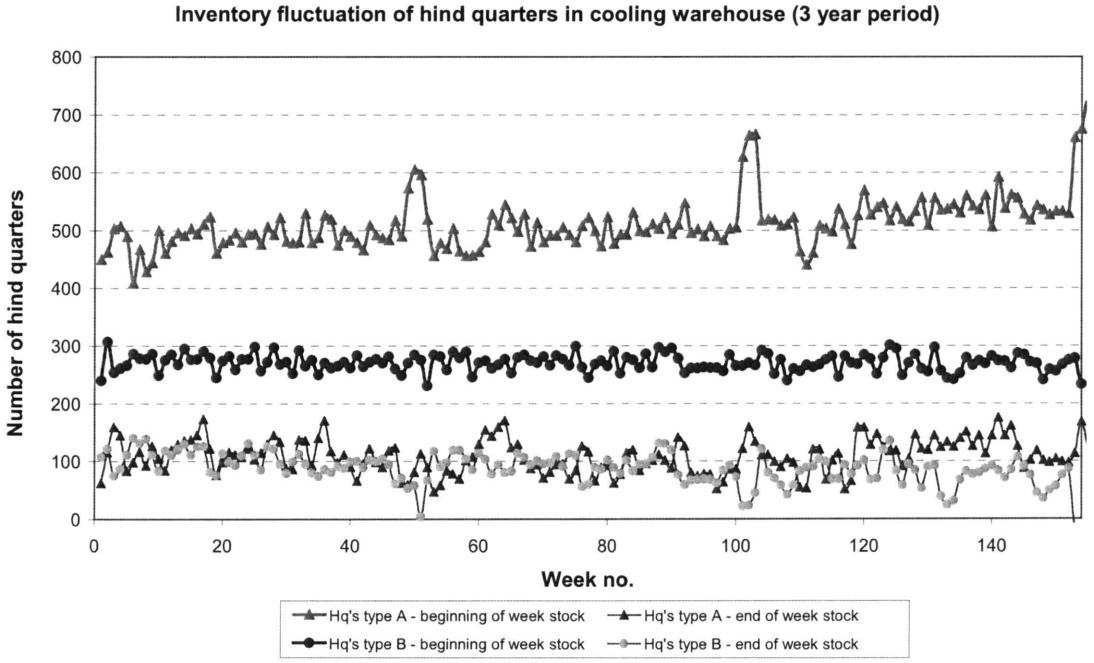

Figure 7. 7 - Inventory fluctuation of hind quarters in the central warehouse in Pretoria.
Source: Dynamic model developed by author

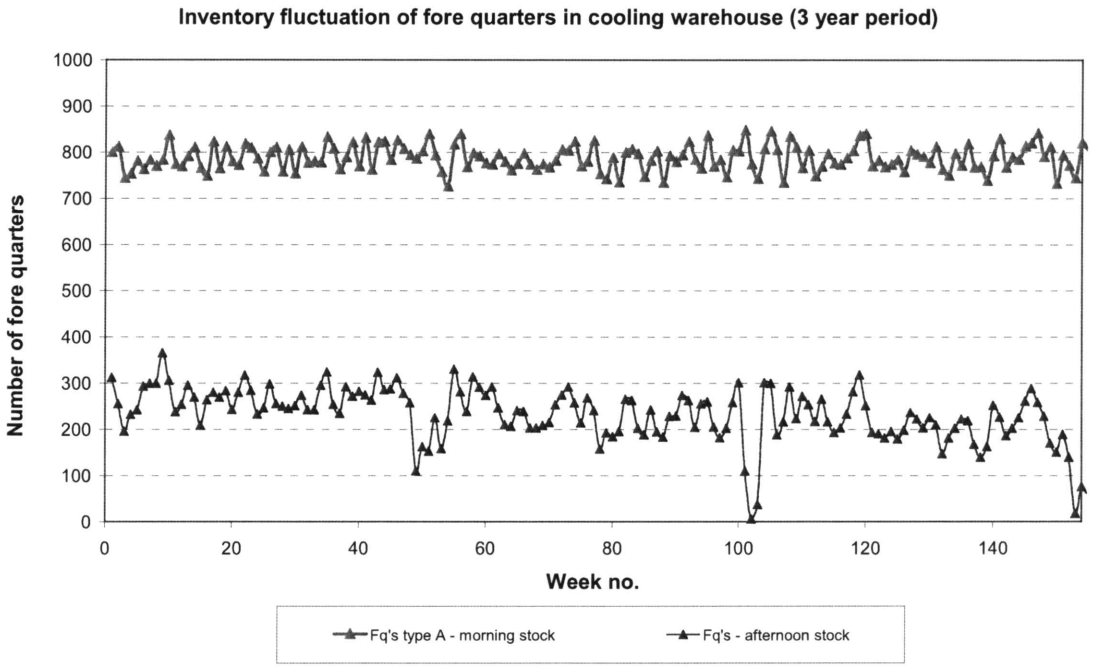

Figure 7. 8 - Inventory fluctuation of forequarters.
Source: Dynamic model developed by author

The total number of quarters in the cooling warehouse is therefore the sum of the "beginning of week stock" for the type A and B hind quarters and the "afternoon stock" for the fore quarters.

When these three quantities are added together, the total storage requirement in terms of quarters is calculated. This is shown in Figure 7. 9 (dynamic model developed by author), where it can be clearly seen that a storage capacity for about 1200 quarters should be adequate.

The demand for beef cattle to be processed by the Waterberg abattoir (Type A) and the Polokwane abattoir (Type B), resulting from this ordering process, are shown in Figure 7. 10 (dynamic model developed by author). At this point it should be noted that the delivery of cattle as synchronised with market demand is totally different from the production-driven view, where cattle is sold according to climatic conditions (annual rainfall). It may not be the most efficient way of cattle farming, but in this way the **system as a whole** is more efficient (refer back to examples 1 and 2 in section 2.5 of this report).

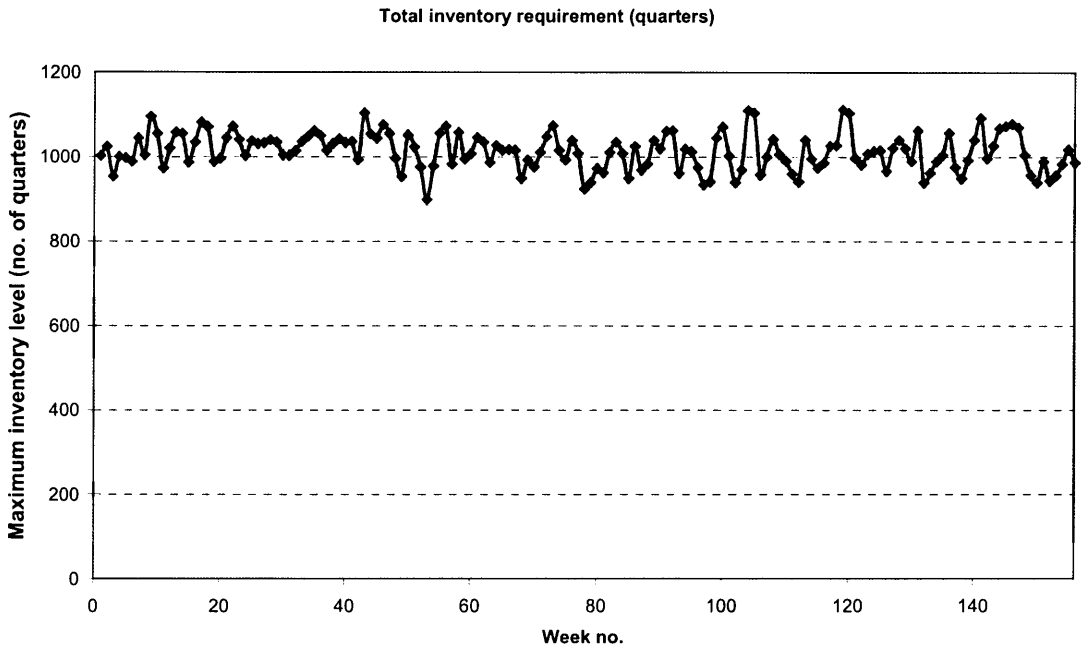

Figure 7. 9 - Total inventory levels (number of quarters) in the central warehouse in Pretoria.

Source: Dynamic model developed by author

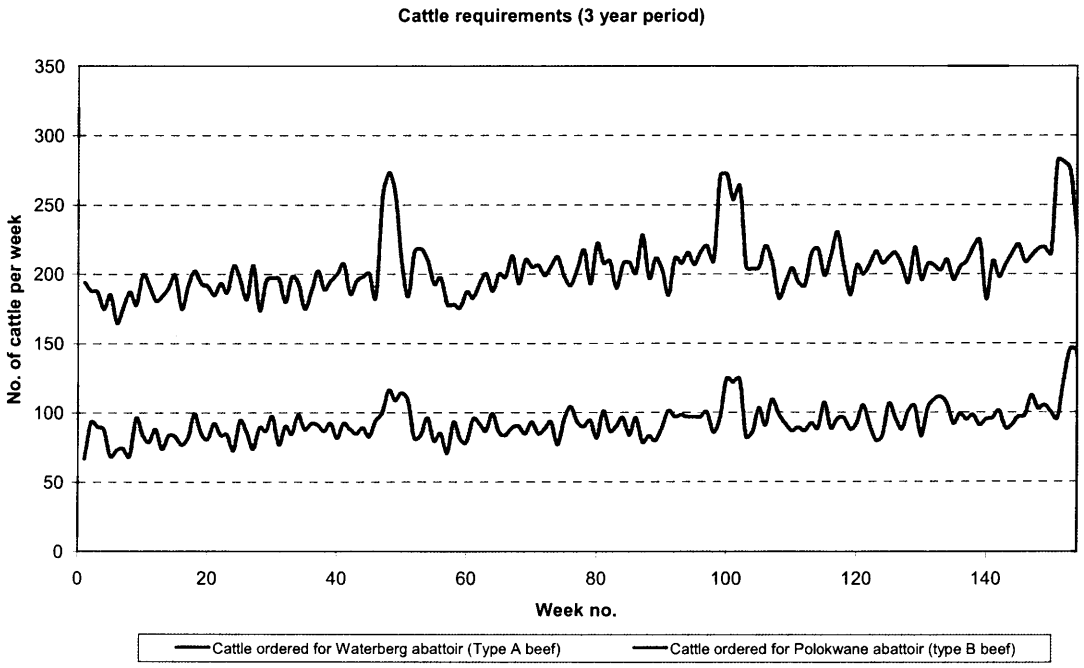

Figure 7. 10 – Weekly demand for cattle in the Waterberg and Polokwane, over a 3 year period.

Source: Dynamic model developed by author

At this point, there is still one outstanding issue that arises and needs to be considered as part of the model:

Since the market demand for hind and fore quarter beef is not tied together, but the production thereof is linked (a cow always consists of two fore and two hind quarters), some regulation needs to be put in place. To explain – if the demand for fore quarters is just slightly higher than demand for hind quarter beef, a surplus of hind quarters will start to build. Clearly, all these hindquarters cannot be stored in the central cooling warehouse as their quantities will just continue to grow.

As an example, consider the case where 400 hind quarters are required but 450 fore quarters are required for a specific week. 225 cattle needs to be slaughtered in order to get the required 450 fore quarters. However, there are also 450 hind quarters, which means that there is a surplus of 50 hind quarters. These hind quarters need to be sold out of the supply chain, or “dumped” into the normal market, where the premium received for the branded natural beef is then unfortunately forfeited. An example of this weekly “dumping” of quarters is shown in Figure 7. 11 (dynamic model developed by author). According to the calculations, roughly 3 % of carcasses need to be sold out of the supply chain in this fashion.

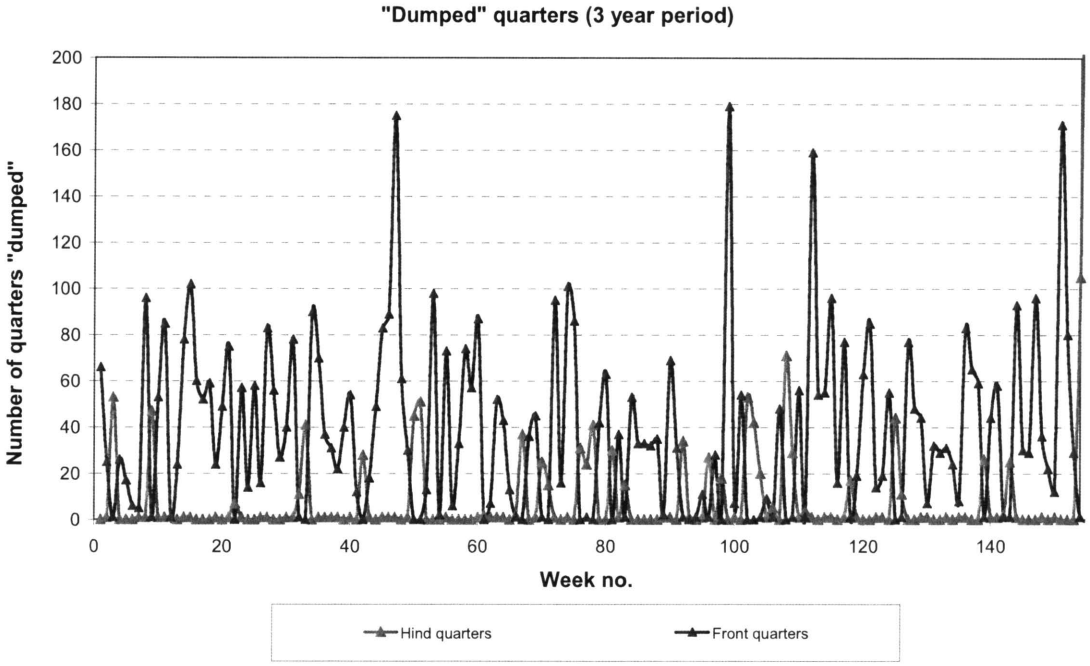

Figure 7. 11 – Surplus quarters sold out of the supply chain from the abattoir.
Source: Dynamic model developed by author

Dynamic analysis for simulation case 2 (increased market size)

Simulation case 2 assumes that by increasing advertising expenditure to 3 % of total sales turnover and also placing a higher volume butchery next to the cooling warehouse in Pretoria, the demand for Gauteng would be increased by 30 %.

This increased, aggregate demand for Gauteng is displayed in Figure 7. 12 (dynamic model developed by author). This increase in demand also necessitates that the capacity of the central cooling warehouse be increased to about 1600 quarters, as shown in Figure 7. 13 (dynamic model developed by author). The weekly demand for cattle for this simulation case is shown in Figure 7. 14 (dynamic model developed by author).

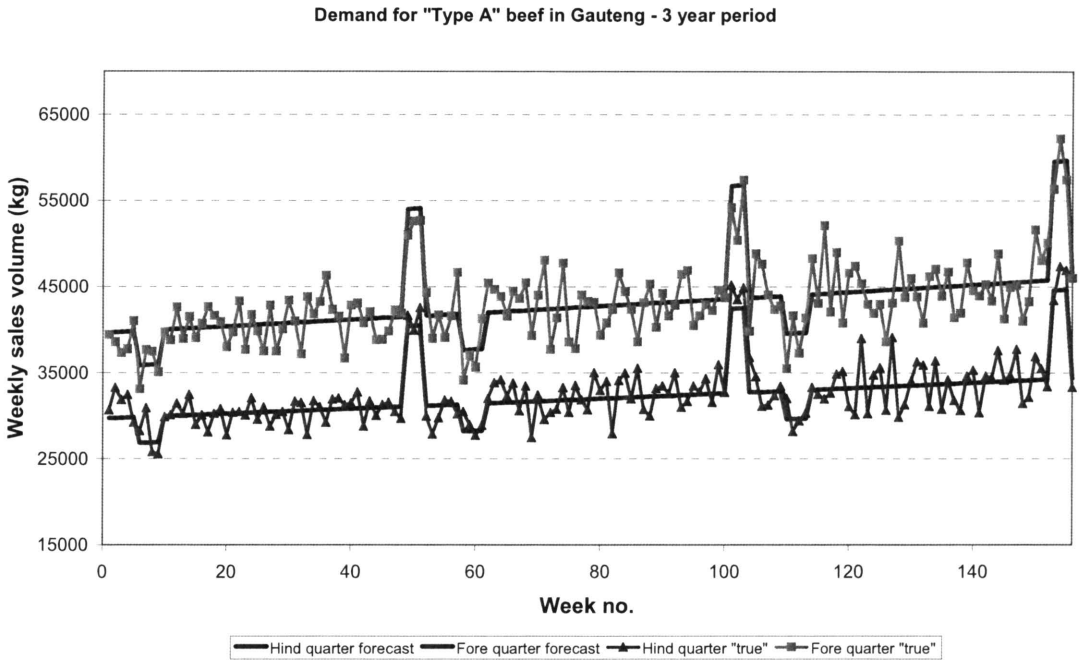

Figure 7. 12 – Aggregate weekly demand for Gauteng.
Source: Dynamic model developed by author

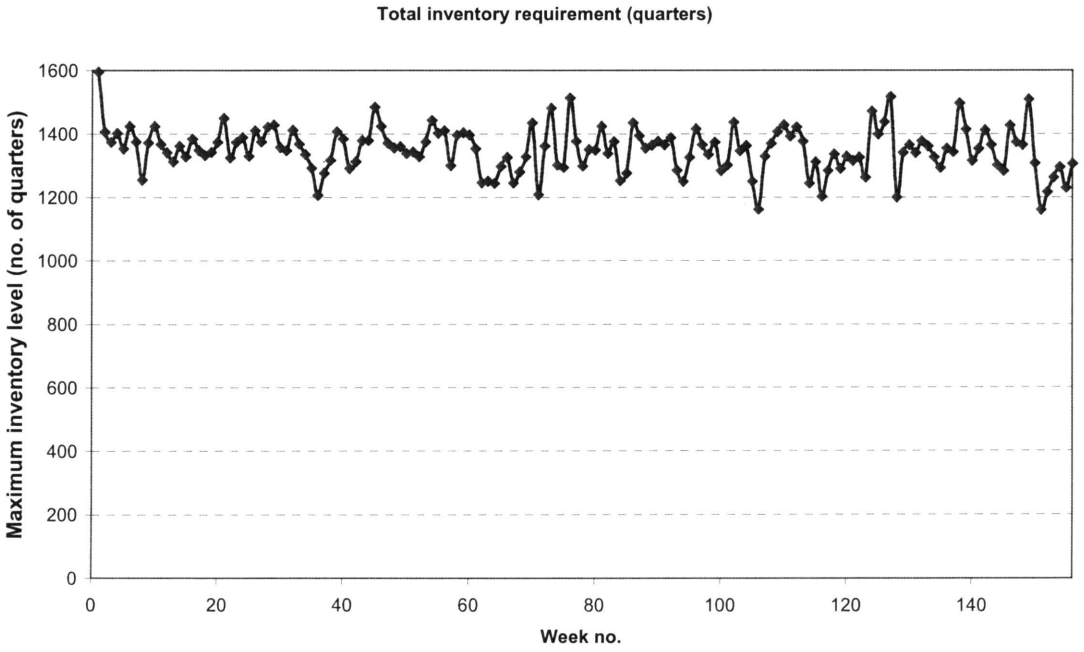

Figure 7. 13 - Total inventory levels (number of quarters) in the central warehouse in Pretoria.
Source: Dynamic model developed by author

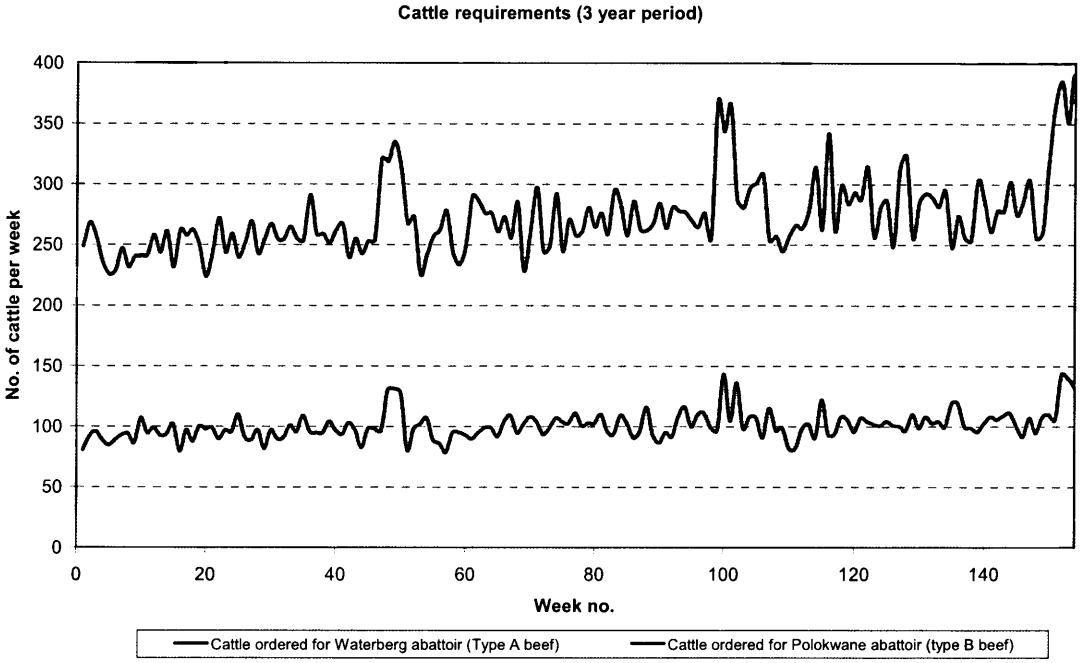

Figure 7. 14 – The weekly demand for cattle.
Source: Dynamic model developed by author

Dynamic analyses for simulation cases 3 and 4

The dynamic analyses for cases 3 and 4 (A and B) are the same as for simulation case 1. The reason for this is that the parameters that were varied for cases 3 and 4 were sales price and costs, hence the sales volumes were not changed in any way.

Dynamic analysis for simulation case 5

Simulation case 5 was performed using exactly the same principles as were explained for case 1. The only differences were that the design configuration was different (refer to Figure 7. 2 – centralised processing close to the source), and that only the market for Gauteng is served. The resulting demand for fore and hind quarters of types A and B beef are shown in Figure 7. 15 (dynamic model developed by author) and Figure 7. 16 (dynamic model developed by author). The required inventory levels are shown in Figure 7. 17 (dynamic model developed by author) and Figure 7. 18 (dynamic model developed by author). The number of cattle required is shown in Figure 7. 19.

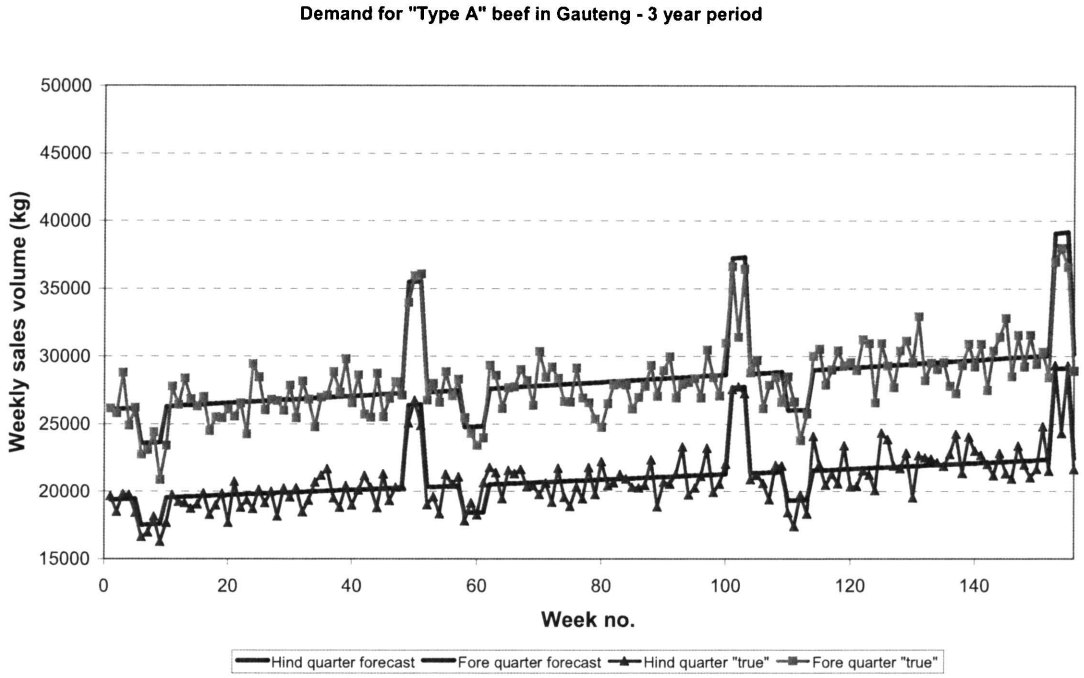

Figure 7. 15 - Aggregate weekly demand from 10 shops in Gauteng.
Source: Dynamic model developed by author

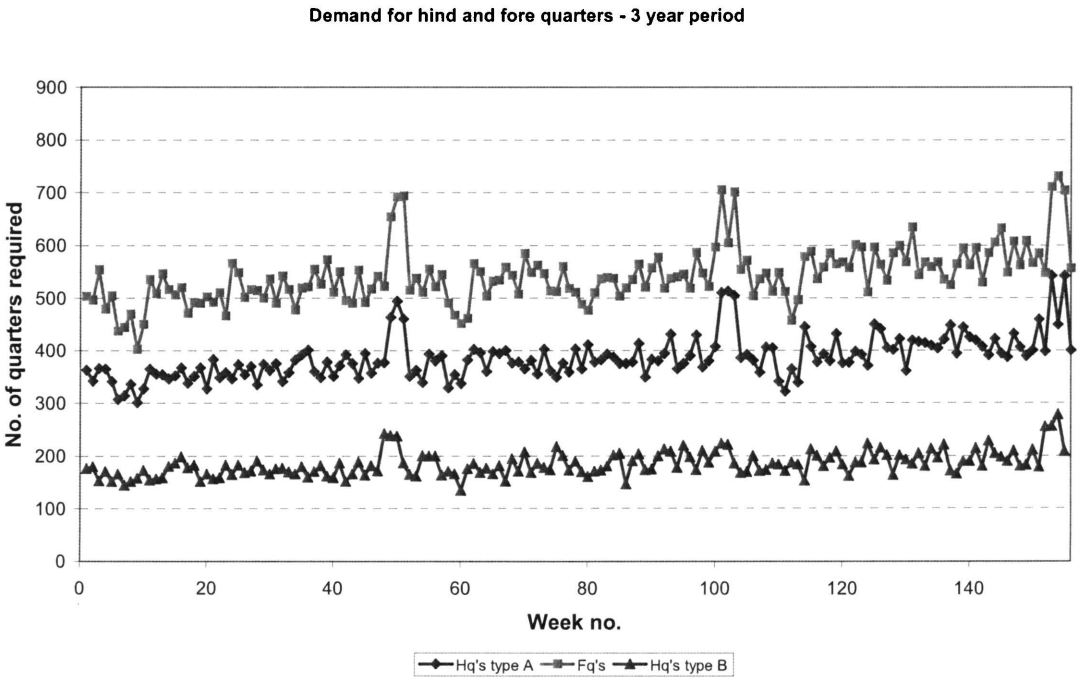

Figure 7. 16 - Aggregate weekly demand for fore and hind quarters.
Source: Dynamic model developed by author

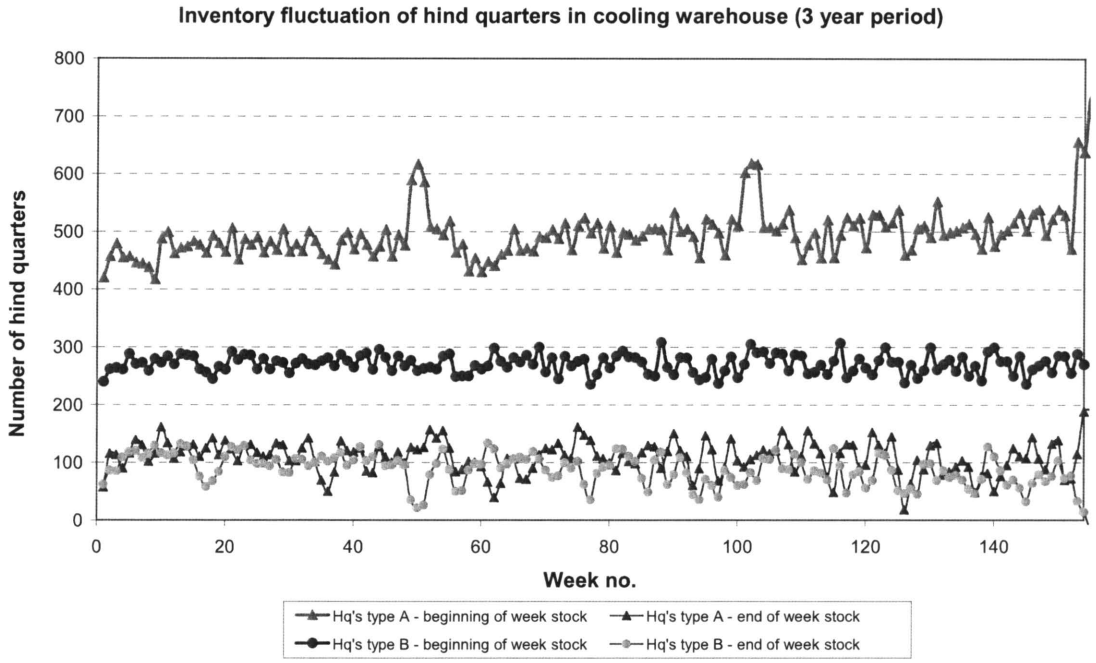

Figure 7. 17 - Inventory fluctuation of hind quarters in the central cooling warehouse in the Waterberg.
Source: Dynamic model developed by author

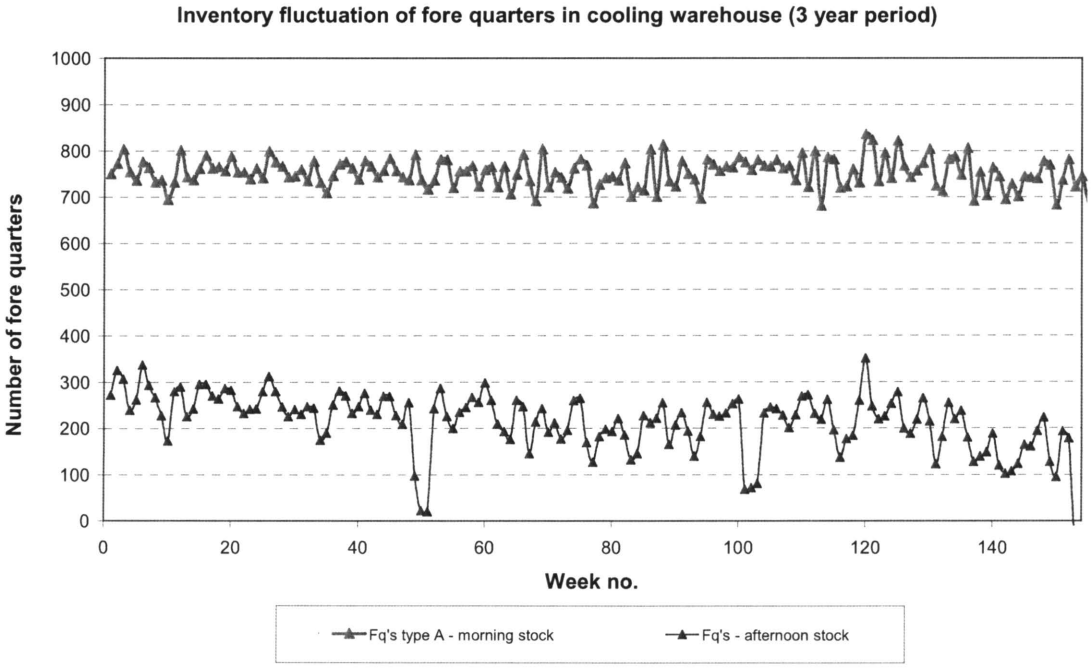

Figure 7. 18 - Inventory fluctuation of forequarters.
Source: Dynamic model developed by author

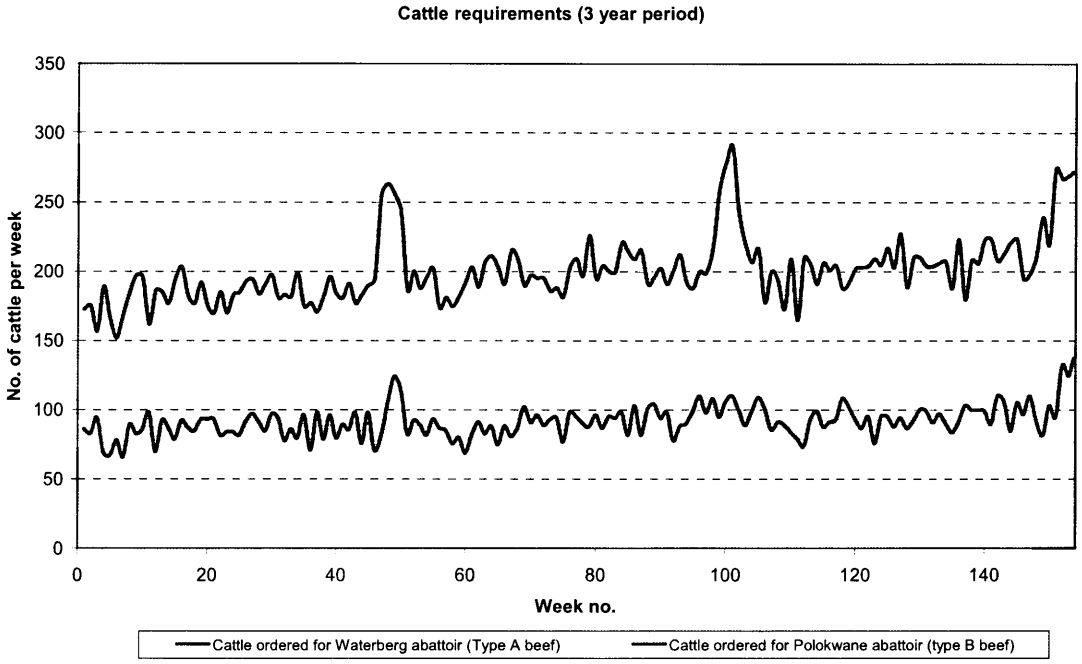

Figure 7. 19 – The weekly demand for cattle.
Source: Dynamic model developed by author

Dynamic analysis for simulation case 6

Simulation case 6 is similar to case 5 in all aspects, except that the meat is sold on a contractual basis to hotels, restaurants, hostels and the like.

The implication is thus that the meat shops in Gauteng fall away, and advertising costs also fall away. The meat will have to be delivered at a discount though.

Dynamic analysis for simulation case 7

Simulation case 7 was not analysed dynamically. Instead the values used for case 5 were assumed, which is a conservative approach.

The static analyses

Once the dynamic analyses were completed, enough information was available to perform “static” analyses. The static analyses consider the supply chain as a process, with constant values for income and expenses, based on a certain sales volume. It also works on a pull system, hence the demand pulls the products through the supply chain.

Static analysis for simulation case 1

Figure 7. 20 (static model developed by author) shows the process flow diagram for the supply chain, simulation case 1. Zoomed views of the left and right hand sides of this process are shown in Figure 7. 21 (static model developed by author) and Figure 7. 22 (static model developed by author) for better visibility.

As can be seen the relevant unit costs and incomes at each element of the supply chain are listed. Three main components are considered, namely:

- Operational cost
- Investment cost
- Income from sales

Since the focus of this thesis is to evaluate the supply chain as a whole, the transfer prices between businesses are not taken into consideration. (Though deciding what the income distribution between businesses should be, would be a very interesting and relevant issue to address).

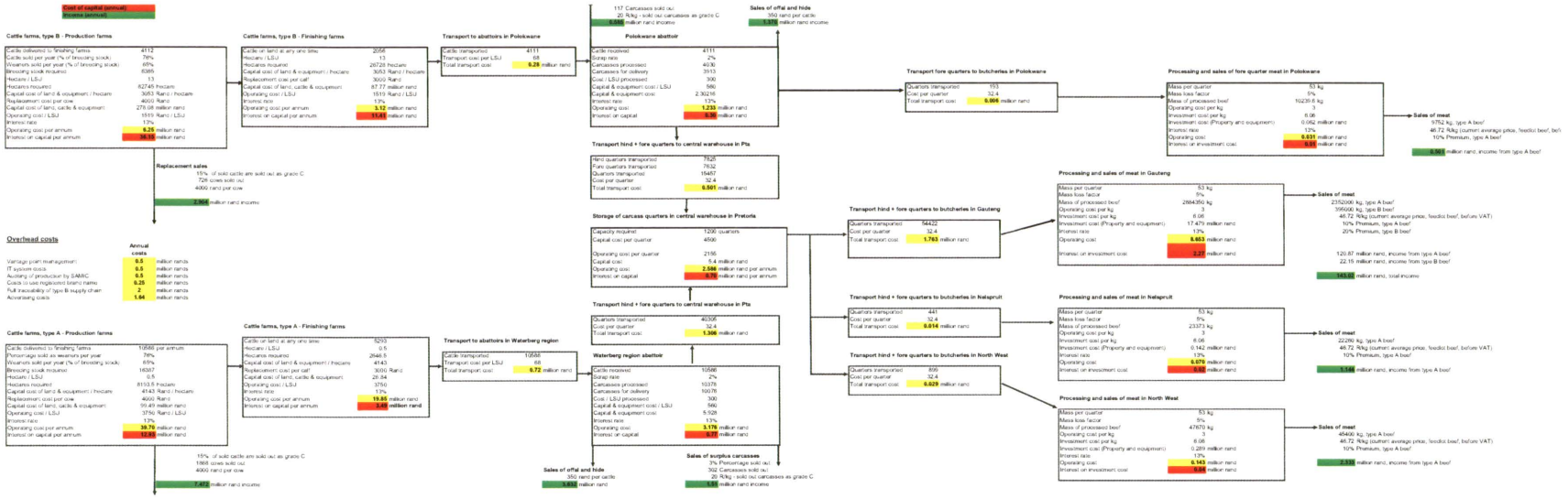

Figure 7. 20 – Process diagram for supply chain, simulation case 1.

Source: Static model developed by author

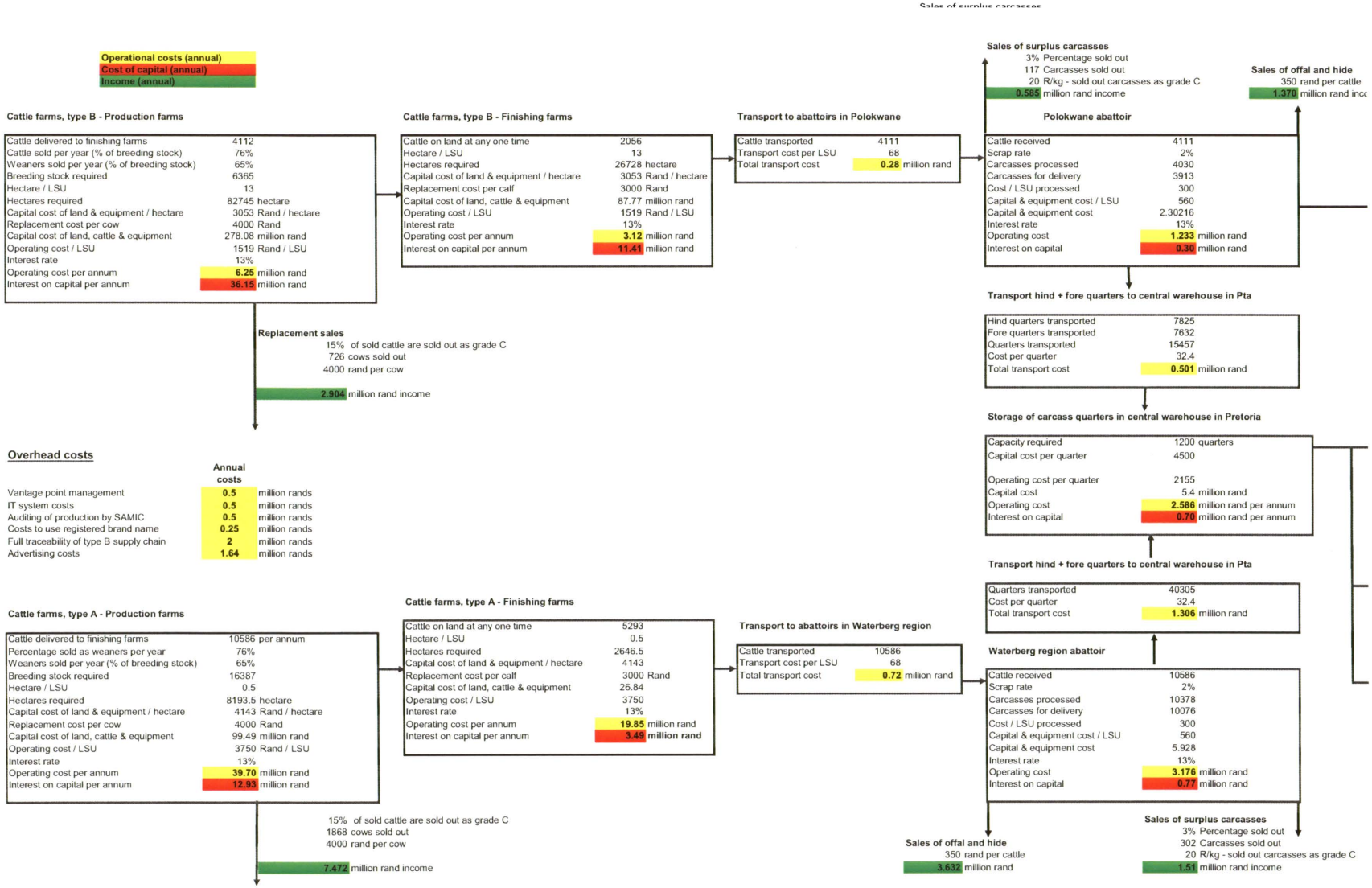

Figure 7. 21 – Process diagram for supply chain, simulation case 1 (zoomed view, left hand side).

Source: Static model developed by author

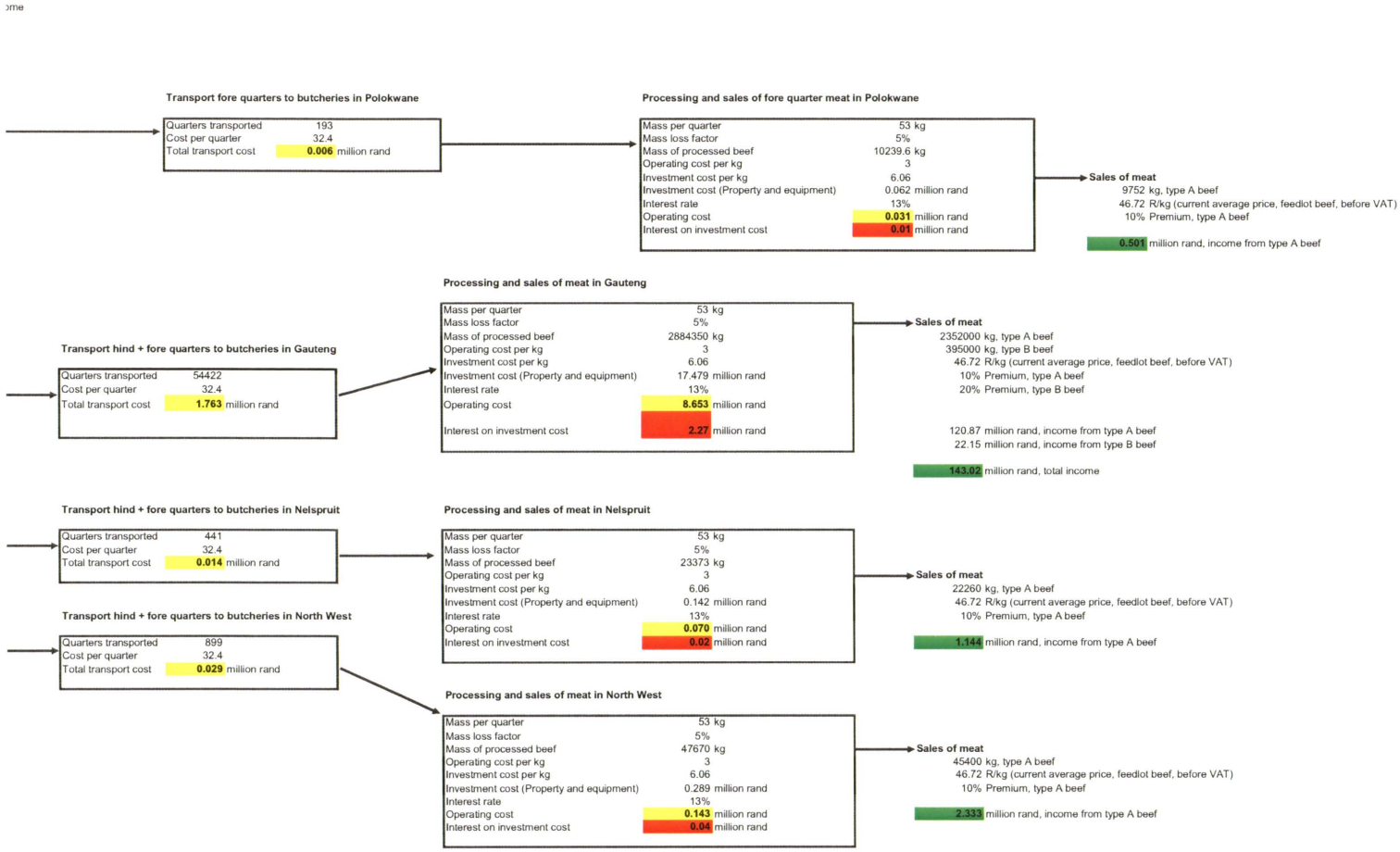

Figure 7. 22 – Process diagram for supply chain, simulation case 1 (zoomed view, right hand side).
Source: Static model developed by author

The summarised values for the supply chain performance for simulation case 1 are shown in Table 7. 3 (static model developed by author). As can be seen, the operational profit for the supply chain is around R70 million. However, this value decreases drastically to about R 7.8 million if cost of capital is included. The main reason for the high cost of capital is the disproportionately large capital cost of farmland.

Table 7. 3 – Summarised financial performance for simulation case 1
Source: Static model developed by author

Total income	**164.470**	**million rand**
Total operational cost	**94.816**	**million rand**
Total cost of capital	**68.09**	**million rand**
Operational profit	**69.654**	**million rand**
Profit - cost of capital included	**1.562**	**million rand**
Total capital value	**523.788**	**million rand**
Return on investment (Ops profit / Total capital value)	**13.30%**	

Similar analyses were performed on simulation cases 2 to 7. The supply chain process maps of these simulation cases are located in Appendix B. The summarised results for the cases are shown in Table 7. 4 (static model developed by author).

Table 7. 4 – Summarised financial performance for simulation cases 1 to 7
Source: Static model developed by author

Simulation case no.	Total income (R milllion)	Total operational cost (R million)	Total cost of capital (R million)	Operational profit (R million)	Profit (cost of capital included) (R million)	Total capital value (R million)	ROI (Ops profit / total capital value)
1	164.47	94.82	68.1	69.65	1.55	479.9	14.51%
2	205.11	123.64	74.87	81.47	6.6	621.13	13.12%
3A	164.47	103.76	68.1	60.71	-7.39	479.9	12.65%
3B	164.47	112.7	68.1	51.77	-16.33	479.9	10.79%
4A	157.87	94.82	68.1	63.05	-5.05	479.9	13.14%
4B	171.1	94.3	68.1	76.8	8.7	479.9	16.00%
5	159.95	92.96	67.01	66.99	-0.02	471.5	14.21%
6	146.2	85.04	65.76	61.16	-4.6	460.12	13.29%
7	135.34	90.12	22.18	45.22	23.04	172.2	26.26%

The overall supply chain profits (cost of capital included) are shown in Figure 7. 23 (static model developed by author). The returns on investment (defined as operational

profit over investment cost) are shown in Figure 7. 24 (static model developed by author).

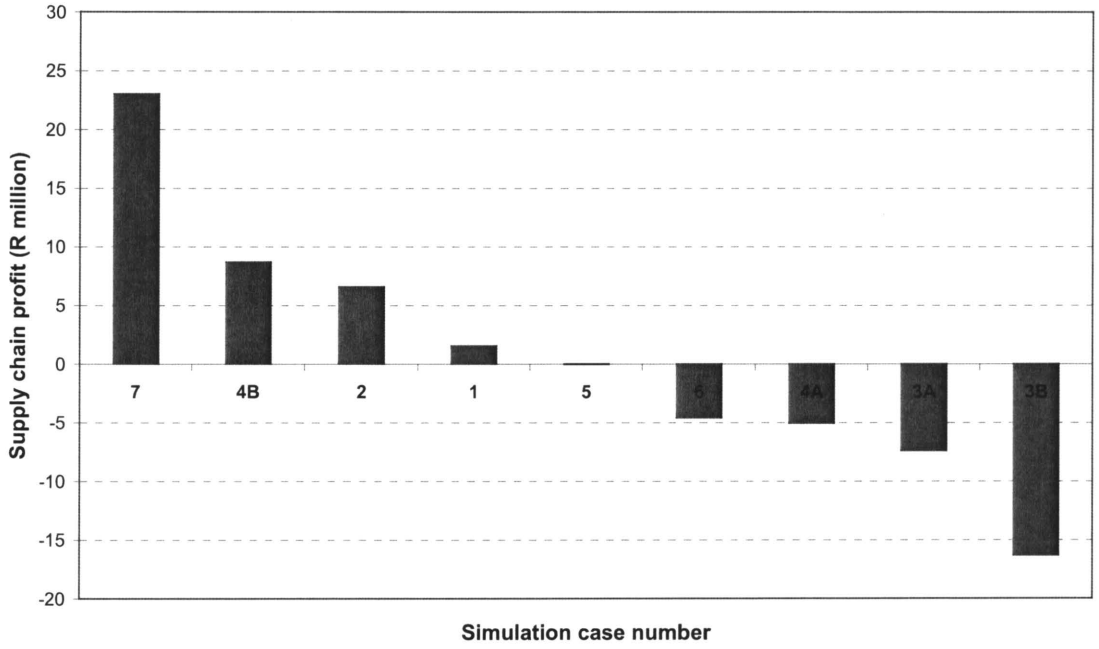

Figure 7. 23 – Overall supply chain profits for simulation cases 1 to 7.
Source: Static model developed by author

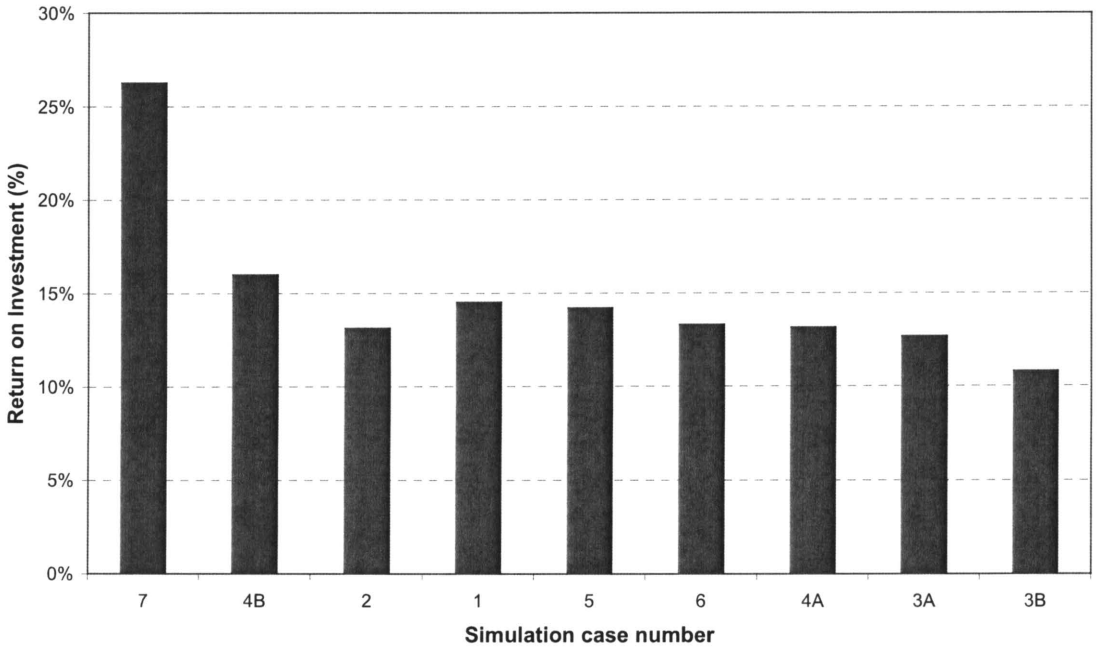

Figure 7. 24 - Returns on investment for simulation cases 1 to 7.
Source: Static model developed by author

As can be seen, the most profitable scenario is simulation case 7 – the case where the type B beef was taken out of the supply chain. This emphasizes the fact that it is probably not worthwhile to produce naturally fed beef in the drier regions of Limpopo. The reason for this is mainly due to the low grazing potential which requires large areas of farmland, combined with the high capital costs of farmland per hectare. Even though a premium of 20 % is asked for this type of beef, the high interest costs of the farmland weigh much more.

Growing cattle naturally on irrigated pasture in the Waterberg region, even though it is more expensive in terms of capital and operational costs per hectare, is a much better proposition. This is due to the fact that a much smaller land area is required.

The second most profitable option is case 4B, where premiums were increased (from 10 % to 15 % for type A and from 20 % to 25 % for type B beef). This emphasizes the increase in profitability that can be achieved by product differentiation and being able to sell at higher prices.

The third most profitable scenario is case 2, where volumes were increased by 30 % by adding another “high volume” outlet and increasing advertising expenditure by a factor of 3.

The best overall strategy would thus probably be to combine cases 7, 4B and 2. In other words, only produce a single type of naturally fed beef from the irrigated pastures in the Waterberg region. Furthermore rather try and sell it at a premium of 15 % instead of 10 %. At the same time sales volumes should be encouraged by intelligent branding and advertising, to position the beef clearly in the market.

Cases 1 and 5 ended up in the middle in terms of profitability. Case 1 was the base case, and case 5 can be seen as the base case for the second configuration that was considered – hence where central processing close to the source was performed instead of distributing carcasses to butcheries for processing close to the market. Case 1 was only just profitable, whereas for all practical purposes Case 5 can be seen as a break-even scenario. There is not really a significant difference between the two supply chain configurations, in terms of profitability.

Case 6 was unprofitable and it therefore does not seem to be a very good idea to deliver lower priced beef products on a contract basis to other businesses such as restaurants and hotels – even though advertising cost fall away. Advertising cost is a low percentage of total supply chain cost, so to save money by cutting it out but sacrifice a premium on the total sales volume does not make sense. The fact that case 4A is also unprofitable emphasizes this point further, showing the detrimental effect when premiums are reduced.

Cases 3A and 3B (where input costs were increased by 10 % and 20 % respectively) were both unprofitable, showing the huge impact of increasing operational costs on the profitability of the supply chain as a whole. It clearly shows the risk to which the beef supply chain is currently exposed to, with fuel prices and other input costs rising sharply.

7.6 Summary

This chapter discussed the design of two basic supply chain configurations, as well as the dynamic and static analyses performed on 9 scenarios, in which a number of parameters were varied.

The parameters analysed through this process included:

- Supply chain configuration.
- Market size.
- Increased operational costs.
- Lower and higher sales prices.
- Direct marketing to hotels and restaurants versus marketing to the general public.
- Type A versus Type B beef.

It was determined that it would be much more profitable to produce type A beef (on irrigated pasture) than type B beef. The reason for this is the high capital cost of land and the low grazing potential for cattle on farms in the Limpopo. It was also determined that through the right combination of branding and advertising, both the price and sales volume of the type A beef should be increased. It was determined that the supply chain

configurations considered did not make a huge impact on profit. Hence, it does not really matter whether meat is processed close to the market or in a central processing plant. An increase in operational costs of 10 % to 20 % would see the base case supply chain become unprofitable – stressing the importance of keeping the supply chain efficient and selling the beef at a premium value.

Chapter 8: Conclusion and recommendations

Research was conducted in order to design and evaluate suitable supply chain strategies for naturally fed beef from the Limpopo province in South Africa.

The research was completed by performing a nine step process, as indicated below:

Step 1: A literature survey.
Step 2: Unstructured interviews and discussions.
Step 3: Visits to farms, abattoirs and butcheries.
Step 4: Gathering, processing and interpretation of data through structured questionnaires to farmers, abattoirs, butcheries, meat processors and meat retailers.
Step 5: Development of conceptual naturally fed beef products.
Step 6: Gathering, processing and interpretation of data through structured questionnaires to consumers of beef, to test the market for the conceptual products as developed in Step 5.
Step 7: Estimation of the market size and requirements for naturally fed beef from Limpopo.
Step 8: Synthesis of the insight gained through steps 1 to 7 above, to design supply chains for naturally fed beef that would likely be successful.
Step 9: Simulation and evaluation of the supply chain designs as were developed in step 8.

The research can be classified as predominantly applied research, as it was aimed at solving a specific problem in the South African beef industry. However, due to circumstances, two of the steps mentioned above (step 5 and step 7) should be classified as explorative research and the results obtained for the market requirements of the naturally fed beef should be viewed as tentative.

The notion of an integrated supply chain, that works together as a single unit and pursues a common goal, was used as the foundation of the research. This approach

implies that in order to optimise the supply chain as a whole, it is not possible to optimise each of the elements separately.

Most important research findings

The South African economy has grown steadily during the past few years. However, at the moment there are a few warning signs in terms of high inflation and increasing interest rates. This reduces the consumer's expendable income and will increase their resistance to buying a premium beef product.

Worldwide, the per capita demand for beef has also declined rapidly during the past 3 decades. The demand for chicken has increased significantly.

On the other hand, the market for organic and naturally fed, or grass fed beef has grown tremendously in the USA over the past decade. The number of producers of naturally fed beef in the USA has grown from 40 to around 1000. This is a clear indication that there is a huge market potential for this type of beef, and it could help to reverse the declining trend in beef demand.

There has also been significant growth of pre-processed and packaged meat consumption over the past 40 years. This could indicate that for the beef supply chain of the future, it may become more important to have meat processing capabilities close to the source (farms and abattoirs) rather than to transport carcasses to butcheries close to the market.

The farming sector in South Africa has been stagnating for the past 15 years, and the same can be said for beef cattle farming in Limpopo. In fact, 80 % of farmers who completed questionnaires are negative about the future prospects of cattle farming in the province.

Ethical and transparent conduct of the beef supply chain is also becoming more important. People are becoming more aware of animal welfare and are skeptical about growth hormones used to artificially increase the growth rate of cattle.

It is also a possibility that, because of global warming, rainfall will decrease over the next 50 years over the drier regions of Limpopo. This highlights the fact that pasture must be utilized much more effectively, and buffer grazing must be harvested or some land must be left open to serve as backup pasture during inevitable drought conditions.

It was determined that salaries and fuel and transport costs added together account for roughly half of the (operational) supply chain costs. It was also determined that cost of capital is almost two thirds of the value of the operational costs – which is exceptionally high. This is mainly due to the high costs of farmland, which is quite simply heavily overpriced when the capital cost is compared to the productive farming capacity of the farmland.

Information regarding operational and investment costs, as well as other process parameters such as process times and capacities were obtained from farmers, abattoirs, butcheries, meat processing plants, retailers and logistics companies. These costs and process parameters were used in the simulation models.

Two types of natural beef concepts were developed, namely a Type A and Type B beef. Type A beef is produced from irrigated pasture in the Waterberg region, while Type B beef is produced from totally natural farms in the drier Limpopo regions. The consumers' willingness to pay a premium on these natural beef types were evaluated through a consumer questionnaire. It was determined that a premium of 10 % could probably be asked for type A beef, while a premium of 20 % could be asked for type B beef.

It was decided that the most feasible markets for naturally fed beef from Limpopo would be Gauteng, the Eastern part of the North West province, Polokwane and Nelspruit. The market sizes at these locations for types A and B beef were estimated through a combination of existing beef sales and information obtained through the research questionnaires. These estimated sales volumes, as well as the process costs and parameters for the operational elements of the supply chain were used in the simulation models.

The supply chain profitability was analysed in a unique way, since only total supply chain income and costs were considered.

Numerical simulations were performed on nine scenarios. The influence of the following parameters were considered through the simulations:

- Supply chain configuration (process close to market versus process close to source).
- Market size.
- Sales premium.
- Input costs.
- B2C versus B2B markets.
- Type A versus type B beef.

The simulations indicated that:

- It is far more profitable to produce type A beef than it is to produce type B beef. This is due to the fact that farmland is extremely expensive and the grazing capacity in the drier regions of Limpopo is very low.
- Through effective branding and advertising, natural beef should be positioned in such a way that both sales volumes as well as price can be increased, since the combination of these two factors has a very positive impact on profitability.
- The supply chain configuration is not very significant in terms of influencing profits.
- Profitability is reduced when opting for contract at a reduced price. However, as a lower risk, lower return option it could be considered, especially if the more profitable type A beef is sold.
- For the base case simulation, the increase of operational costs by 10 % to 20 % has a significant impact on the supply chain, as it results in supply chain losses.

Recommendations

- It is recommended that naturally fed beef from Limpopo can be produced, in a profitable way, as a differentiated alternative to feedlot produced beef.

- It is recommended that the cattle should preferably be produced on irrigated pasture, typically in the Waterberg region (type A beef), rather than on natural arid farmland (type B beef).

- It is recommended that the key success factors of the Brazilian beef industry be investigated. Brazil has grown tremendously as an exporter of beef since 2000. There may be valuable lessons to learn for the South African beef industry.

- It is recommended that more pre-processed beef be manufactured and sold, as there is definitely a growing trend in terms of buying pre-packaged meat. This would imply processing the beef close to the source (farms) and transporting case ready packages to the market.

- It is recommended that a significant effort be put into branding and advertising of naturally fed beef, in order to increase sales volumes and enable a premium of about 15 % above normal, feedlot produced beef.

- It is recommended that the supply chain is managed as a process, by a dedicated and unbiased vantage point manager. The vantage point manager should ensure that the supply chain works together as a single unit.

- It is recommended that the focus of the vantage point manager should be on optimizing the system as a whole, as opposed to optimizing each business unit separately.

- It is recommended that much better use is made of the farmland in Limpopo, by using better pasture management and developing synergies between game and cattle farming.

- It is recommended that further research be conducted to determine how the supply chain profit should be distributed to each of the business units in the supply chain.

Appendix A – Structured research questionnaires

This appendix contains the structured questionnaires that were sent out as part of the research.

It also contains summaries of the processed results for each questionnaire.

The first part of the appendix contains:

- The questionnaire for beef cattle farmers.
- The questionnaire for butcheries / meat retailers / meat processing plants.
- The questionnaire for abattoirs.
- The questionnaire for general consumers of beef.

The second part contains:

- Results summary for beef cattle farmers.
- Results summary for butcheries / meat retailers / meat processing plants.
- Results summary for abattoirs.
- Results summary for general consumers of beef.

Questionnaire for beef cattle farmers in Limpopo.

Please note:

This questionnaire has 14 questions

Where applicable, please tick the appropriate boxes

Questions:

1. How long have you been farming with beef cattle in the Limpopo province?

Less than 5 years	
6 to 10 years	
11 to 20 years	
More than 20 years	

2. What is the size of the farm on which beef cattle farming is performed?

	hectares

3. On average, how many cattle typically graze on the farmland as specified in question 2?

	cattle

4. How many cattle do you typically sell in a year?

	cattle

5. Indicate the percentage of cattle that you sell into the following market segments:

Feedlot process	%
Naturally fed	%

6. What breeds of cattle do you farm with?

Nguni	
Bonsmara	
Brahman	
Simmentaler	
Hugenote	
Drakensberger	
Other (please specify)	

7. Please give reasons for selecting the breeds of cattle which you chose to farm with, as specified in question 6.

8. What type of cattle production system do you use?

* Weaner System	
** Speculation system	
Other (please specify)	

* The weaner system implies keeping a core breeding stock of cows and a small stud component.
** The speculation system implies buying younger cattle at a lighter weight and feeding them for a period of time before selling.

9. What is your estimated annual total operational cost that has to be incurred to keep your business running?

Rand

10. What are your main cost components (more or less) as percentages of the total cost as indicated in question 9? Please specify in the table below:

Cost component	Percentage of total cost (%)
***Administration costs	%
Disease control	%
Utilities	%
Salaries and wages	%
Fuel and transportation costs	%
Rental of premises	%
Maintenance	%
Fodder	%
Irrigation of pastures	%
Others: (please specify)	%
	%
	%
	%
	%

*** Administration costs include all accounting fees, stationery, telephone bills, insurance, UIF, internet, computers, printing, bank charges, postage etc.

11. Do you own or lease the farmland (with buildings) and equipment that you use for your farming business?

	Own	Lease
Farmland with buildings		
Equipment		

12. What would it currently cost to buy the buildings and equipment that you use for your farming business?

Capital cost of farmland with buildings	R
Capital cost of equipment	R

13. What is your survival strategy when affected by a severe drought?

Sell excess cattle	
Buy fodder and feed cattle	
Feed cattle with stored, harvested grass (collected from own farm over one or two years)	
Other: (Please specify)	

14. What is your view on the future of beef cattle farming in the Limpopo province?

Steady growth	
Stagnation	
Slow decline	
Rapid decline	

Questionnaire for butcheries / meat retailers / meat processing plants.

Please note

This questionnaire has 13 questions.

Where applicable, please tick the appropriate boxes

Questions:

1. How many outlets / factories do you have?

Branches	
Franchises	

2. What quantity (in kilograms) of beef do you sell or process per year?

	kg

3. What percentage of your annual sales revenue comes from beef products?

	%

4. What is the ratio (in terms of percentage) of hind quarter and forequarter beef that you sell?

Beef from the hind quarter	%
Beef from the forequarter	%

5. What percentage of the beef that you currently sell is naturally fed beef?

	%

6. What is the average turnaround time that beef spend in your premises? (from when the carcass is received to when the final product is sold to the consumer)

	days

7. If you are not already selling naturally fed beef products, would you consider selling naturally fed beef products?

Yes	
No	

8. If you are selling, or would be willing to sell naturally fed beef, would you only sell it under your own brand name?

Yes	
No	

9. What do you expect would be your market size for naturally fed beef?

Current	kg / year
10 years in the future	kg / year

10. What is your estimated annual operational cost that has to be incurred to keep your business running?

Rand

11. What are your main cost components (more or less) as percentages of the total cost as indicated in question 10? Please specify in the table below.

Cost component	Percentage of total cost (%)
*Administration costs	%
Utilities	%
Salaries and wages	%
Fuel and transportation costs	%
Rental of premises	%
Maintenance and cleaning	%
Inspection fees	%
Advertising	%
Others:	%
	%

* Administration costs include all accounting fees, stationery, telephone bills, insurance, UIF, internet, computers, printing, bank charges, postage etc.

12. Do you own or lease the buildings and equipment that you use for your business?

	Own	Lease
Buildings		
Equipment		

13. What would it currently cost to buy the buildings and equipment that you use for your business?

Capital cost of buildings	R
Capital cost of equipment	R

Questionnaire for abattoirs.

Please note:

This questionnaire has 11 questions. The questions have reference to the processing of beef cattle only.

Where applicable, please tick the appropriate boxes

Questions:

1. What is the capacity of your abattoir?

	Cattle per day

2. What is your average utilization rate (expressed as a percentage of maximum capacity)?

	%

3. What percentage of your annual sales revenue comes from processing beef cattle?

	%

4. To whom do you sell your final carcasses (percentage)?

Wholesalers	%
Butcheries	%
Retailers	%

5. What is the current average price per kilogram that you receive for the processed carcasses?

	R / kg

6. What percentage of your total cattle throughput is from “natural” cattle (hence cattle that did not go through the feedlot process)?

	%

7. How long is the process typically (hence from the moment an animal arrives at the abattoir, to the moment when the carcass leaves the abattoir)

	days

8. What is your estimated annual operational cost that has to be incurred to keep your business running?

	Rand

9. What are your main operational cost components as percentages of the total cost as indicated in question 9? Please specify in the table below:

Cost component	Percentage of total cost (%)
*Administration costs	%
Utilities	%
Salaries and wages	%
Fuel and transportation costs	%
Rental of premises	%
Maintenance and cleaning	%
Inspection fees	%
Advertising	%
Others: (please specify)	%
	%
	%

* Administration costs include all accounting fees, stationery, telephone bills, insurance, UIF, internet, computers, printing, bank charges, postage etc.

10. Do you own or lease the buildings and equipment that you use for your business?

	Own	Lease
Buildings		
Equipment		

11. What would it currently cost to buy the buildings and equipment that you use for your business?

Capital cost of buildings	R
Capital cost of equipment	R

Questionnaire for general consumers of beef.

Before answering the questions, please read the following:

Description of feedlot produced beef

Most beef available in South Africa is feedlot produced beef.

Feedlot beef is produced from cattle that spent about 4 months in confined feedlots. In the feedlots, they are fed on grain and other supplements. Included in their diets are growth stimulants and antibiotics that cause artificially fast growth, which cannot be attained under natural circumstances.

Feedlot beef is normally tender, has a light red colour and white fat. The fat content of feedlot beef is about 13%

Questions:

1. What are your views on beef? (tick appropriate boxes)

Beef is an essential part of a healthy diet	
Beef is not essential, you can substitute it with the right combination of vegetables, fruits and nuts	
Beef is detrimental to health	
I am satisfied with the variety of beef products that are available	
I am not satisfied with the variety of beef products that are available – I would like to see more variety	
I am concerned about the treatment of beef cattle	
I am not concerned about the treatment of beef cattle	
I would prefer if beef products could be traced back to farm and animal level	
I am worried or concerned about the use of growth stimulants to produce beef	
Beef is too expensive as a source of protein	
I prefer other meats such as chicken or pork	

2. What is your gross monthly **total household** income?

Less than R 5 000 per month	
R5001 to R10 000 per month	
R10 001 to R15 000 per month	
R15 001 to R20 000 per month	
R20 001 to R25 000 per month	
More than R25 000 per month	

3. How many people are in your household?

1	2	3	4	5	More than 5

4. What is your household's monthly expenditure on beef products?

Less than R50	R51 to R100	R101 to R200	R201 to R300	R301 to R500	More than R500

5. I prefer to buy beef products at:

A butchery	
A meat deli	
A supermarket	
Other (please specify)	

6. If there are beef products on the market (Natural beef **Type A**), which differs from feedlot beef in the following ways:

- The cattle grazed on irrigated natural pasture on a farm in the Waterberg region of the Limpopo province and were never put in a confined feedlot.
- No growth stimulants and related antibiotics were given to the animals to increase growth rate.
- This beef has more or less the same tenderness as feedlot beef.
- This beef tastes better than feedlot beef.
- The fat content is less than that of feedlot beef.
- The beef is slightly darker and have a yellowish fat (yellow fat is full of good omega 3 and 6 acids, which is healthier than white fat)
- The beef is pre-packaged and branded.
- The beef is only available at a limited number of shops and butcheries.

I will pay the following amount more for "Natural beef **Type A**" (as described above) than for feedlot beef:

I won't pay more at all	I will pay 5 to 10% more	I will pay 11 to 20 % more	I will pay 21 to 30 % more	I will pay 31 to 50% more	I will pay in excess of 50 % more

7. If there are beef products on the market (Natural beef **Type B**), which differs from feedlot beef in the following ways:
   - The cattle grazed on totally natural pasture on farms in the Bushveld region of the Limpopo province and were never put in a confined feedlot.
   - No growth stimulants and related antibiotics were given to the animals to increase growth rate.
   - The beef is fully traceable – back to farm and animal level
   - This beef has more or less the same tenderness as feedlot beef.
   - This beef tastes better than feedlot beef.
   - The fat content is less than that of feedlot beef.
   - The beef is slightly darker and have a yellowish fat (yellow fat is full of good omega 3 and 6 acids, which is healthier than white fat).
   - The beef is pre-packaged in a high quality branded packaging.
   - The beef is only available at a very few selected shops.
   - A higher than usual variety of cuts and products are available.
   - Tailor made packages can be pre-ordered over the internet (lead time 3 to 5 days).
   - An option for home delivery exists.

I will pay the following amount more for "Natural beef **Type B**" (as described above) than for feedlot beef:

I won't pay more at all	I will pay 5 to 10% more	I will pay 11 to 20 % more	I will pay 21 to 30 % more	I will pay 31 to 50% more	I will pay in excess of 50 % more

Table A. 1 – Summary of questionnaire results from beef cattle farmers in Limpopo

Source: Completed questionnaires received from beef cattle farmers

Questionnaire for beef cattle farmers (sweet veld region of Limpopo) - Summary Table												
Total number of respondents	**9**		**Respondent no.**									
	No. of respondents who selected the option	**Percentage of respondents who selected the option**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Average**
How long have respondent been farming with cattle in Limpopo?												
Less than 5 years	1	11.1%										
6 to 10 years	3	33.3%										
11 to 20 years	2	22.2%										
More than 20 years	3	33.3%										
Size of land used for cattle farming (hectares)			3800	3300	2400	318	840	1200	2000	11000	1460	**2924**
Typical number of cattle on farm at any one time			190	150	500	100	180	175	150	430	135	**223**
Average number of cattle sold per year			110	90	280	280	120	100	80	432	30	**169**
What types of cattle breeds are used?												
Nguni	2	22.2%										
Bonsmara	9	100.0%										
Brahman	3	33.3%										
Hugenote	4	44.4%										
Simmentaler	2	22.2%										
												% of total
Total annual operational cost (R 000's)			125.4	350	150	490.82	270	215	120	1200	131.85	**339.23** **cost**
Administration			6.9	10.5	0.0	58.9	2.7	6.5	13.2	84.0	5.0	**20.85** 6.1%
Disease control			6.9	17.5	30.0	24.5	27.0	53.8	19.2	72.0	17.0	**29.77** 8.8%
Utilities			15.0	17.5	12.0	14.7	5.4	8.6	7.2	156.0	24.0	**28.94** 8.5%
Salaries			35.1	70.0	96.0	49.1	94.5	64.5	43.2	396.0	36.0	**98.27** 29.0%
Fuel and transport			11.3	87.5	12.0	39.3	5.4	25.8	19.2	228.0	18.6	**49.67** 14.6%
Rental of farm and equipment			0.0	0.0	0.0	24.5	0.0	43.0	0.0	24.0	0.0	**10.17** 3.0%
Maintenance			1.9	70.0	0.0	117.8	5.4	4.3	6.0	120.0	0.1	**36.17** 10.7%
Fodder			13.8	42.0	0.0	162.0	126.9	4.3	6.0	24.0	31.1	**45.56** 13.4%
Insurance			14.4	35.0	0.0	0.0	2.7	4.3	6.0	24.0	0.0	**9.60** 2.8%
Irrigation			14.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**1.60** 0.5%
Others			1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.21** 0.1%
Capital cost of farmland and equipment (R millions)			11.6	10.1	N/A	1.8	5.3	N/A	5.1	25.0	10.5	**9.91**
Farmers' opinions on the future of cattle farming												
Steady growth	2	22.2%										
Stagnation	1	11.1%										
Steady decline	5	55.6%										
Rapid decline	1	11.1%										
What is the typical drought survival strategy?												
Sell excess cattle	6	66.7%										
Buy fodder and keep cattle	4	44.4%										
Harvest and store grass from own farm	2	22.2%										
Hectare per LSU (breeding stock)	**13.1**											
Cost of capital on land and equipment (average)	**3052.65**	Rand per hectare										
Operational cost per LSU (average)	**1518.94**	Rand per LSU (breeding stock)										
Questionnaire for beef cattle farmers (irrigated pasture in the Waterberg) - Summary Table (Abbreviated)												
Total number of respondents	**2**											
Hectare per LSU (breeding stock)	**0.5**											
Cost of capital on land and equipment (average)	**4142.86**	Rand per hectare										
Operational cost per LSU (average)	**3749.50**	Rand per LSU (breeding stock)										

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Table A. 2 - Summary of questionnaire results from butcheries, retailers and meat processing plants

Source: Completed questionnaires received from butcheries, retailers and processors

Questionnaires for butcheries, retailers and meat processing plant - Summary Table							
	Butchery number:					**Meat plant**	**Retailer**
	1	2	3	4	**Average**	1	1
Annual quantity processed and / or sold (tonnes)	400	150	300	2500	**837.5**	1300	840
Percentage sales revenue from beef	70%	70%	50%	70%	**65%**	100%	59%
Percentage from hind quarter	99%	80%	90%	50%	**80%**	50%	43%
Percentage from fore quarter	1%	20%	10%	50%	**20%**	50%	57%
Average process time	7	3	9	6	**6.3**	3	6
Total annual operational cost (R millions)	3	0.454	2	10	**3.9**	2.071	3
Cost breakdown as % of total ops cost							
Administration	9.0%	2.4%	10.0%	4.0%	**6.4%**	N/A	N/A
Utilities	4.0%	20.7%	7.0%	7.0%	**9.7%**	N/A	N/A
Salaries and wages	55.0%	50.2%	52.0%	51.0%	**52.1%**	N/A	N/A
Fuel and transportation	14.0%	6.3%	3.3%	10.0%	**8.4%**	N/A	N/A
Rental of premises	9.0%	15.8%	18.5%	15.0%	**14.6%**	N/A	N/A
Maintenance and cleaning	4.5%	4.4%	3.4%	5.0%	**4.3%**	N/A	N/A
Inspection fees	0.0%	0.0%	0.0%	1.0%	**0.3%**	N/A	N/A
Advertising	4.5%	0.0%	1.5%	3.0%	**2.3%**	N/A	N/A
Others	0.0%	0.0%	4.3%	4.0%	**2.1%**	N/A	N/A
Capital costs of buildings and equipment	4	1.35	5.9	20	**7.8**	8	5.9

Butcheries		
Total operational cost (4 butcheries)	15.45	million rand
Total capital cost (4 butcheries)	31.25	million rand
Total meat processed / sold	3350	tonnes
Percentage of beef attributable to beef	65%	
Operational cost per kg processed	**3.00**	Rand / kg
Capital cost per kg processed	**6.06**	Rand / kg
Meat processing plant		
Operational cost per kg processed	**1.59**	Rand / kg
Capital cost per kg processed	**6.15**	Rand / kg
Meat retailer		
Operational cost per kg sold	**2.11**	Rand / kg
Capital cost per kg sold	**4.14**	Rand / kg

Table A. 3 – Summary of questionnaire results from abattoirs

Source: Completed questionnaires received from abattoirs

Questionnaire for abattoirs - Summary Table								
Total number of respondents	7							
	Respondent number:							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**Average**
Abattoir capacity (per day)	15	160	40	100	12	80	80	**69.6**
Utilization rate	70%	90%	100%	95%	80%	60%	50%	**77.9%**
Percentage of sales from beef cattle	50%	80%	80%	80%	50%	100%	65%	**72.1%**
Cattle processed per year (240 working days)	1260	27648	7680	18240	1152	11520	6240	**10534**
How long is the process? (days)	3	2	2	2	3	3	4	**2.7**
Total annual operational cost (R millions)	1.30	8.10	1.63	12.00	2.12	4.21	1.35	**4.4**
Cost breakdown as % of total ops cost								
Administration	10.0%	2.5%	10.5%	7.5%	10.5%	20.0%	22.0%	**11.9%**
Utilities	6.0%	5.8%	4.6%	6.0%	7.0%	6.5%	5.0%	**5.8%**
Salaries	36.5%	32.1%	39.2%	32.0%	42.0%	34.2%	35.0%	**35.9%**
Fuel and transport	25.0%	20.4%	30.6%	44.0%	18.0%	17.0%	20.0%	**25.0%**
Rental of premises	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%	**0.1%**
Maintenance and cleaning	7.0%	10.2%	8.7%	3.5%	5.0%	5.7%	10.0%	**7.2%**
Inspection fees	2.5%	2.7%	0.0%	1.5%	3.5%	3.1%	2.0%	**2.2%**
Advertising	1.0%	0.0%	0.0%	0.5%	3.5%	0.0%	0.0%	**0.7%**
Others	12.0%	26.4%	6.4%	5.0%	10.5%	13.5%	5.0%	**11.3%**
Capital cost of buildings + equipment (R millions)	1.2	17	3.5	10	2.5	11	12	**8.2**

Total cattle processed (by all 7 abattoirs)	**73740**	
Total operational cost (all 7 abattoirs)	**30.71**	million rand
Total capital cost (all 7 abattoirs)	**57.2**	million rand
Percentage of cost attributable to cattle processing	**72.1%**	
Ops cost per LSU processed	**300.44**	Rand per LSU
Capital cost per LSU processed	**559.61**	Rand per LSU

Table A. 4 - Summary of questionnaire results from general consumers of beef

Source: Completed questionnaires received from beef consumers in general

Questionnaire for general consumers - summary table		
Total number of respondents	**56**	
	No. of respondents who selected the option	**Percentage of respondents who selected the option**
Consumer opinions on beef		
Beef is an essential part of a healthy diet	40	71.4%
Beef is not essential, you can substitute it with the right combination of vegetables, fruits and nuts	12	21.4%
Beef is detrimental to health	2	3.6%
I am satisfied with the variety of beef products that are available	43	76.8%
I am not satisfied with the variety of beef products that are available - I would like to see more variety	5	8.9%
I am concerned about the treatment of beef cattle	33	58.9%
I am not concerned about the treatment of beef cattle	13	23.2%
I would prefer if beef products could be traced back to farm and animal level	27	48.2%
I am worried or concerned about the use of growth stimulants to produce beef	25	44.6%
Beef is too expensive as a source of protein	22	39.3%
I prefer other meats such as chicken or pork	21	37.5%
Total gross monthly household income		
Less than R5000 per month	12	21.4%
R5001 to R10 000 per month	14	25.0%
R10 001 to R15 000 per month	6	10.7%
R15 001 to R20 000 per month	8	14.3%
R20 001 to R25 000 per month	5	8.9%
R25 001 to R30 000 per month	2	3.6%
R30 001 to R35 000 per month	3	5.4%
R35 001 to R40 000 per month	1	1.8%
More than R40 000 per month	5	8.9%
Number of people in household		
One person	5	8.9%
Two people	18	32.1%
Three peope	11	19.6%
Four people	15	26.8%
Five people	4	7.1%
More than five people	3	5.4%
Household's monthly expenditure on beef products		
Less than R50	3	5.4%
R51 to R100	4	7.1%
R101 to R200	13	23.2%
R201 to R300	13	23.2%
R301 to R500	16	28.6%
More than R500	7	12.5%
Preference of buying location		
Butchery	39	69.6%
Meat deli	6	10.7%
Supermarket	18	32.1%
Willingness to pay a premium for "Type A beef"		
Would not pay more at all	15	26.8%
Will pay 5% to 10% more	25	44.6%
Will pay 11% to 20% more	10	17.9%
Will pay 21% to 30% more	5	8.9%
Will pay 31% to 50% more	0	0.0%
Will pay in excess of 50% more	0	0.0%
Willingness to pay a premium for "Type B beef"		
Would not pay more at all	9	16.1%
Will pay 5% to 10% more	23	41.1%
Will pay 11% to 20% more	11	19.6%
Will pay 21% to 30% more	10	17.9%
Will pay 31% to 50% more	3	5.4%
Will pay in excess of 50% more	0	0.0%

Below are selected responses from the 56 general consumers of beef. Please note that the table entries must be read in conjunction with the legend as given.

Table A. 5 – Selected answers from some of the general consumers of beef

Source: Completed questionnaires received from beef consumers in general

Respondent number	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Monthly household income	1	1	1	1	1	2	2	2	2	3	3	3	3	4
No. of people in household	6	4	2	6	3	2	3	2	6	3	2	4	2	5
Monthly expenditure on beef	5	3	3	6	3	5	5	5	3	5	3	5	4	2
Willingness to pay premium: Type A	2	2	2	2	1	2	2	2	1	2	1	2	4	2
Willingness to pay premium: Type B	3	3	2	3	1	2	2	2	1	4	1	2	4	4
Respondent number	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Monthly household income	4	5	5	6	7	9	9	8	5	7	2	2	2	4
No. of people in household	2	4	2	3	2	5	2	4	3	4	4	2	2	3
Monthly expenditure on beef	2	5	6	6	3	6	5	4	4	5	5	5	5	4
Willingness to pay premium: Type A	3	2	0	3	2	3	3	3	1	2	2	2	2	4
Willingness to pay premium: Type B	4	2	5	3	2	2	3	4	2	3	3	2	2	5
Respondent number	29	30	31	32	33	34	35	36	37	38	39	40	41	42
Monthly household income	2	4	9	2	9	4	1	1	2	9	4	2	1	3
No. of people in household	4	4	3	4	2	3	5	1	2	2	4	5	3	4
Monthly expenditure on beef	4	5	4	4	3	6	1	3	3	5	4	3	4	6
Willingness to pay premium: Type A	1	1	2	2	3	1	1	3	1	1	2	4	1	1
Willingness to pay premium: Type B	2	1	3	2	4	2	1	4	1	1	2	4	2	2
Respondent number	43	44	45	46	47	48	49	50	51	52	53	54	55	56
Monthly household income	2	1	1	1	2	1	2	3	4	4	6	7	5	5
No. of people in household	2	4	2	1	2	4	3	3	1	1	2	1	4	4
Monthly expenditure on beef	3	5	3	2	4	6	4	5	1	1	4	3	4	2
Willingness to pay premium: Type A	3	2	1	1	3	2	2	3	2	1	4	4	2	2
Willingness to pay premium: Type B	3	2	1	1	4	2	2	3	2	2	4	5	2	3

Legend for Table A. 5

LEGEND					
No.	Monthly household income ('000 Rand)	No. of people in household	Monthly expenditure on beef	Willingness to pay premium: Type A	Willingness to pay premium: Type B
1	< 5	1	< R50	0%	0%
2	5 to 10	2	R51 to R100	5 to 10 %	5 to 10 %
3	10 to 15	3	R101 to R200	11 to 20 %	11 to 20 %
4	15 to 20	4	R201 to R300	21 to 30 %	21 to 30 %
5	20 to 25	5	R301 to R500	31 to 50 %	31 to 50 %
6	25 to 30	>5	> R500	> 50 %	> 50 %
7	30 to 35				
8	35 to 40				
9	> 40				

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Appendix B – Detail of static analyses for simulations 2 to 7

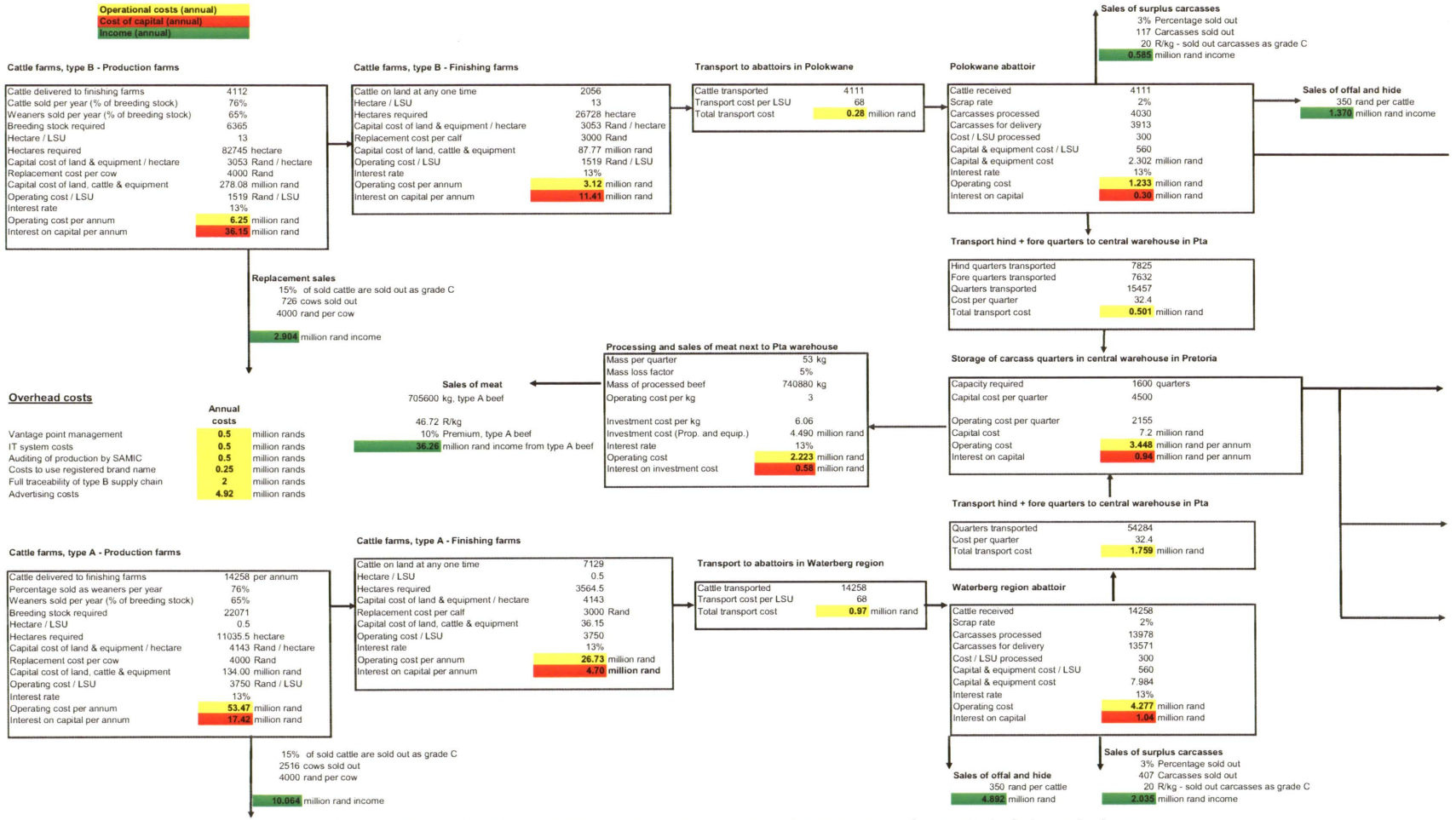

Figure B. 1 – Supply chain process map for Simulation Case 2, left hand view.
Source: Static model developed by author

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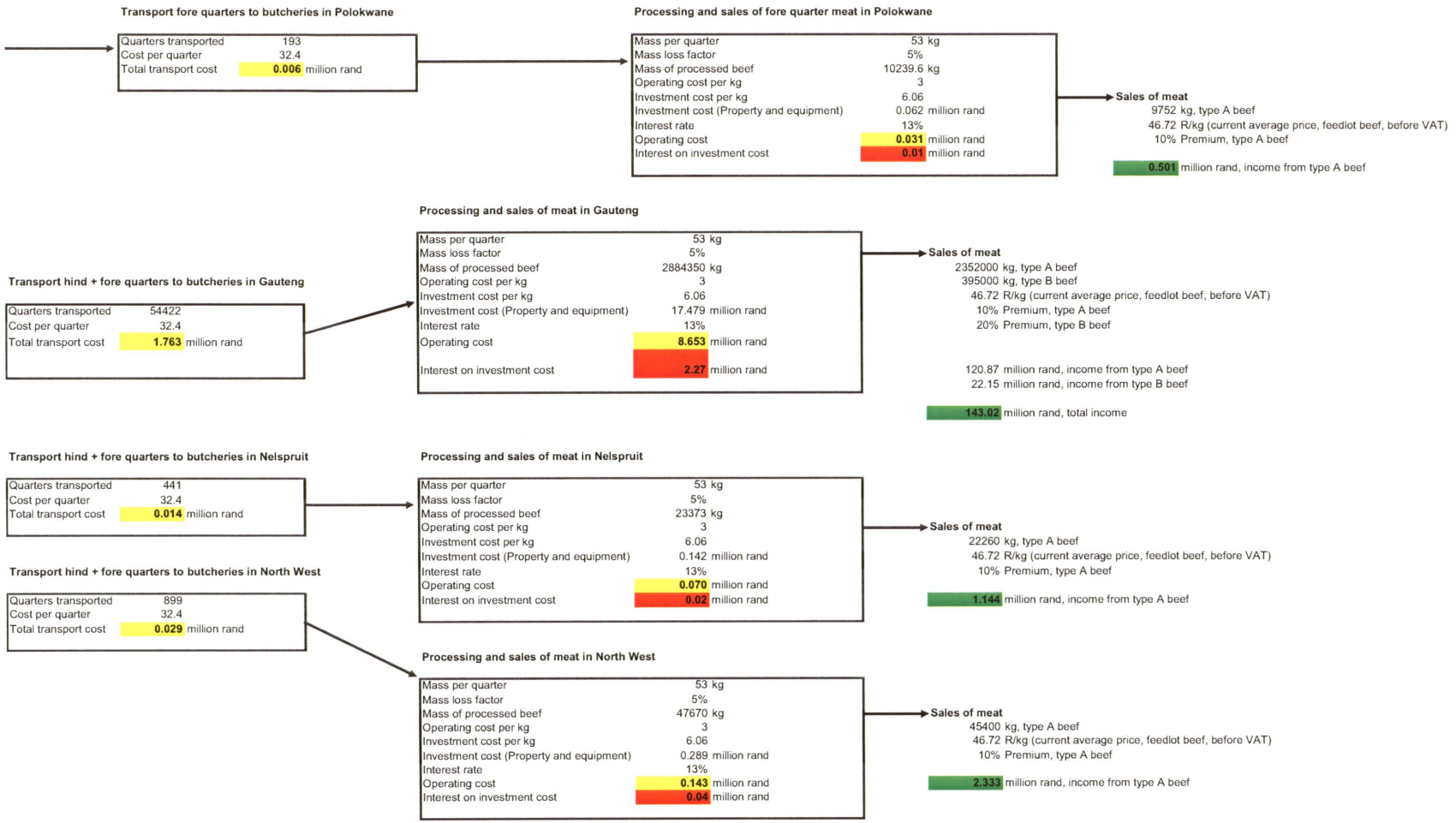

Figure B. 2 – Supply chain process map for Simulation Case 2, right hand view.
Source: Static model developed by author

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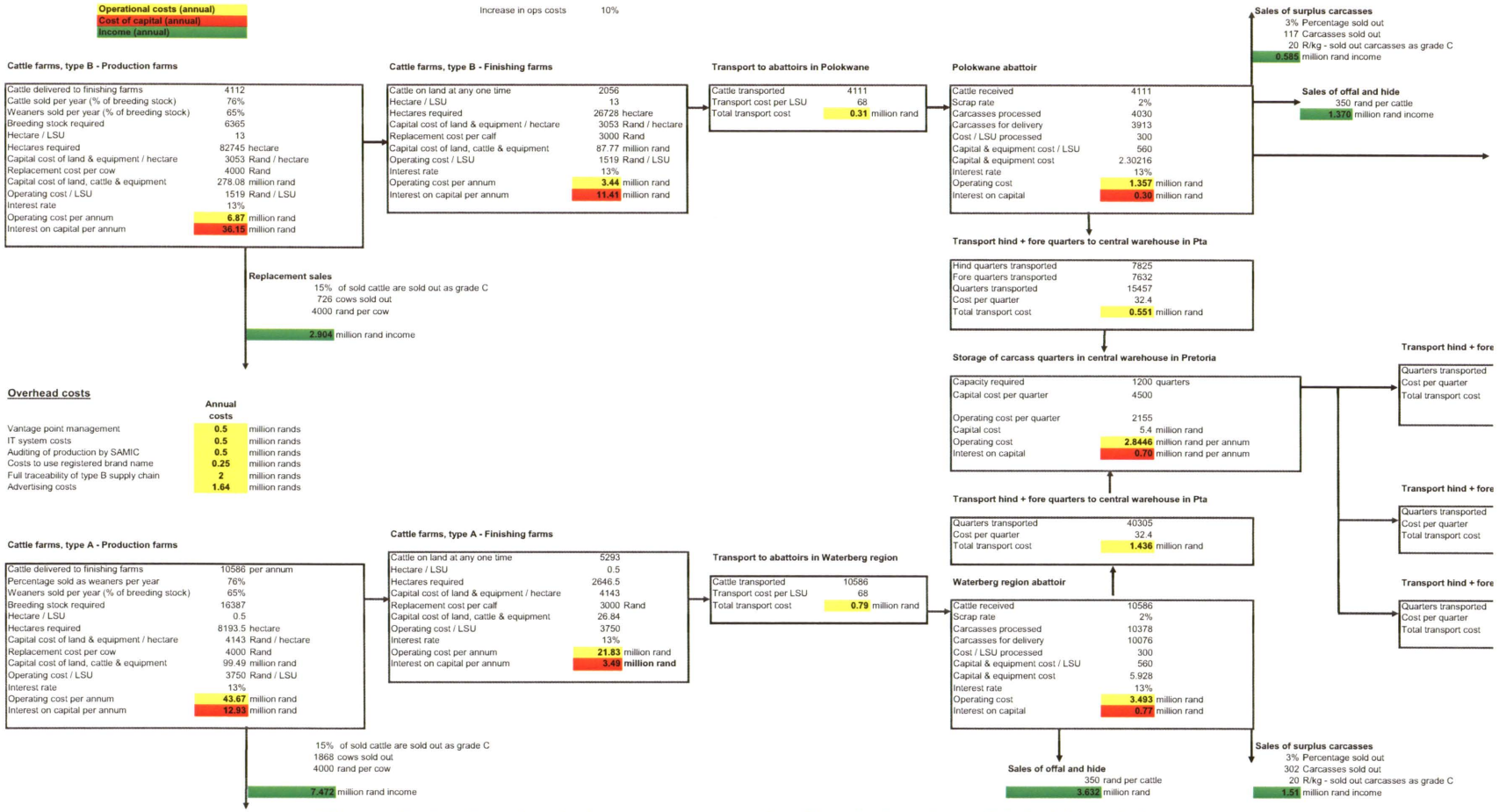

Figure B. 3 – Supply chain process map for Simulation Case 3A, left hand view.

Source: Static model developed by author

Source: Static model developed by author

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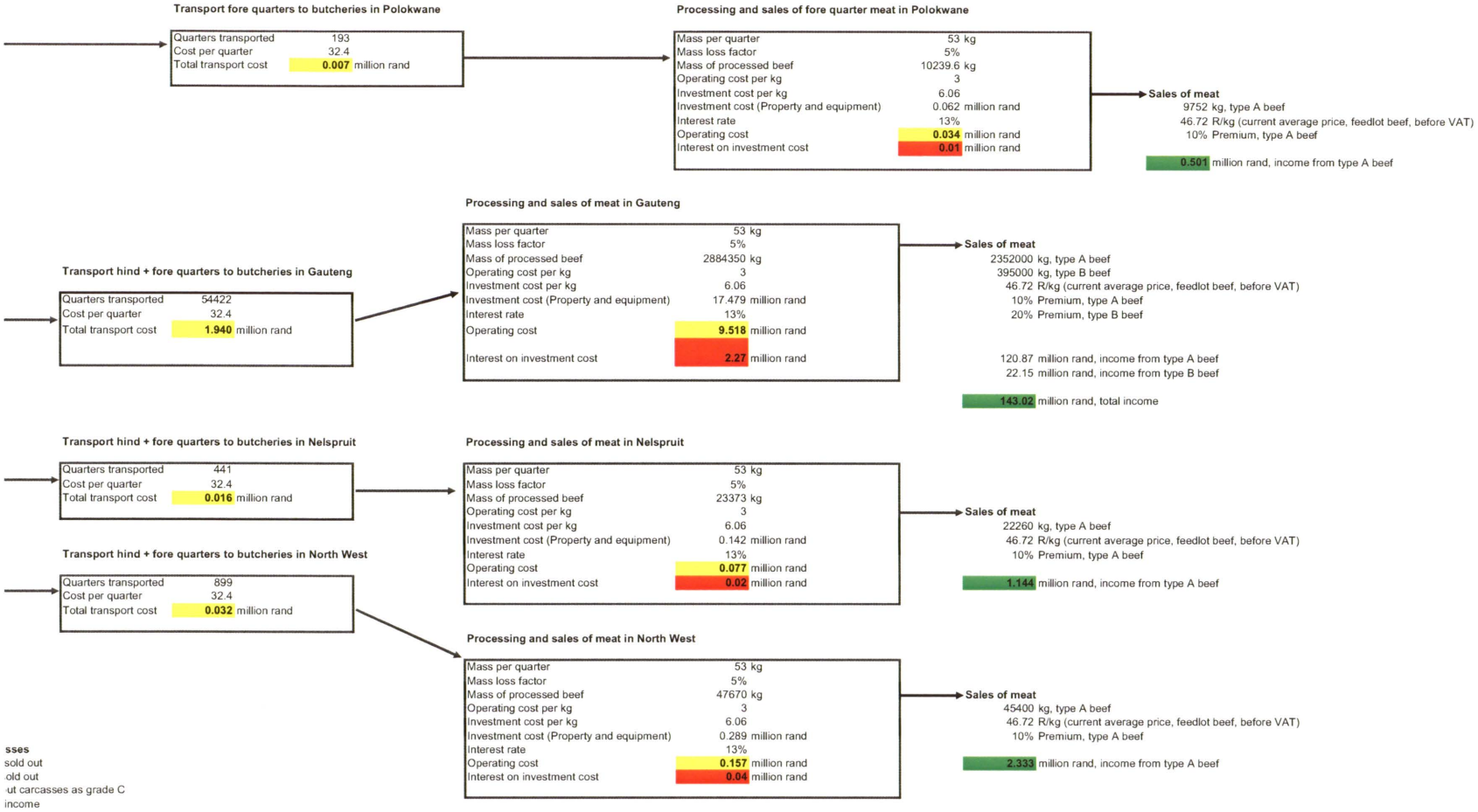

Figure B. 4 – Supply chain process map for Simulation Case 3A, right hand view.
Source: Static model developed by author

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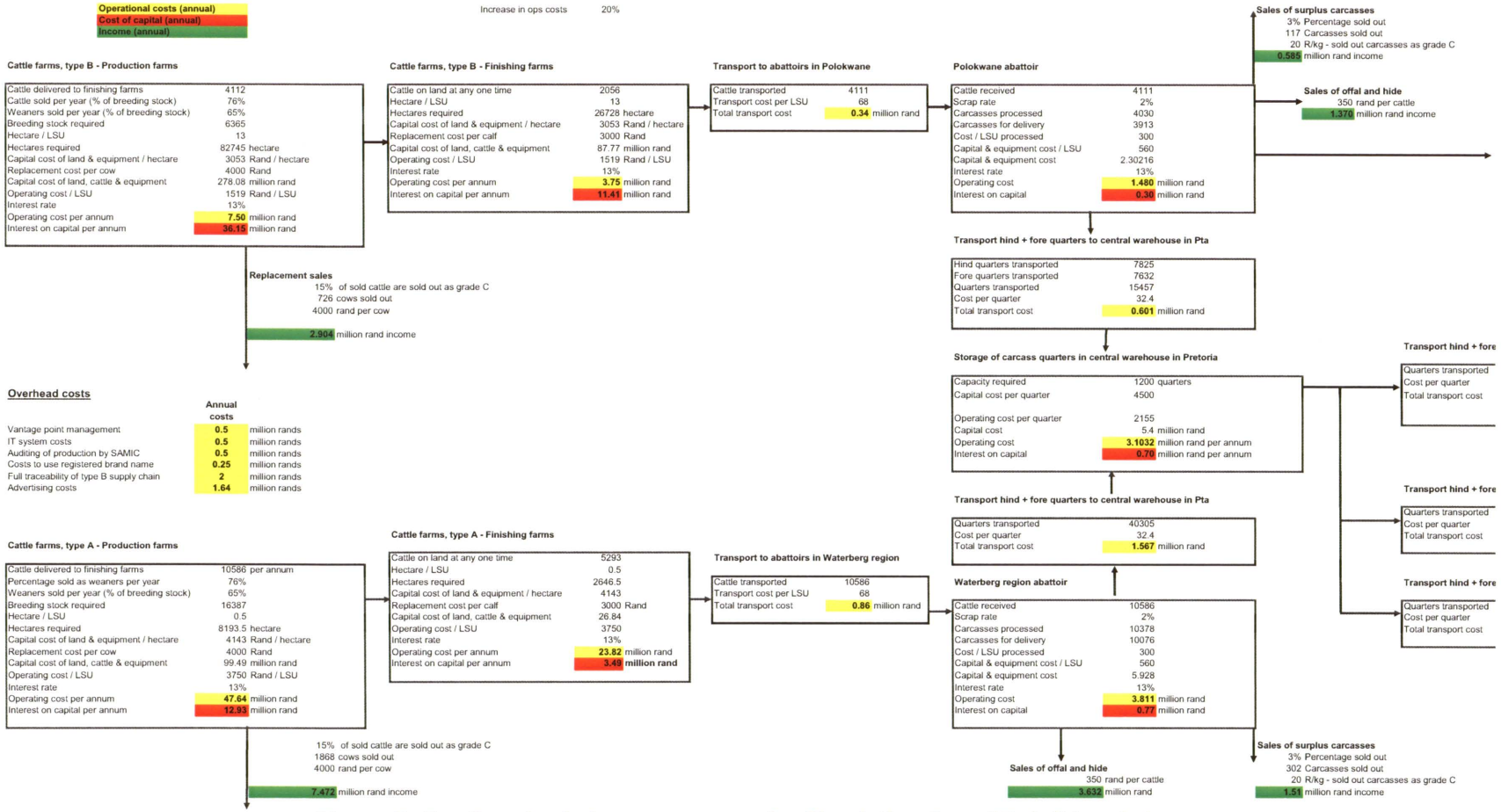

Figure B. 5 – Supply chain process map for Simulation Case 3B, left hand view.

Source: Static model developed by author

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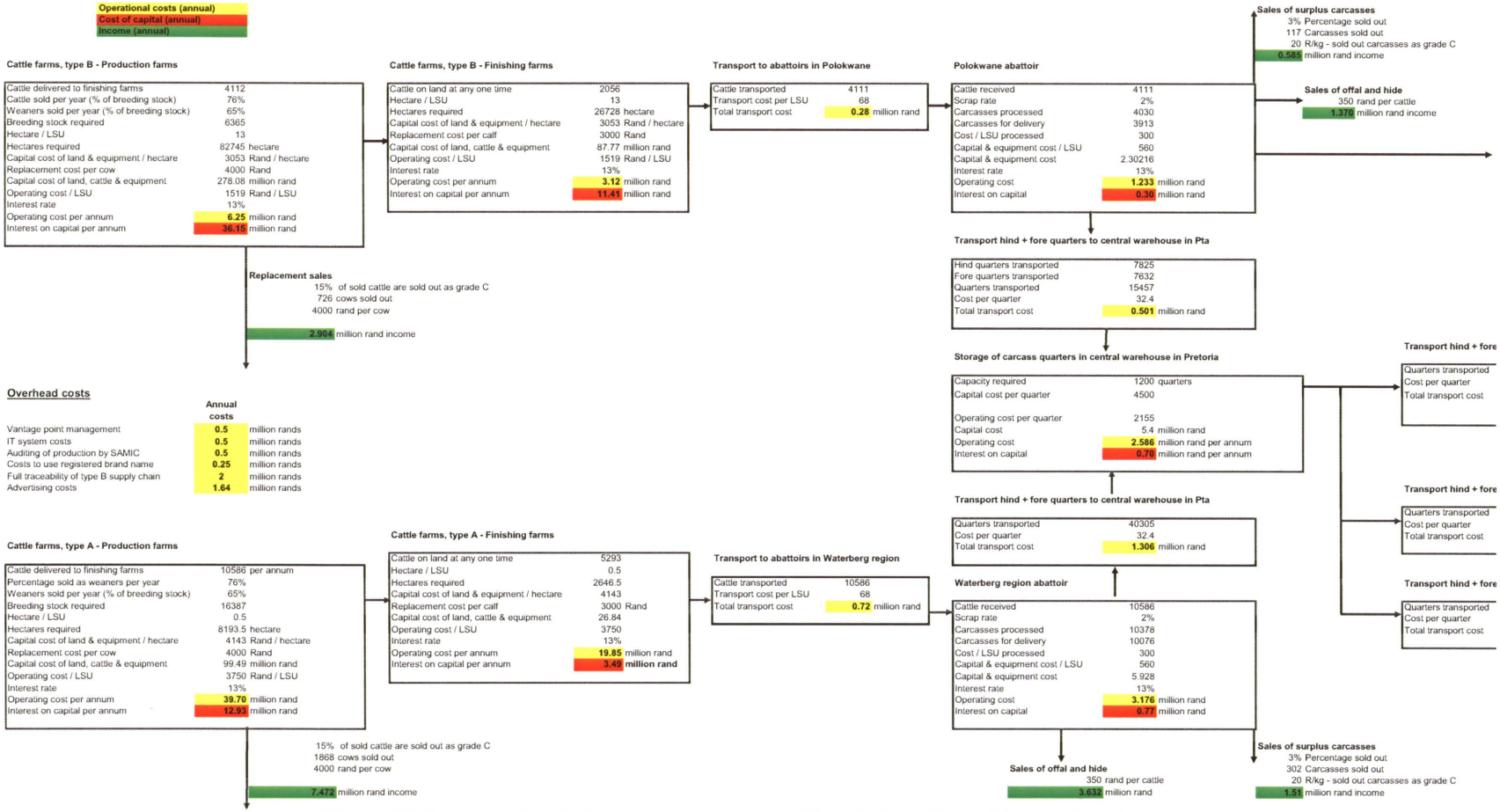

Figure B. 7 – Supply chain process map for Simulation Case 4A, left hand view.

Source: Static model developed by author

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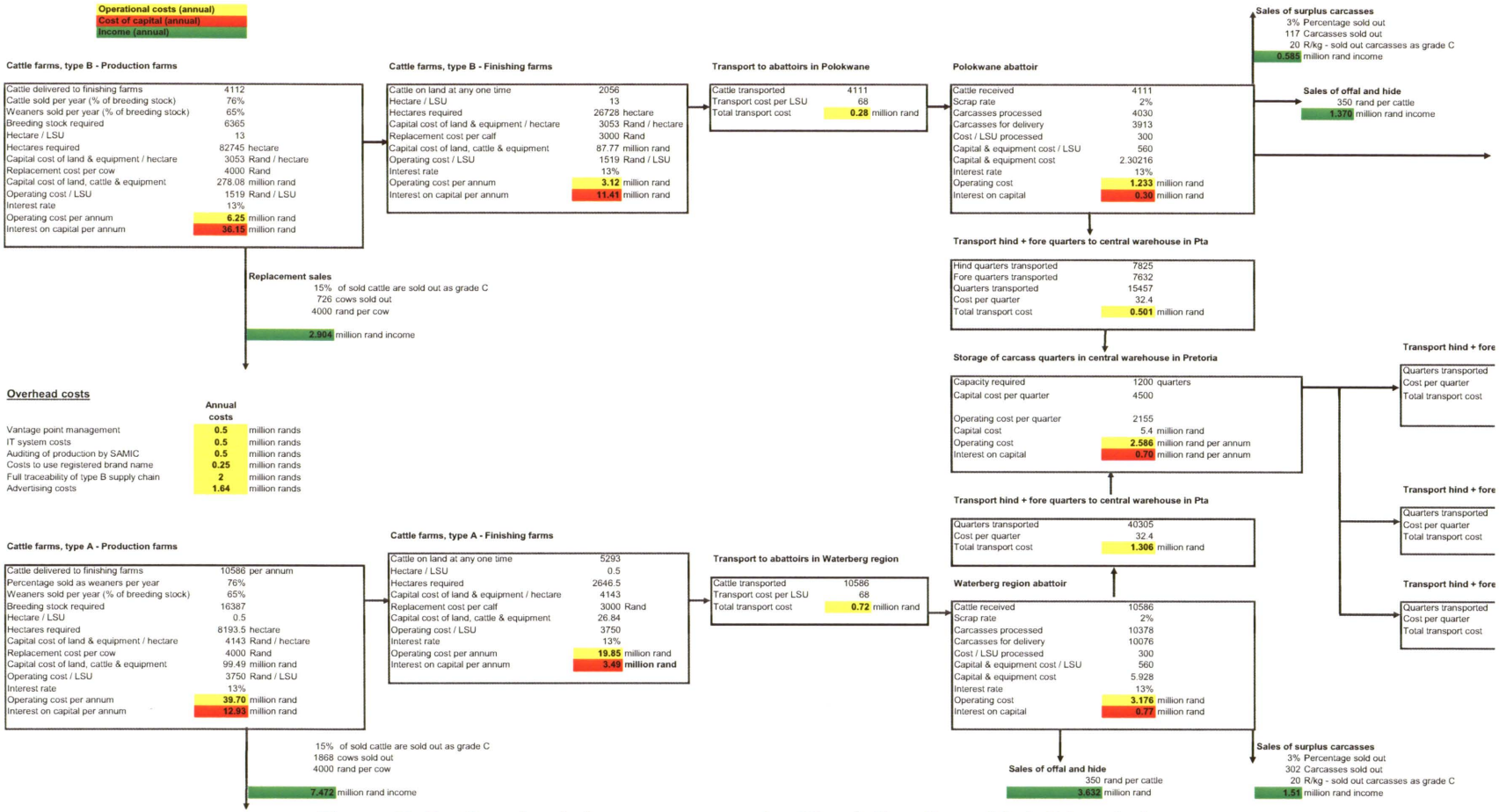

Figure B. 7 – Supply chain process map for Simulation Case 4A, left hand view.

Source: Static model developed by author

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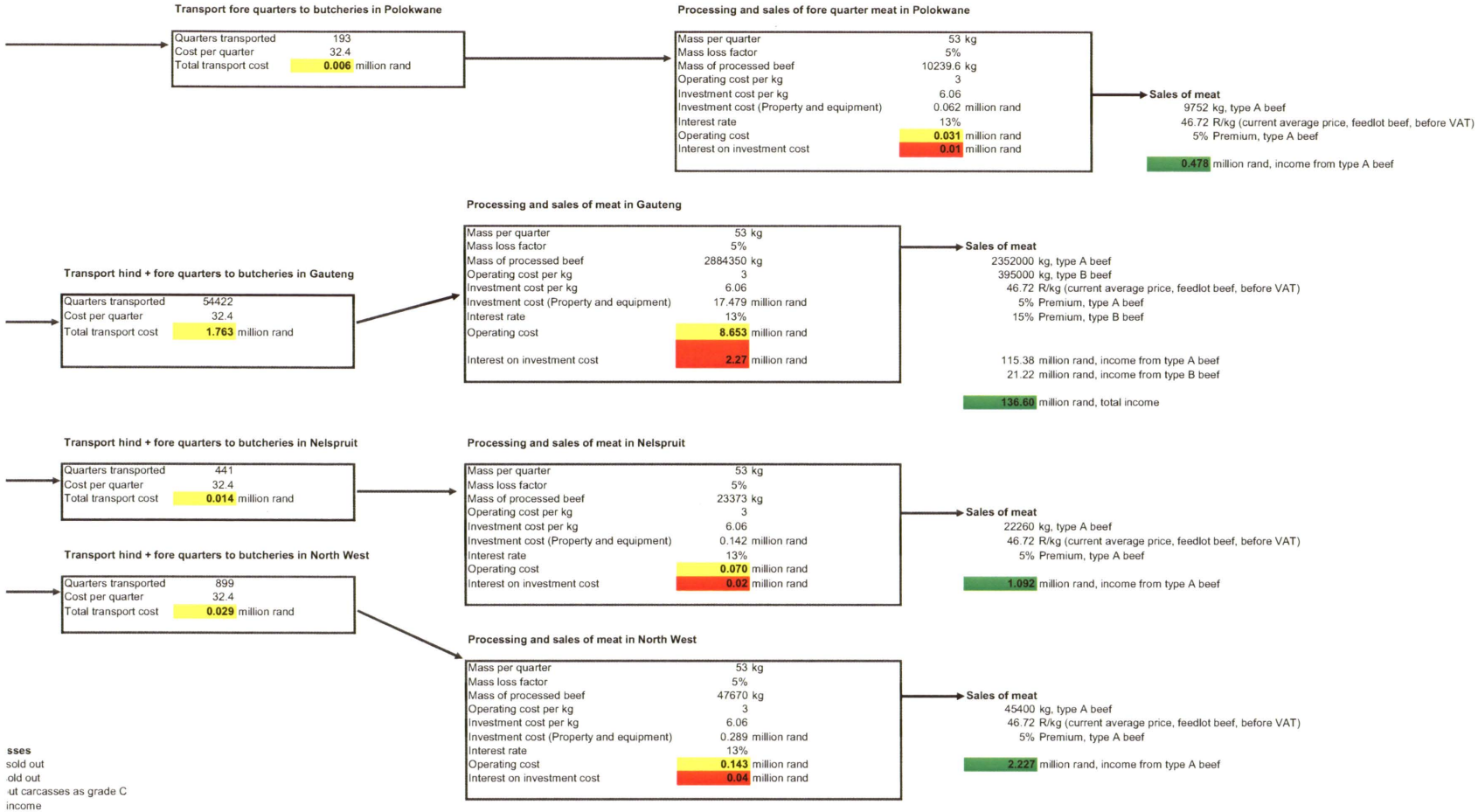

Figure B. 8 – Supply chain process map for Simulation Case 4A, right hand view.
Source: Static model developed by author

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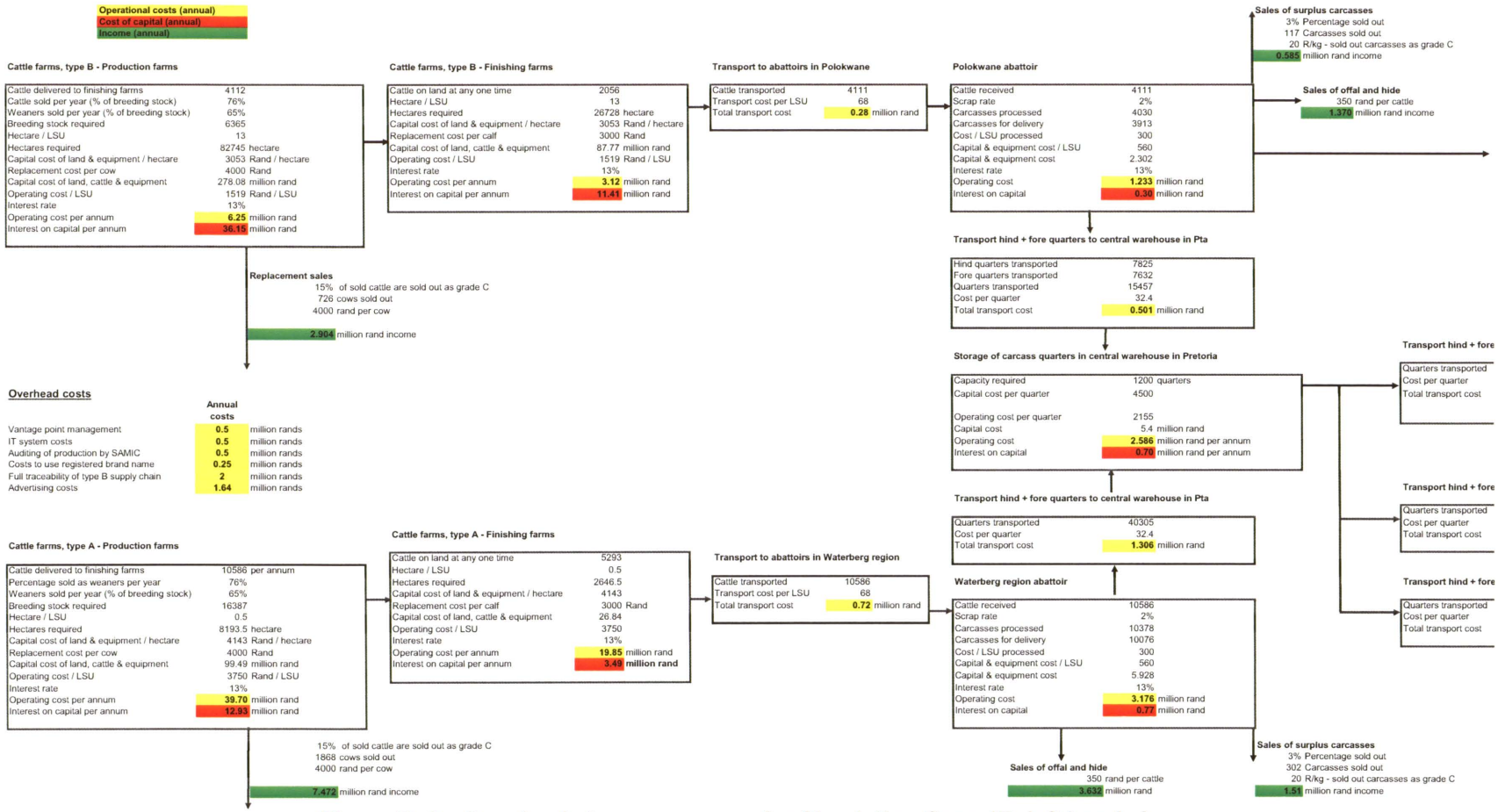

Figure B. 9 – Supply chain process map for Simulation Case 4B, left hand view.

Source: Static model developed by author

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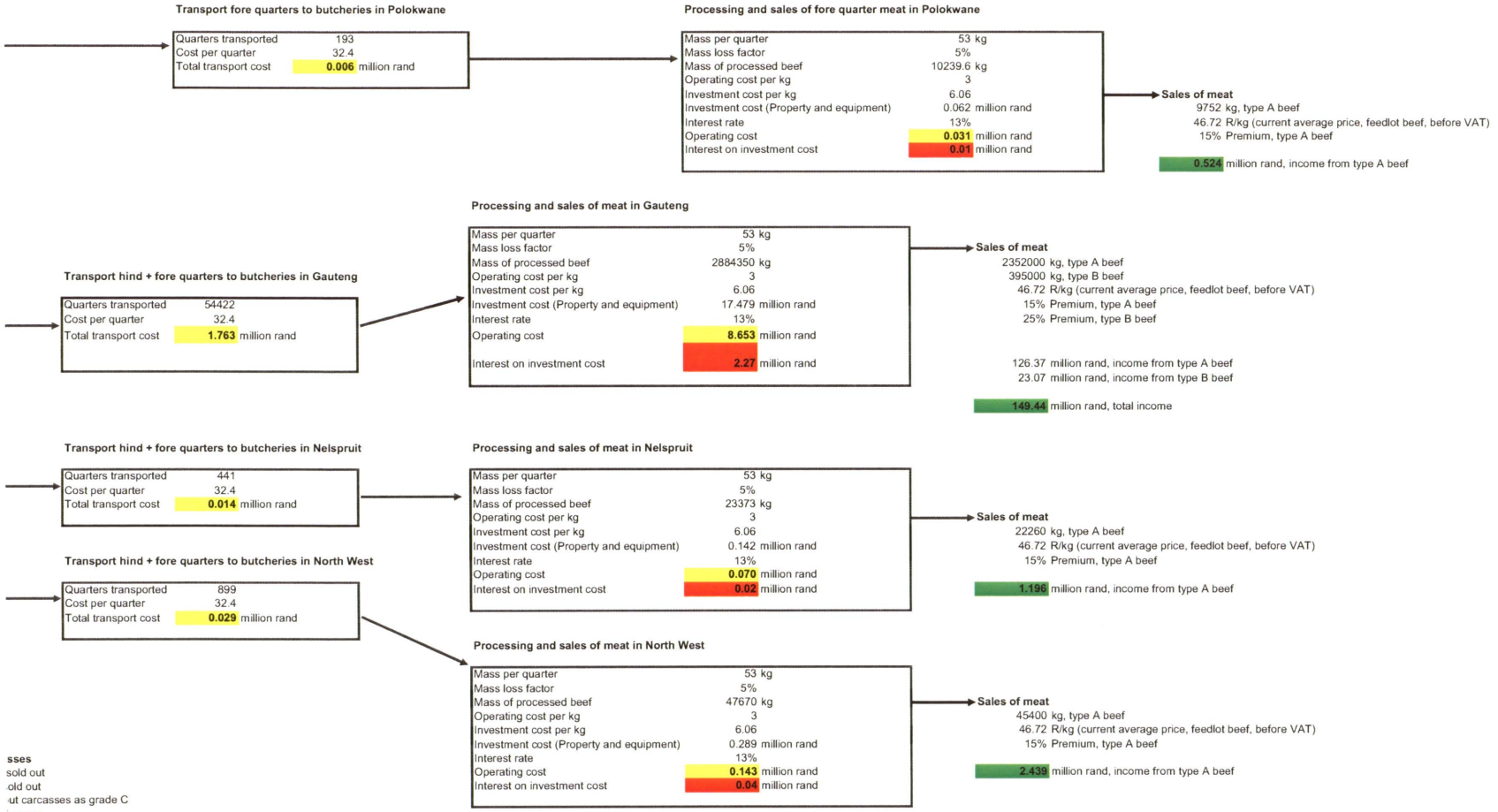

Figure B. 10 – Supply chain process map for Simulation Case 4B, right hand view.

Source: Static model developed by author

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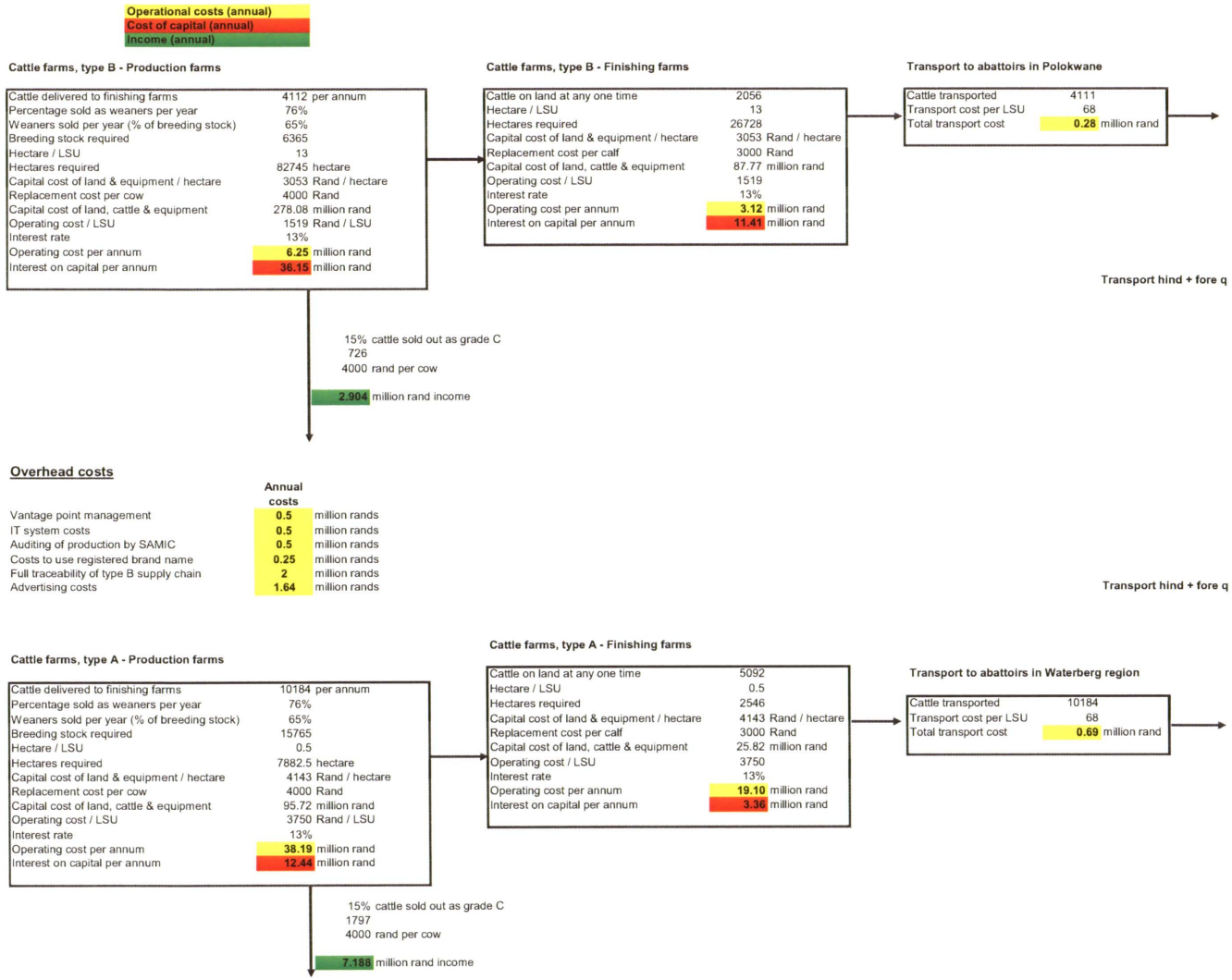

Figure B. 11 – Supply chain process map for Simulation Case 5, left hand view.
Source: Static model developed by author

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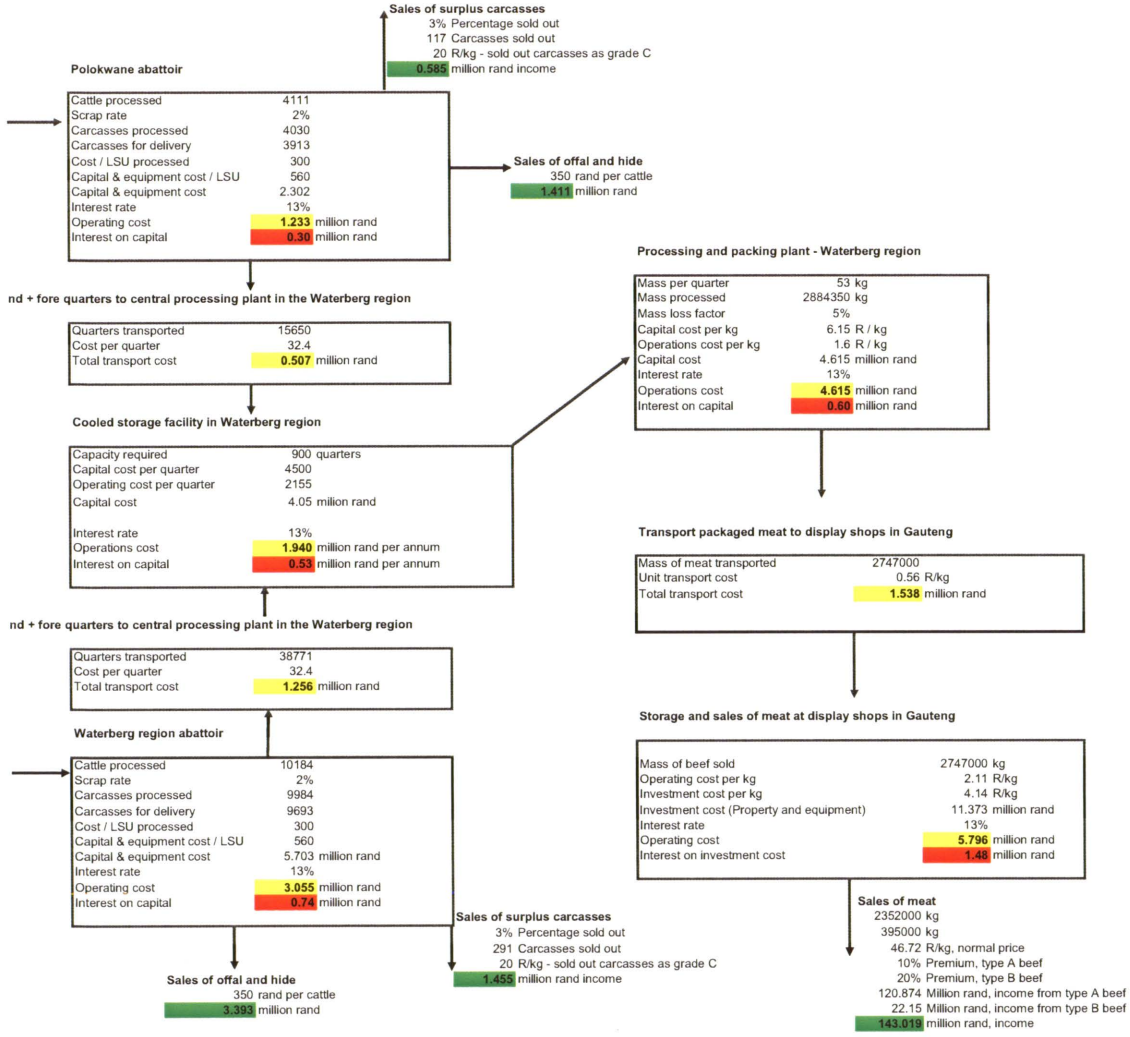

Figure B. 12 – Supply chain process map for Simulation Case 5, right hand view.
Source: Static model developed by author

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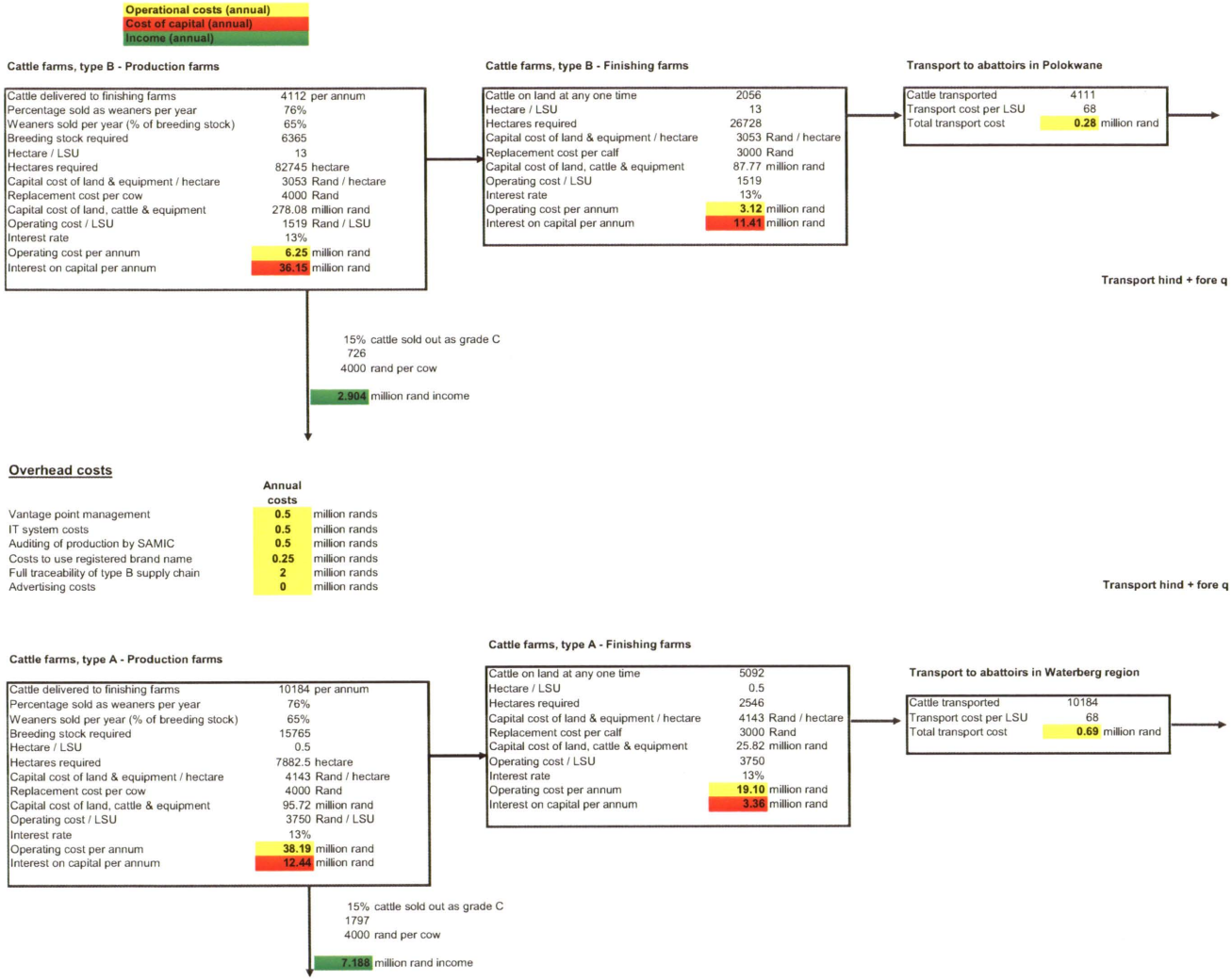

Figure B. 13 – Supply chain process map for Simulation Case 6, left hand view.
Source: Static model developed by author

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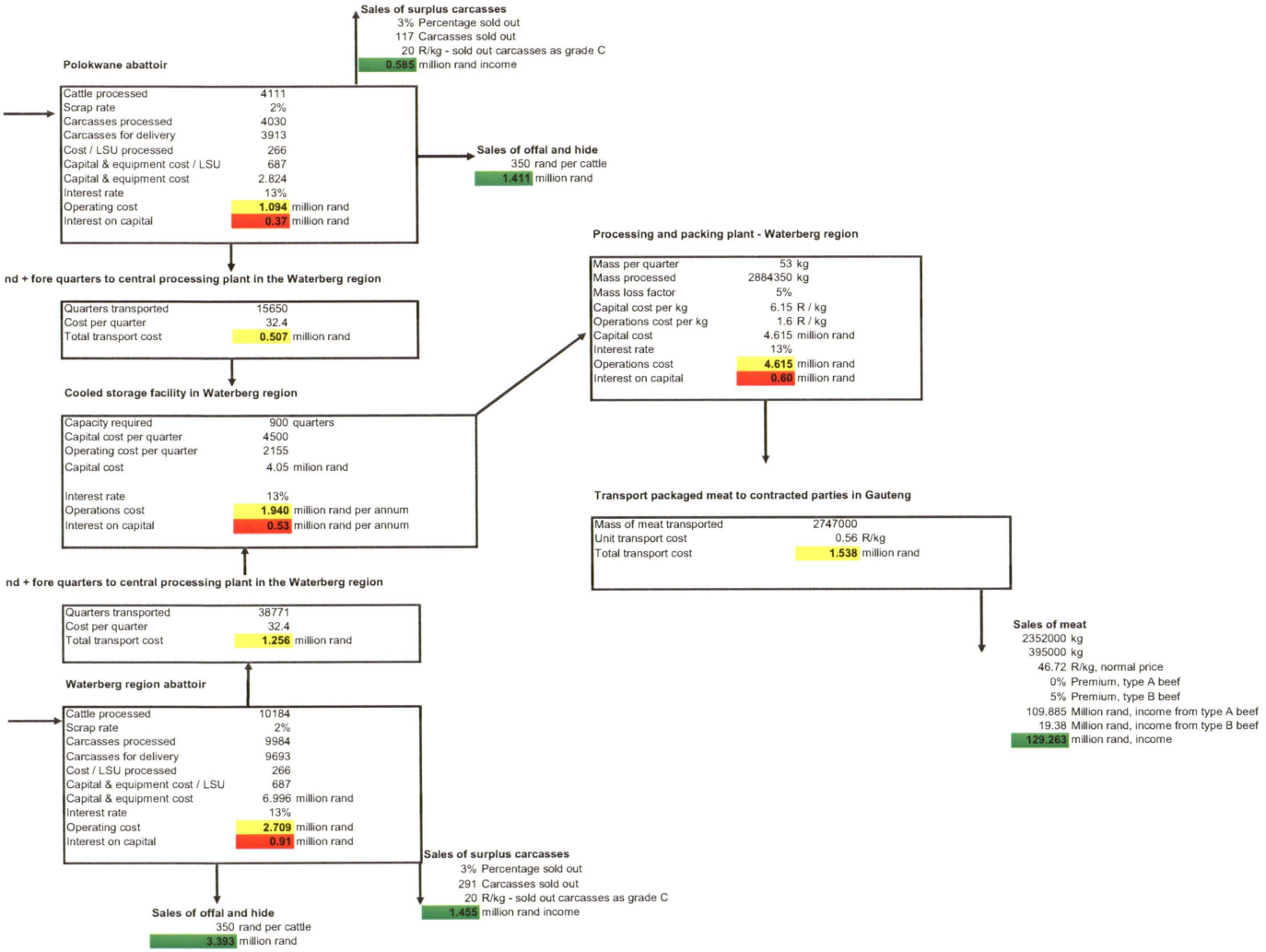

Figure B. 14– Supply chain process map for Simulation Case 6, right hand view.
Source: Static model developed by author

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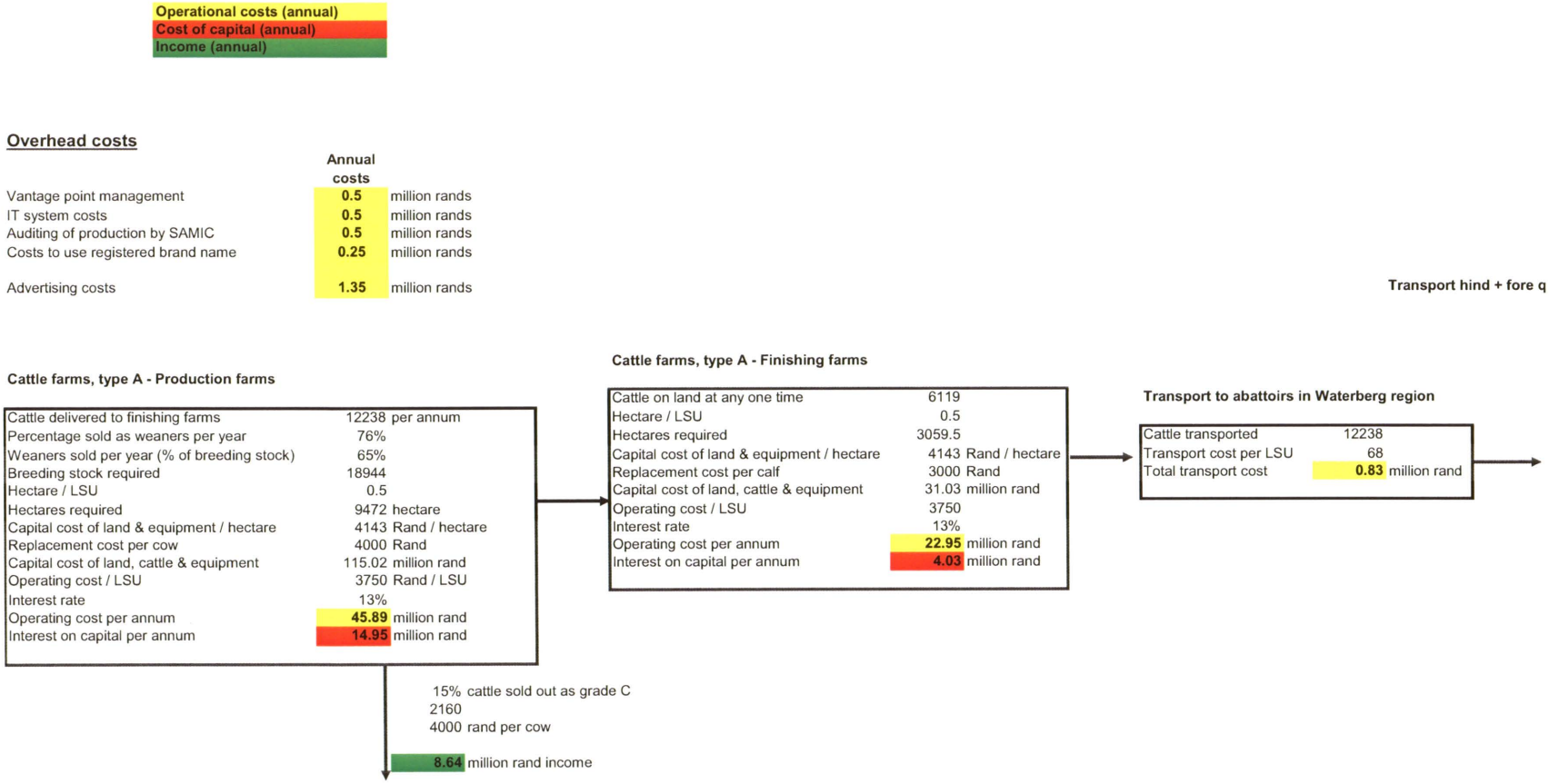

Figure B. 15 – Supply chain process map for Simulation Case 7, left hand view.
Source: Static model developed by author

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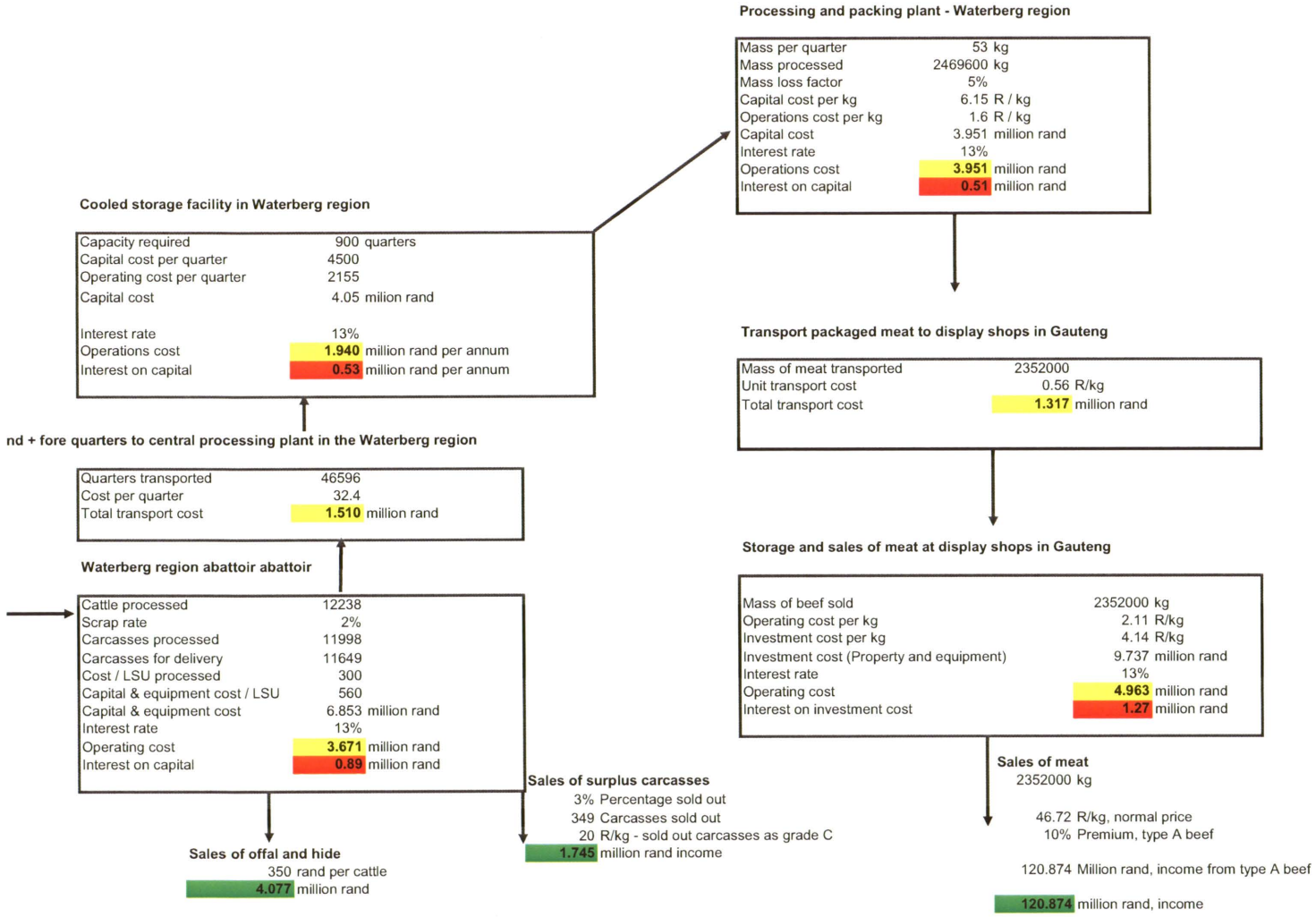

Figure B. 16 – Supply chain process map for Simulation Case 7, right hand view.
Source: Static model developed by author

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