

**A FINANCIAL EVALUATION OF RFID TECHNOLOGY IN
SHEEP FEEDLOTS**

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DECLARATION

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TABLE OF CONTENTS

DECLARATION.....	i
ACKNOWLEDGEMENTS	ii
TABLE OF CONTENTS	iii
LIST OF TABLES.....	vi
LIST OF FIGURES.....	vii
APPENDICES	viii
LIST OF ABBREVIATIONS AND ACRONYMS	ix
ABSTRACT	xi
CHAPTER 1: INTRODUCTION	1
1.1 BACKGROUND AND MOTIVATION	1
1.2 PROBLEM STATEMENT AND AIM.....	2
1.2.1 PROBLEM STATEMENT	2
1.2.2 AIM OF THE STUDY	3
1.3 LAYOUT OF THE STUDY	3
CHAPTER 2: LITERATURE REVIEW	5
2.1 INTRODUCTION.....	5
2.2 SOUTH AFRICAN SHEEP INDUSTRY	5
2.2.1 SHEEP HISTORY IN SOUTH AFRICA	5
2.2.2 CURRENT SHEEP INDUSTRY	6
2.2.3 SHEEP FEEDLOTS IN SOUTH AFRICA	7
2.2.4 MAIZE (FEED) PRICE IN SOUTH AFRICA.....	7
2.3 RELEVANCE OF THE SHEEP INDUSTRY TO THE SOUTH AFRICAN ECONOMY	8
2.4 INVESTMENT OPTIONS TO INCREASE PROFITABILITY IN FEEDLOTS.....	13
2.4.1 FEEDING SYSTEMS	14
2.4.2 GROWTH HORMONES.....	14
2.4.3 MANAGEMENT	15
2.4.4 TECHNOLOGY	17
2.5 FEEDLOT FACTORS INFLUENCING FEEDLOT PROFIT	19
2.5.1 ECONOMIC FACTORS	19
2.5.2 FINANCIAL FACTORS	21

2.5.3 PRODUCTION FACTORS.....	23
2.6 FINANCIAL ANALYSIS TECHNIQUES.....	25
2.7 SUMMARY OF CHAPTER.....	29
CHAPTER 3: RESEARCH METHODOLOGY	31
3.1 INTRODUCTION.....	31
3.2 STUDY AREA AND DATA COLLECTION.....	31
3.3 ASSUMPTIONS	32
3.4 DATA PROCESSING AND ANALYSIS	37
3.4.1 DETERMINING THE CAPITAL OUTLAY	38
3.4.2 FACTORS AFFECTING CAPITAL OUTLAY	38
3.4.3 DETERMINING THE SAVINGS.....	39
3.4.4 PRACTICES APPLIED TO REACH OBJECTIVES	42
3.4.5 SELECTION PROCESS	42
3.4.6 CALCULATIONS OF FINANCIAL INDICATORS	45
3.5 FINANCIAL ANALYSIS TECHNIQUES	45
3.5.1 THE SIMPLE PAYBACK PERIOD.....	46
3.5.2 THE RETURN ON INVESTMENT METHOD.....	47
3.5.3 NET PRESENT VALUE METHOD	48
3.5.4 INTERNAL RATE OF RETURN METHOD	48
3.6 SUMMARY OF CHAPTER.....	49
CHAPTER 4: RESEARCH RESULTS	50
4.1 INTRODUCTION.....	50
4.2 SUMMARY OF STATISTICS.....	50
4.3 JOINT DATA RESULTS FROM FEEDLOT	51
4.4 RESULTS FOR SCENARIO 1 – DRAFTING OF NON-PERFORMERS.....	53
4.4.1 EFFECT OF ANIMAL DRAFTING ON FEEDLOT PROFIT.....	53
4.4.2 SENSITIVITY ANALYSIS.....	54
4.5 RESULTS FOR SCENARIO 2 – IDENTIFYING TOP SUPPLIERS	58
4.5.2 RESULTS OF SUPPLIER AND ANIMAL DRAFTING	59
4.6 FINANCIAL ANALYSIS.....	60
4.6.1 RESULTS OF FINANCIAL MODEL – SCENARIO 1	61

4.6.2 RESULTS OF FINANCIAL MODEL – SCENARIO 2.....	62
4.7 EVALUATION OF FINANCIAL MODELS	64
4.8 SUMMARY OF DISCUSSION	64
CHAPTER 5: CONCLUSION AND RECOMMENDATIONS.....	66
5.1 INTRODUCTION.....	66
5.2 MEETING THE AIM OF THE STUDY.....	66
5.2.1 DETERMINING THE FINANCIAL VIABILITY OF A RFID SYSTEM	66
5.2.2 OBSERVATIONS FROM THE STUDY.....	68
5.3 LIMITATIONS OF THE STUDY	69
5.4 RECOMMENDATIONS.....	70
5.5 SUGGESTIONS FOR FURTHER RESEARCH.....	70
REFERENCES.....	72

LIST OF TABLES

Table 2.1: Effects of zilpaterol chlorhydrate supplementation on feedlot lambs.....	15
Table 2.2: Minimum wages for employees in the farm worker sector.....	23
Table 2.3: Eskom Ruraflex tariff for 2017/2018	25
Table 3.1: Total veterinary costs.....	34
Table 3.2: Capital investment cost on a 7 500-head sheep feedlot.....	38
Table 3.3: Observed benefit categories in using RFID systems.....	40
Table 3.4: Visual explanation of drafting methodology	43
Table 4.1: Batch A, B and C summary of results	50
Table 4.2: Production averages of sample population.....	51
Table 4.3: Input cost averages of sample population	52
Table 4.4: Revenue averages of sample population	52
Table 4.5: Feedlot gross profit/year	53
Table 4.6: Sensitivity analysis of feed price/t.....	54
Table 4.7: Sensitivity analysis of meat price/kg	55
Table 4.8: Sensitivity analysis of ADG (g/day).....	56
Table 4.9: Sensitivity analysis of FCR	57
Table 4.10: Supplier data ranked in descending order according to gross profit/head	59
Table 4.11: Feedlot gross profit/year with current suppliers.....	60
Table 4.12: Feedlot gross profit/year from top 66.6% of suppliers' lambs.....	60
Table 4.13: System and financial inputs of the RFID system	61
Table 4.14: Cash flow of feedlot without drafted animals	61
Table 4.15: Financial indicators for Scenario 1.....	62
Table 4.16: Cash flow of feedlot without drafted suppliers and animals.....	63
Table 4.17: Financial indicators without drafted suppliers and animals	63
Table 5.1: Financial indicators for Scenario 1	67
Table 5.2: Financial indicators for Scenario 2.....	68

LIST OF FIGURES

Figure 2.1: A comparison of the efficiency of major farm livestock in converting crude protein in feed into edible protein in the form of meat, milk and eggs (protein deficiency).....	9
Figure 2.2: South African meat consumption per capita from 1970-2011	10
Figure 2.3: South African meat consumption – 2026 vs. 2014-2016 base period.....	11
Figure 2.4: The gross value of mutton production in South Africa.....	12
Figure 2.5: Production vs. consumption of mutton in South Africa.....	12
Figure 2.6: Prime interest rate, 2007 to 2017	20
Figure 2.7: Weekly meat prices (A2/3).....	22
Figure 3.1: Formulating the benefits of implementing RFID technology in sheep feedlots	41
Figure 3.2: Description of practices applied to achieve objectives	42
Figure 4.1: Feedlot profit vs. percentage culled according to ADG	58

APPENDICES

Appendix A1: Scenario 1 – Cash flow calculations.....82

Appendix B1: Scenario 2 – Cash flow calculations.....83

Appendix C1: Summary of suppliers.....84

LIST OF ABBREVIATIONS AND ACRONYMS

ADG	Average Daily Gain
Apps	Applications
AVG	Average
BFAP	Bureau for Food and Agriculture Policy
c	Cent
CEC	Crop Estimates Committee
CFO	Chief Financial Officer
CIF	Cost Insurance and Freight
cm	Centimetre
DAFF	Department of Agriculture, Forestry and Fisheries
DM	Dry matter
EID	Electronic identification
EST	Estimate
FCR	Feed Conversion Ratio
g	Gram
GPS	Global Positioning System
HP	Horsepower
IRR	Internal Rate of Return
ISO	International Standards Organization
kg	Kilogram
kW	Kilowatt
kWh	Kilowatt-hours
L	Litre
LM	Longissimus Muscle

LW	Live weight
m	Metre
MHz	Megahertz
MIS	Management information systems
NPV	Net Present Value
PAT	Precision Agriculture Technology
PBP	Payback Period
PPI	Producer Price Index
R	Rand
RFID	Radio Frequency Identification
RPO	Red Meat Producer's Organisation
ROI	Return On Investment
SARS	South African Revenue Service
SPP	Simple Payback Period
UAV	Unmanned Autonomous Vehicles
UGV	Unmanned Ground Vehicles
UAV	Unmanned Aerial Vehicles
VAT	Value-Added Tax
VISN	Veterans Integrated Service Network
V	Volts
Zilmax	Zilpaterol chlorhydrate

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ABSTRACT

Agricultural producers are confronted with a wide range of challenges early in the third millennium. Population growth and changing consumption patterns will cause world food, feed and biofuel requirements to more than double by 2050 and will require sustainable solutions. South Africa also faces these challenges with the population predicted to increase further, and the demand for mutton is predicted to increase by 5% between 2016 and 2026. This poses a challenge to the local sheep producers in South Africa to meet the growing demand.

The implementation of digital systems will greatly improve the way producers use the resources available to produce the required amount of food for the growing population. Precision agriculture technology is paving the way for South African agricultural producers to manage inputs more precisely. One of the latest additions to the South African precision farming tools is the use of radio frequency identification (RFID) systems.

However, the available precision farming research investigating these technologies and systems has mostly focused on the crop industry. Limited precision research has focused on the livestock industry, especially on the South African sheep feedlot industry. The aim of this study was to evaluate the financial viability of implementing RFID technology in a South African sheep feedlot.

This study is based on data that was collected from a sheep feedlot in the Western Cape province of South Africa. The sample size comprised 508 lambs supplied from 35 different producers.

In the study, two feedlot scenarios were created to investigate the monetary benefit that a RFID system would hold for an investor. The analysis of the first scenario was done by drafting (removing) non-performing animals from the feedlot on day 14 to determine how much feed can be saved by culling them early on in the feedlot cycle. The analysis of the second scenario was done by identifying the worst third of the suppliers after a one-year test period based on the performance of their lambs. From year 2 onwards, the feedlot only bought lambs from the top two-thirds of suppliers. Besides only purchasing lambs from these top suppliers, the RFID system continued drafting non-performing animals based on their performance up to day 14 in the feedlot. By drafting the non-performing animals and suppliers, a monetary value could be placed upon the management benefits provided by the system to the investor. The cash flows of each of the scenarios were measured with selected financial indicators to determine the viability of investing in a RFID system.

The financial indicators indicated that investment in a RFID system should only be considered under the condition of scenario 2, in which the information gathered by the system was used to identify better performing suppliers of lambs. If the only purpose of investing in a RFID system is to draft animals during their feedlot period, it should not be considered.

The model developed in this study contributes to the knowledge base of the South African sheep feedlot industry. It is a convenient instrument to assist sheep feedlots in decision making regarding an investment in RFID technology.

Key terms: RFID, Feedlot, Meat, Traceability, Technology, Producer, Capital, Investment, Lamb

CHAPTER 1: INTRODUCTION

1.1 BACKGROUND AND MOTIVATION

Modern-day agriculture has been confronted with a wide range of challenges at the beginning of the third millennium. The task is to meet the growing demand for food, pet food, feed, fibre, fuel, industrial products and products based on 'functional' plants, and improved agricultural production systems. By 2050, world food, feed and biofuel requirements will more than double as a result of population growth and dramatically changing consumption patterns. Sustainable solutions are what is required (Kern, 2015). South Africa's population was estimated at 55.9 million in 2016 and is predicted to increase to 59.8 million by 2026 (Department of Agriculture, Forestry and Fisheries, 2017a; Bureau for Food and Agricultural Policy, 2017). The demand for mutton is projected to increase by 5% from 2016 to 2026; this poses a serious threat to the local sheep producers in South Africa to meet the growing demand (BFAP, 2017).

The implementation of digital systems such as smartphones, applications, global positioning systems (GPS), sensors, radio frequency identification (RFID) systems, robotics, drones, unmanned ground vehicles (UGVs), unmanned aerial vehicles (UAVs) and others will greatly improve the way producers use the resources available to produce the required amount of food for the growing population (Fan *et al.*, 2012).

Precision agriculture technology (PAT) is paving the way for South African agricultural producers to fulfil this demand by allowing more precise management of inputs. This precision production farming system involves the sampling, mapping, analysis and management of specific focus areas. Improvements in these areas allow for further improvement with regard to using resources more efficiently than competitors (Watson, 2005).

With technology constantly improving, it is of the utmost importance to make full use of the technology available in our society so as to be more productive in less time with fewer resources. Today, software, management information technology (MIS) and internet applications allow users to perform a great variety of functions using a smartphone. According to research done by Statista (2017), 2.89 billion applications were downloaded in 2011 for all industries. Download figures for paid mobile applications are projected to reach 352.9 billion by 2021 (Statista, 2017).

Special applications have been introduced by the John Deere Company that offer guidance systems and field and crop management programs, together with information and logistics systems. The agrochemical company, Monsanto invented a "Climate Basic App", covering soil, weather and crop data on the field to ensure better production choices. Bayer Crop Science in Germany provides applications for the determination of 232 pests and 218 diseases of different crops, with recommendations for relevant control measures. The chemical producing company, BASF has implemented a "Weed ID Application" in the UK to identify 140 weed species, as well as a "Cereal

Disease ID Application” to offer fast and easy mobile access to information on 36 cereal diseases, including information about symptoms, hosts, life cycle, importance and control options (Kern, 2015).

Farmers can benefit from recordkeeping applications such as Pasturemap, Agronote and the iLivestock app that allows record keeping for pasture grazing, livestock stock, serial numbers and check book registers to improve management in the farming business and give the farmer more options to make informed business decisions. Management information systems (MIS) allow farmers to access their information quickly and easily (Hammer, Pfeifer, Staiger, Adrion, Gallmann & Jungbluth, 2017). Another application, the scientific calculator, with its ability to calculate quantities of inputs, square footage of fields or the impact of grain costs on break-evens, is another simple example, yet it is an essential tool for the modern-day farmer (Rose *et al.*, 2016).

In the near future, unmanned ground vehicles (UGV) and drones will help the modern-day farmer and development services to enhance agricultural production systems. The agricultural robot market is projected to reach \$US 16.3 billion by 2020 (ReportsnReports, 2014).

One of the latest additions to the South African precision farming tools is the use of RFID systems. RFID has been available for decades, but it has only recently been implemented in agriculture. This technology refers to a small, electronic chip (animal) and an antenna (monitor). The chip typically is capable of carrying 2 000 bytes of data or less and uses a high radio frequency of 13.56 MHz (Roberti & Violino, 2005). The application of this technology, especially in the livestock industry, is a new field in which this technology is being utilised. With this technology, the farmer is able to evaluate his/her animals individually on a daily basis. The RFID systems available on the market today are capable of weighing and drafting the animals automatically with RFID tags (RFID-Experts, 2017). This leads to a decrease in time used, precision in data collection, better management decisions, reduced labour costs, better genetics and an increase in efficiency and accuracy, resulting in a higher profit margin (Hammer *et al.*, 2017).

1.2 PROBLEM STATEMENT AND AIM

1.2.1 PROBLEM STATEMENT

The livestock industry is an important role player in the South African economy because low-quality biomass can be converted by livestock into high-quality food (Schwartz, 2005). South Africa is a net importer of mutton from countries such as Namibia and Botswana to supply local demand (Fox, 2014). With the projected increase in the population, more mutton will be required, placing more pressure on the global and South African food security statuses and resources. Precision production practices are one of the options that allows increase technical efficiency. Investing in precision production practices will increase production costs, placing greater pressure on producers to remain profitable. A financial analysis of such an investment is critical to determine whether the technological investment will repay the financial investment.

What is worrisome is that limited research has focused on the investment in precision production practices in the livestock industry, in which precision methods such as RFID systems have been investigated. The available precision farming research investigating these systems has mostly focused on the crop industry (Hammer, *et al.*, 2017). Limited precision research has focused on the livestock industry, especially on South African sheep feedlot conditions (Hammer *et al.*, 2017). With the country's population increasing rapidly, producers will have to produce more food with fewer resources and with better results to remain feasible (DAFF, 2017a). Improvement in production systems should be one of the goals of the modern livestock farmer in order to ensure sustainable and productive use of limited resources in the farming industry (Kern, 2015). To the knowledge of the author, no such study has been done under South African sheep feedlot conditions, thus no basis can be provided to producers as yet regarding whether they should invest in this technology. Such a study would provide sheep feedlots in South Africa with accurate information on which they could base their decisions.

1.2.2 AIM OF THE STUDY

The aim of this study was to evaluate the financial viability of implementing RFID technology in a South African sheep feedlot.

To reach this objective, a financial model will be developed to determine the financial viability of implementing RFID technology in a South African sheep feedlot. This model will then be applied to two sheep feedlot scenarios to determine which management decisions should be taken based on the information provided from the RFID system. Also, it will be determined whether sheep feedlots should invest in this type of technology.

1.3 LAYOUT OF THE STUDY

The layout of the study is as follows:

Chapter 1 presents the background to, the introduction and problem statement of the study, and discusses the aim of the study.

Chapter 2 provides a detailed view on investment options for the feedlot investor, the background of the sheep industry, why sheep production is important to the South African economy, and factors influencing feedlot profit. Furthermore, the literature on financial tools will be reviewed to evaluate the investment in RFID technology for sheep feedlots.

The research methodology is explained in Chapter 3, as well as the data-collection process, description of the area and assumptions made. The analysis and processing of the data obtained are explained in detail in Chapter 3.

The results of the study are analysed in Chapter 4. The results from the financial models developed for the feedlot are evaluated and analysed by applying the NPV, IRR, SPP and ROI tools in the two feedlot scenarios.

The findings and conclusions of the study are discussed in Chapter 5. Recommendations are made regarding further research in this field and the limitations of the study are discussed.

CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

Profitability is defined by the Oxford Dictionary (2017) as the degree to which a business or activity yields profit or financial gain. Another definition of profitability is as to whether or not something makes money or has a benefit (Your Dictionary, 2017). Not all of the profitability-enhancing methods in agriculture are measurable in a practical sense. In this chapter, a number of methods are discussed, along with RFID technology in livestock practices, which are discussed in greater detail. The relevance of the sheep industry is also presented shortly to indicate the importance of investing in profitability-enhancing methods or machinery. The focus of the chapter then moves to the different capital-budgeting techniques to evaluate RFID technology, and how these techniques are applied for profitability enhancement.

2.2 SOUTH AFRICAN SHEEP INDUSTRY

2.2.1 SHEEP HISTORY IN SOUTH AFRICA

According to Fairman (2015), discoverers who visited the Cape before 1652, when Jan van Riebeeck set foot to shore, had seen sheep on the shores of the coastline and managed to obtain a few sheep from the local citizens (Hottentots) for their crew members. South Africa's first sheep originated in Southern Asia, and moved down to Egypt and then migrated down through Africa until they finally reached the Cape. The first sheep to arrive in South Africa were extremely large, had excellent meat and had huge tails. The sheep did not have wool on their backs, but were covered with hair (Fairman, 2015). Sheep trading between the Hottentots and the Dutch resulted in an unfair contest, because once the Dutch bought the sheep from the Hottentots in return for beads and copper, the Hottentots found ways to steal the newly bought sheep from the Dutch. The angered Dutch then decided to import sheep from Holland and breed them in and around the Cape area. The first of these sheep, called milk sheep, entered the Cape in 1657 (Fairman, 2015).

One of the most successful breeds in South Africa is the Dorper, specially bred for the more arid areas of the country. Dorpers are renowned for their carcass quality, special taste and fat distribution (Dorper Sheep Breeders' Society of South Africa [DORPERSA], 2015). As the saying goes: "Breeders breed Dorpers for more money in their pocket." Other dual-purpose mutton and wool breeds in South Africa are Vandoor, Damara, Meatmaster, Van Rooy, Ill de France, Suffolk, Merino, Dohne-Merino, SAVM and Dormer (DAFF, 2012).

2.2.2 CURRENT SHEEP INDUSTRY

Today, sheep farming is being practised throughout the whole of South Africa, but it is focused mainly in the more arid areas of the country, i.e. the Eastern, Western and Northern Cape, the Free State and Mpumalanga. There are approximately 8 000 commercial and 5 800 communal sheep farms in South Africa, farming with approximately 23.1 million sheep (DAFF, 2017b). Eighty-six percent of the country's sheep are produced in the Western, Eastern and Northern Cape and Free State collectively. The remaining 14% are produced in the five other provinces, with Limpopo province producing the fewest sheep, at 1%, and the Eastern Cape producing the largest number of sheep, at 29.5% of the total sheep production in 2010 (DAFF, 2017b). Domestic livestock figures declined from November 2013 until 2017, mainly due to stock theft and predation (DAFF, 2017b). Between 2001 and 2010, the average gross production value of mutton per year was R2.59 billion (DAFF, 2012). The gross value of mutton production in South Africa decreased from 2005 to 2006, and then increased continuously from 2006 until 2014 (DAFF, 2015).

Mutton is very popular among meat consumers in South Africa because of its unique taste and texture. It is viewed as a luxury food, while the meat in itself is argued to be a luxury food within the lower income consumer group (Delpont, Louw, Davids, Vermeulen & Meyer, 2017). During 2007, mutton consumption reached a peak of 188 million kilograms in South Africa (DAFF, 2015). On average, 145 million kilograms of mutton meat is consumed annually in South Africa (DAFF, 2012). Mutton is generally consumed by South Africa's medium-and high-income consumer groups. With the low-income class representing the largest share of the South African population, cheaper meats such as chicken and pork will always be strong competitors for mutton (Delpont *et al.*, 2017).

According to the DAFF (2017a), the consumption of mutton per capita was recorded at 3.5 kg per person in 2015/2016, 0.1 kg less than in 2014/2015. The most mutton consumed per capita in the last 40 years was 7.3 kg per person in 1984/1985 (DAFF, 2017a). A total of 5 249 257 sheep were slaughtered during 2016, and 4 780 740 in 2017. December was the month with the greatest number of sheep slaughtered in 2015, 2016 and 2017, mainly because of the high demand for sheep meat during the annual end-of-the-year holidays (Red Meat Levy Admin, 2018).

The mutton niche markets are positioned for the high-income class that wants a more sophisticated product, but these are not limited only to the high-income market. One of the recent additions to the niche markets of South Africa is Karoo lamb. When people think of the Karoo they have a calm and tranquil image of semi-arid scenery. There is no crop production in this area, and farmers produce wool and mutton on natural grazing. The grazing capacity of the Karoo is 6 to 8 ha per small stock unit (Kirsten *et al.*, 2012). The Karoo mutton brand has developed a good reputation over the last years for its quality attributes, such as the unique Karoo bush taste and flavour of the meat. This unique taste, along with the semi-arid, nostalgic production area of the Karoo, gives it a powerful identity for a strong marketing opportunity (Kirsten *et al.*, 2012). According to Kirsten *et al.* (2012) 60.5% of consumers purchased normal non-Karoo mutton once or twice per week, versus 14.6% of

consumers who purchased Karoo lamb once or twice per week. This gives us an indication of the market share that Karoo lamb has in South Africa.

2.2.3 SHEEP FEEDLOTS IN SOUTH AFRICA

South Africa has 8 000 commercial sheep farmers, along with 5 800 communal sheep farmers, and a sheep stock of 23 108 340 head (DAFF, 2017b). Feedlots usually finish weaned lambs of 25 to 28 kg to a slaughter weight of 45 to 50 kg (live weight). Adding weight to the carcass is how feedlots add value and generate profit. Feed additives are added to facilitate adaption, if necessary. The adaption phase can make or break the growth rate of the lamb (Ilisiu, Dărăban, Gabi-Neacsu, Ilişiu & Rahmann, 2010).

According to Van der Westhuizen (2010), the more productive breeds in terms of only meat production for feedlots in South Africa are the Merino, Dorper and SA Mutton Merino. Crossbreeds such as Merino, Dohne or SA Mutton Merino crossed with Dormer or Ile de France rams have indicated to have a better average daily gain (ADG) in feedlots (Fourie, Kirton & Jury, 1970). Lambs are normally weaned at ± 70 to 90 days at a weight of ± 22 kg to 26 kg. After the weaning process, the best ewe lambs are generally selected for replacement ewes ($\pm 20\%$); ram lambs and leftover ewe lambs are then marketed to the feedlot for finishing. Lambs in the feedlot are fed for approximately 48 days until they reach slaughter weight.

Feedlot managers usually have a procedure to follow on arrival of the lambs (Louw, 2017):

1. Tag all sheep with an electronic identification (EID) and update information on the database for administrative and traceability purposes.
2. Dip and dose animals for good animal health.
3. Vaccinate sheep for disease control.
4. Weigh sheep for management purposes.
5. Put animals in batches according to pen size and special characteristics.

2.2.4 MAIZE (FEED) PRICE IN SOUTH AFRICA

The profit in a feedlot is determined mainly by the price relationship between the feed price, slaughter price and purchase price. The feed price relies heavily on what the maize price trades at, because up to 70% of feedlot rations contain maize meal (DAFF, 2015). Therefore, the maize price will be a determining factor for this study.

The domestic price of maize in South Africa is usually determined by the relative size of the domestic maize crop, the world price for maize, stock levels and the exchange rate (Kirsten, Geyser, Jooste Van Schalkwyk, 2009). Globally, maize prices have remained weak following another record harvest in the 2016/2017 season (BFAP, 2017). American maize does not have the exact same financial worth for the local buyer in South Africa. "The price of maize on different markets must be adjusted to take account of the differences in transport costs, exchange rates, etc., in order to make comparisons possible" (Kirsten *et al.*, 2009). The adjusted price that Kirsten *et al.* (2009) refer to is normally called

the reference price. The reference price is calculated with respect to a reference point located in South Africa. Randfontein is the commonly used reference point for commodities trading on Safex in the case of maize.

To calculate the reference price, the international commodity price needs to be recalculated to include all the costs involved to get the maize to Durban. This recalculated price is called the Cost Insurance and Freight (CIF) price. The CIF price is adjusted to the South African rand by using the current exchange rate. Once all the above-mentioned calculations have been made, the transport costs, off-loading, interest and losses are added to give the price per ton at the reference point.

The first production estimates of the Crop Estimates Committee (CEC) (DAFF, 2017a) showed that there could potentially be a record crop harvest for the 2016/2017 production season (yellow and white maize). The CEC indicated that yellow and white maize production was set to increase by 79% from the crop harvested in 2016. A total of 7.7 million tons were harvested in the 2015/2016 season, and the estimated crop harvest for 2017 was 13.9 million tons. An effect of the large estimated maize harvest could be that future maize prices drop even further and a reality of surplus maize in South Africa will be likely to happen. This gives the country a big opportunity for exports. The favourable production conditions were the main factor for the maize surpluses, and not the number of hectares planted. The number of hectares planted is reduced by crop farmers in South Africa.

Maize prices decreased from January 2017, mainly because a big crop harvest was estimated for the 2016/2017 season. The reports were indeed backed up by superb rainfall and excellent crop conditions in the biggest crop-producing parts of South Africa. The 2015/2016 drought played a major role in why maize prices were exceptionally high before that period. Almost half the production tonnage was lost because of the drought (DAFF, 2017a). During the 2015/2016 season, the area planted was 2 213 000 ha and, in 2016/2017, the area expanded by 875 000 ha due to the attractive maize price (DAFF, 2017a). According to Safex (2017), the yellow maize price for 2016 peaked at R4 130/ton in January and normalised after the drought. The yellow maize price dropped by 31% from 18 July 2016 to 4 March 2017 (Safex, 2017).

2.3 RELEVANCE OF THE SHEEP INDUSTRY TO THE SOUTH AFRICAN ECONOMY

Farmers want new ways to improve their efficiency in order to increase their profitability in supplying the demand for meat (Luo & Hu, 2015). This study is important to supply sheep farmers and feedlots with relevant decision-making information on evaluating new investment options to improve efficiency and profitability by implementing the latest technology. According to Meissner, Scholtz and Palmer (2013), South African livestock production contributes significantly to food security, but it is a topic of public debate because of a lack of knowledge and wrong information. It is thus important to understand the correct information and why it is so important to the economy to make valuable decisions according to changing markets.

Cheaper meats, such as chicken and pork, are very competitive in the commodity market because of their R/kg value (BFAP, 2017). As a result of this, the market share of mutton becomes heavily reduced. The dilemma that sheep farmers have is that they need to increase their profitability with a fixed market price, because farmers are price takers instead of price makers (Ray, 2015).

Figure 2.1 shows a comparison of the efficiency of major farm livestock in converting crude protein in feed into edible protein in the form of meat, milk and eggs. It is important to recognise the differences so as to understand that sheep production has the potential to genetically improve a great deal more (Gillespie & Flanders, 2010). It is then the producer's job to use the scientifically proven methods and research available to improve characteristics such as the feed conversion ratio and the efficiency of converting crude protein into edible protein.

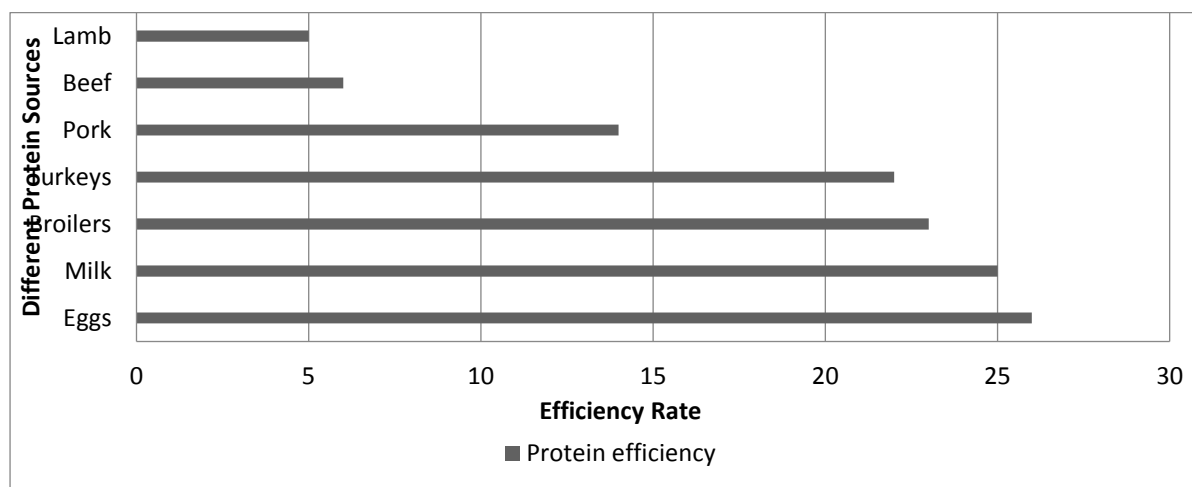


Figure 2.1: A comparison of the efficiency of major farm livestock in converting crude protein in feed into edible protein in the form of meat, milk and eggs (protein efficiency)

Source: Gillespie & Flanders (2010)

Livestock is an important contributor to the South African economy, since low-quality biomass can be converted into high-quality food by livestock (Figure 2.1) and animal-origin food is steadily increasing (Schwartz, 2005). Figure 2.1 shows that lamb have the lowest efficiency rate to convert crude protein into edible protein. This gives us an indication that there is still potential for an improvement in terms of the genetic abilities of feedlot lambs. The farmer can make sure that the right rams mate with the right ewes in order to improve feed conversion rates that may improve the above figure. RFID technology can play an important part in selection, particularly in the form of the automatic drafter that can weigh and draft lambs individually according to individual data.

South Africa's average consumption of mutton is 145 000 000 kilograms per year, and that demand needs to be supplied by domestic sheep farmers (DAFF, 2012). However, the gap between production and consumption is narrowing, thus South Africa is moving towards self-sufficiency with regard to sheep meat (DAFF, 2015). South Africa's meat consumption per capita, the predictions of the Red Meat Producers Organisation (RPO) and how much meat South African farmers need to supply in order to satisfy the demand of South Africa are all important numbers to South African

farmers who want to position their businesses to accommodate future economic changes within the livestock industry. The South African consumption per capita from 1970 to 2011 can be seen in Figure 2.2 below.

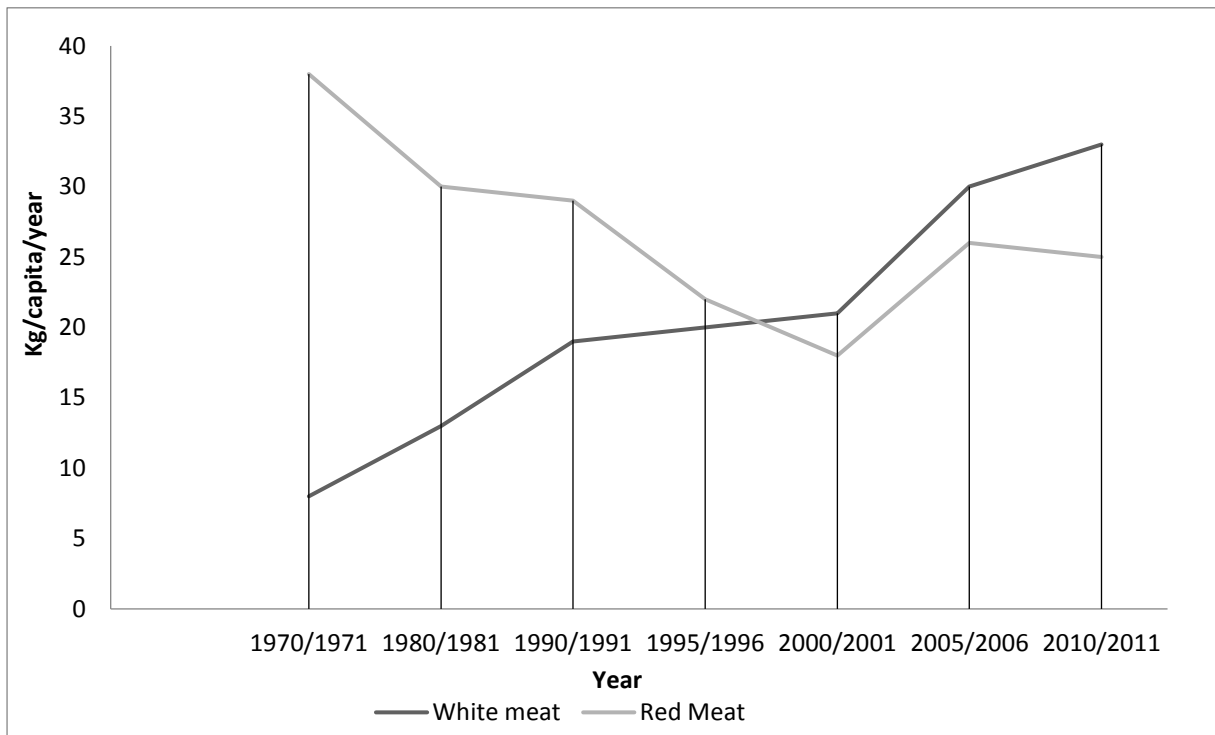


Figure 2.2: South African meat consumption per capita from 1970-2011

Source: Schönfeldt (2011)

As shown in Figure 2.2, red meat consumption has declined rapidly from 1970 to 2001. The popularity of white meat is increasing and is likely to expand by an annual average of 1.9% over a ten-year period, most likely due to the growing numbers of the middle class and their preference of white meats such as chicken (BFAP, 2017; Schönfeldt, 2011; thinkb4ublink, 2008). The middle class of South Africa represents 52.4% of the total population and earns about 27% of the total income (BFAP, 2017).

A prediction for meat consumption is important to the farmer in order to position his business according to what will happen in the near future (BFAP, 2017). The meat consumptions predictions for 2023 are shown in Figure 2.3.

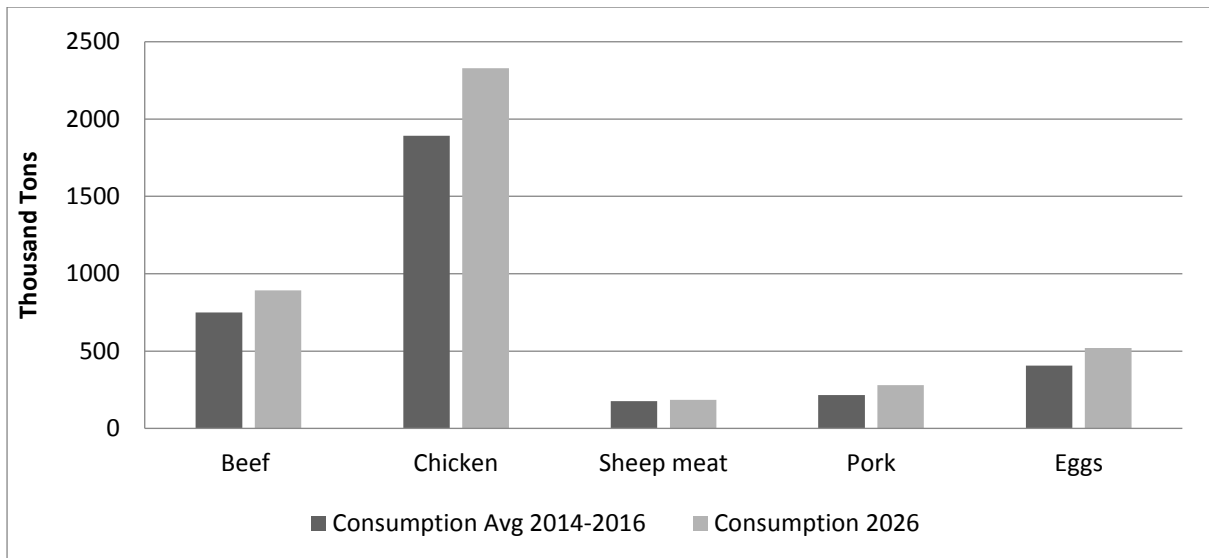


Figure 2.3: South African meat consumption – 2026 vs. 2014-2016 base period

Source: Schutte (2015)

According to BFAP (2017), beef consumption in 2026 will be 19% more than the average of 2014 to 2016 (Figure 2.3). The most significant predicted increase in the different meat types from 2016 to 2026 is the 23% increase in chicken consumption. The reason for this rapid increase is probably, as above mentioned, the rise in the middle class and the fact that chicken is a much cheaper source of meat in R/kg than lamb or mutton (Holmes, 2013). Expenditure on fish and meat by the South African lower-middle class increased by 18% from 2010/2011 to 2014/2015 (BFAP, 2017). The consumption of sheep meat in 2023 is predicted to be only 5% more than the 2014-2016 average, which is a big concern in terms of demand for sheep producers in South Africa (Schutte, 2015). The construction of a positive image for red meat production will be a challenge for the mutton producer in South Africa. RFID technology may aid the process of making mutton more marketable in terms of what the added benefits, such as traceability and food security, can offer the consumer.

The gross value of mutton production from 2002 to 2014 can be seen in Figure 2.4 below.



Figure 2.4: The gross value of mutton production in South Africa

Source: DAFF (2015)

The gross value of mutton production increased from 2005 to 2014 (Figure 2.4), but the steady increase between 2005 and 2014 was largely due to inflation (DAFF, 2015). The average gross production value over the last ten years, from 2004 to 2014, amounted to R33.8 billion/year (DAFF, 2015).

The level of local production and consumption of mutton is important to the industry because it will indicate how much meat must be imported. The production and consumption of mutton in South Africa is illustrated in Figure 2.5.

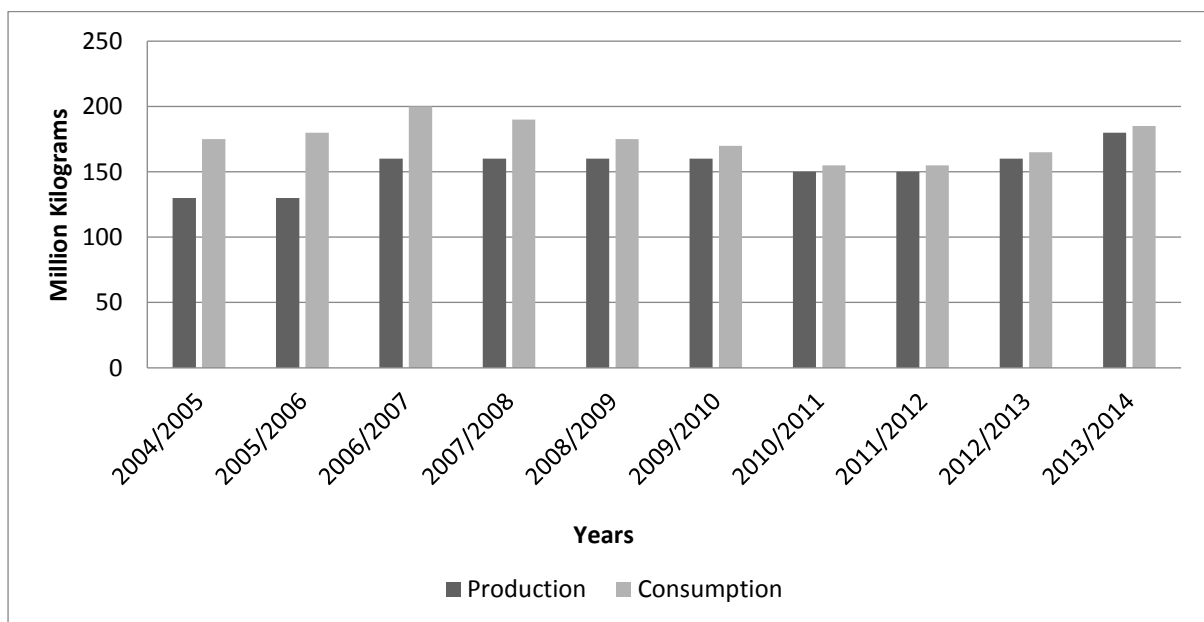


Figure 2.5: Production vs. consumption of mutton in South Africa

Source: DAFF (2015)

Figure 2.5 shows that more mutton is being consumed annually than what was produced locally from 2004 to 2014 (DAFF, 2015). Declining sheep numbers and quick population growth in South Africa have led to an increase in demand for, and subsequent shortages in the supply of, mutton (BFAP, 2017; DAFF, 2015). The most mutton that was produced was 183 million kilograms in 2014. This was still not enough to meet the demand for mutton in the country. The difference is made up of imports of mutton into South Africa, mostly from Australia and Namibia (this includes live animals). Mutton imports from overseas constitute 3.5% of the overall local number of sheep slaughtered between April 2016 and April 2017 (Cornelius, 2017). In South Africa, mutton has an import tariff of 27%, which means that South African sheep farming is ineffective and not competitive against a country such as Australia. In other words, Australian farmers are 27% more profitable in their farming practices than South African farmers (Cornelius, 2017). With their mutton produced under the same extensive conditions and without government support, Australian farmers are certainly more effective at this point in time. South African sheep-farming practices need to improve, but the question is how this can be done? RFID technology has been used in Australia since 1999 with great effect (on sheep, and on goats since 2009), so this is maybe just one reason why South African farmers need to invest in management technology (Souza-Monteiro & Caswell, 2004). A list of options to improve profitability is discussed in Chapter 2.4 in more detail.

As seen in Figure 2.5, South Africa is a net importer of mutton, and most of South Africa's mutton imports are from Namibia, Australia and Botswana (Fox, 2014). The largest quantity of mutton meat consumed was in 2007, at 203 million kilograms (DAFF, 2015). South Africa will always have the need for sheep farmers/feedlots to produce the meat demand of the country, although Goddard and Glance (1989) found that there is no "correct" or "final" demand relationship for a specific commodity market and thus the monitoring of a specific commodity market is an ongoing procedure.

It can be observed in the above-mentioned figures (2.1 to 2.5) that the South African agricultural industry is a vital sector in South Africa's socio-economic development, but the future of this sector depends on important issues, such as shifts in the global economy, population growth, changes in consumer needs, climate change and skills shortages (DAFF, 2014). It is the responsibility of farmers to keep on producing good-quality meat, in spite of being dependent on many issues that are out of their control. As the famous scientist Charles Darwin said: "It is not the strongest of the species that survives, or the most intelligent; it is the one most adaptable to change" (Proykova, 2004, p.2). How will the sheep farmer of today change his farming practices to survive in an already competitive market tomorrow?

2.4 INVESTMENT OPTIONS TO INCREASE PROFITABILITY IN FEEDLOTS

Because South African sheep producers are price takers and do not receive government support, the sheep industry will always be under pressure to produce effectively (Van Heerden, 2014). Sheep producers have to be on the lookout for other methods of improving their product or the process of

production to stay competitive in the commodity-orientated market. An external method of increasing profitability in a sheep feedlot is to invest in new technologies that can take a producer to the next level of production (Nudell, Hughes & Faller, 1998). In this section, different investment options for a sheep feedlot are discussed. RFID technology in livestock practices will be discussed in greater detail in the latter parts of this section.

2.4.1 FEEDING SYSTEMS

One option is to invest in automatic mixers to blend the different required feeds together into a complete ration. Automatic systems transport the feed to the troughs through pipes when empty. This method makes sure all the animals' nutrient requirements are met on a daily basis. The 'total mixed ratio' has been found to increase animal health, decrease labour costs and give farmers better flexibility regarding feed ingredients (Seager, 2014). All the above-mentioned factors together increase farm profitability by reducing feed costs. According to Seager (2014), feed costs make up 60% of total farm costs.

2.4.2 GROWTH HORMONES

Supplementation with Zilmax (zilpaterol chlorhydrate) is an alternative method to increase profitability in feedlots. According to Merck Animal Health (2017), this non-steroidal growth stimulant improves total body weight gain and feed conversion ratios. The supplier also claims that it improves the meat-fat ratio in the animal by minimising fat deposition. In a study done by Estrada-Angulo *et al.*, (2008), the influence of the level of zilpaterol chlorhydrate supplementation on growth performance and carcass characteristics of feedlot lambs was tested. The researchers tested crossbred male lambs, supplied them with a wheat-based finishing ration for 32 days, and supplemented them with zilpaterol chlorhydrate. Estrada-Angulo *et al.* (2008) state that dry matter (DM) intake, carcass weight, fat thickness and longissimus muscle (LM) area were not affected by the supplementation, although grain efficiency increased by 15.8%, total gain by 17.7%, average daily gain (ADG) by 16%, and carcass dressing percentage by 2.3%.

Table 2.1 indicates that a farmer could make R113.04 more per head with Zilmax supplementation on the average carcass price for 2017. Optimum responses found in lambs supplemented with zilpaterol were with 0.20 mg of zilpaterol/kg of live weight (Estrada-Angulo *et al.*, 2008). In terms of feed ratios, 15.9 mg/kg DM was found to be the optimum feed ratio to show positive effects on carcass traits and growth performance (Mondragón *et al.*, 2010).

Table 2.1: Effects of zilpaterol chlorhydrate supplementation on feedlot lambs

	Lamb Y (without Zilmax supplementation)	Lamb Z (with Zilmax supplementation)
Starting weight (kg)	33.5	33.5
Average daily gain (ADG) (kg)	0.225	0.261
Days in feedlot (days)	32	32
Total gain (kg)	7.2	8.352
End weight (kg)	40.7	41.852
Dressing %	46.5	48.8
Price A2/3 R/kg RPO (2017)	R36.98	R36.98
Total gross earnings R/head	R699.86	R755.27
Difference in gross earnings in R/head with Zilmax supplementation		<u>R55.41</u>

Source: Author's calculations based on Estrada-Angulo *et al.* (2008)

The positive effects of zilpaterol chlorhydrate on lamb performance are in line with what Steinfeld (2003) stated about improving profitability in the sheep industry. According to Steinfeld (2003), the formula for making more profit out of sheep entails lowering the production cost of the marketable product (meat). In fact, this must happen without decreasing the input cost (supplementation, injections, dose and feed costs), but by producing a more marketable product (heavier and more lambs weaned) per hectare by making adjustments to farming practices.

2.4.3 MANAGEMENT

Expert management of a sheep feedlot is non-negotiable to improve productivity and results. It is the investor's duty to do thorough research in terms of his management practices, as this is the basis of the feedlot business. A feedlot is a high-turnover, high-volume, low-margin enterprise, and therefore it needs impeccable management to increase low margins (Jolly & Goers, 2007).

In the next part of this chapter, the following management aspects with regard to sheep feedlots will be discussed: feeding trough size, pen size, water intake, shade and feed rations.

Feeding trough size

The minimum size for the feeding troughs in sheep feedlots is 15 cm/lamb (DAF, 2012). The optimum size for feeding troughs is between 25 and 30 cm/lamb. It is critically important that there is enough space for all the lambs to eat at once (Duddy, Shands, Bell, Hegarty & Casburn, 2016). Troughs with a depth of 20 to 25 cm and a width of 30 cm are ideal for lamb production (Slusser, 2008).

Pen size

According to Slusser (2008), the minimum surface area for each lamb is 5 m². However, he insists that each lamb should have 10 to 20 square meters. Investing in 10 to 20 square metres will reduce the social stress, which in turn will add to the profitability of the feedlot in the long run by producing mutton in a more efficient manner. Stress will inhibit the animal to add meat onto the carcass.

Water intake

The water intake by animals is an extremely important management tool to maximise production in animals. According to Olkowski (2005), 70% of an animal's body weight is water. Schwartz (2005) states that 90% of all molecules in the animal's body are water. Water is used for all the metabolic processes in the body and is crucial for the production of muscle mass. Without water, the animal's weight and feed intake will decrease, resulting in an animal that does not perform well. The more water the animals drink, the more feed they consume – eventually resulting in more profit. It needs to be borne in mind, however, that daily water intake varies enormously, depending on animal activity, environmental temperature and class of livestock, and is significantly influenced by physiological variables. The physiological variables include nutritional status, production parameters, physiological status, age and development stage (Olkowski, 2005). Water intake by ruminants is of utmost importance to produce quality meat.

The three sources that provide water to livestock are drinking water from troughs, metabolic water and water found in feed (Olkowski, 2005). According to Olkowski (2005), lactating ewes need 4.0 to 12.0 L/day, dry ewes need 4.0 to 5.0 L/day, and weaned lambs need 3.5 to 4.0 L/day. De Wet (2015) stated that water troughs should allow 75 cm/100 lambs. It is the work of the producer to invest in efficient water troughs to ensure that ruminants get sufficient water during the day to produce optimally.

Shade

Another practical way to increase production in livestock is to provide sufficient shade for the animals. Hot temperatures affect the animal's bioenergetics and have a decreasing impact on animal well-being and performance (Brown-Brandl, Eigenberg, Nienaber & Hahn, 2005). In a study done on heat stress on feedlot cattle by the University of Nebraska, the implications were rather evident. They took eight crossbred steers, weighing approximately 294 kg each, and put them into one of eight individual pens, in which one or two treatments were applied. The steers' treatments comprised either no shade access or shade access. Daily feed consumption, core body temperature and respiration rate were collected during eight periods, using automated systems, for 37 days. Four categories of the daily maximum temperature humidity index were used for measurement: < 74, < 78, < 84 and > 84. The impact of the shade was seen in all four categories, but the biggest impact was on the < 84 and > 84 categories. Shade decreased core body temperature by 0.6° Celsius and respiration rate by 11.9 breaths/minute during the day, resulting in less energy used. The impact of shade was the biggest in the high-temperature categories (Brown-Brandl *et al.*, 2005).

Feed rations

Feed rations in a feedlot are a critical factor for sheep production. It is a wise decision to invest in quality feed rations from trusted suppliers. A good-quality, well-balanced ration contains the following ingredients (Slusser, 2008):

- Minerals
- Trace elements
- High follow-through protein intake
- Ammonium salts
- High energy content
- Growth stimulants
- Low roughage content
- Necessary buffers
- Vitamins

The quality vs price factor should be managed by the producer to get the most amount of value for the least amount of money.

2.4.4 TECHNOLOGY

Technological aspects consist of mobile applications and RFID technology, and are discussed separately.

Mobile applications (Apps)

The mobile application usage of farmers has increased in recent years. One of the latest additions to the collection of agricultural apps is the mobile application called VetAfrica. The software company, Cojengo, created the app, which enables producers and animal health workers to diagnose illness and to find the correct drugs to treat the disease. This could reduce health costs and improve profitability, especially in feedlots and smallholder farming. Another application that provides useful information to the livestock farmer is the farming instructor app. This application provides online and offline agricultural information to rural communities and their farmers (Seager, 2014).

RFID

Virtually every product on the market has a barcode that contains basic information about the product. As a result of improved identification of a product through barcodes, store owners can keep track of inventory and shoppers can check out faster than ever before. However, despite their advantages, barcodes must be read one at a time and the information they contain is fixed. Barcodes are now being replaced by chips that can be read more easily and come with an improved function to update information automatically (McCathie, 2005). These chips are called RFID, short for radio frequency identification. RFID is defined as "... a system that transmits the identity (in the form of a unique serial number) of an object or person wirelessly, using radio waves" (RFID Journal, 2005). RFID tags

contain a small microchip and a transmitter, but can only be activated by a RFID reader to which the tag returns its signal.

RFID tags are already being used in transport and logistics, and the tags are built into tollgate pass cards and railway passes, while they are also being used on luggage and freight for tracking. Retailers are also integrating RFID tags and readers into their stores. With the price of RFID dropping, other industries are opting for this technology (Schneider, 2003). European research projects are working together with large companies from other sectors to find clever ways to save costs and boost efficiencies with RFID. New uses of RFID are in hospitals. The RFID tag is built into an armband and could contain a unique identification for the patient. Doctors can read the tag and immediately trace the patient's medical history and link it to a database of diseases and medication side effects. This could speed up diagnosis and treatment. RFID can be integrated into almost any everyday object (Schneider, 2003). The need for RFID in livestock practices has arisen to speed up stock taking and improve the management of herds.

RFID technology has been available for almost thirty years, but has only recently achieved popularity in various supply chains (Turri, Smith & Kopp, 2017). RFID technology has also been utilised in the livestock industry for breeding, stock management and disease control. The utilisation of the RFID technology in animal identification has moved to demands for small tags that can be attached to the collar (Finkenzeller, 1999). The current tags for this operation are passive and mostly operated in the low-frequency zone. Unfortunately, low-frequency RFID tags can only be read close range and may not perform well when a large number of tags are nearby. Livestock farmers nowadays use high-frequency identification tags. These not only give a better reading range, but also support higher data rates. Other uses of the system, along with extensive adoption of RFID technology, are leading to a reduction in the price per user. Barcode tags represent a lower cost alternative to RFID tags. However, the automation of data collection and the ability to easily transfer records from RFID readers may actually represent a lower net cost per application when the cost of labour is calculated. An expanding number of countries are exporting animals to other countries. This international trade in livestock has led to the establishment of record-keeping standards that use RFID technology as the leading animal-identification technique. Almost all the animal-identification systems across the globe use the guidelines of the International Standards Organization (ISO). Some countries have not yet adopted the ISO and need to be incorporated into their system (Calitz, 2016).

Livestock farmers have the capability to capture information on the tags. Information may include birth weight, inoculation information, birth date, the daily gain in kilograms, dam or sire information, every classing score and comment in its life, and all its progeny and comments on those that are displayed. RFID allows for enhanced data management and data capture of crucial performance indicators. RFID technology facilitates the automatic collection and distribution of information with numerous parties, such as found in public and private traceability programmes. In its easiest application, a RFID tag verifies animal identity electronically. When the tags are used as a performance or quality database, the resulting statistics can be a clever tool to supply management information for enhanced

feeding programmes, advancement of genetics, and the evaluation of other variables in animal production such as daily gain and carcass yields (RFID-Experts, 2017).

Inventory administration is the motivation behind animal tracking using RFID technology. Being aware of the location and number of stock at all times allows livestock farmers to enhance the value of their livestock. RFID tags help livestock farmers to provide feed and water to locations when necessary, round up stock more efficiently, and even handle basic health control such as the frequency with which livestock visit feeding troughs. A decline in the frequency of visits to feeding troughs may be a sign of illness and can be managed accordingly. This technology is frequently deployed in automatic feeding stations and in slaughterhouses so that the animal's carcass can be accounted for. Auto-drafters can also be incorporated into the farmer's management system to reduce labour costs and stress on animals. Furthermore, export and import considerations can be controlled to ensure customs authorities can verify the animal's health history (Wang & Maohua, 2006).

2.5 FEEDLOT FACTORS INFLUENCING FEEDLOT PROFIT

Feedlot profit is affected by a wide range of factors. To identify, measure and adjust these factors, it needs more precise investigation. The factors influencing feedlot profit will be discussed in the next section. This section is divided into three sub-sections, namely economic, financial and production variables.

2.5.1 ECONOMIC FACTORS

Inflation – Assuming all factors remains constant, a rise in inflation would result in higher total costs without increasing quality, resulting in a situation that is less favourable in terms of the financial indicators for an investment in RFID technology. In this evaluation model of RFID technology, production price index (PPI) is used as a measure of inflation. The PPI is defined by Statistics South Africa (2017) as a measure of the change in the prices of goods either as they leave their place of production or as they enter the production process, or as relative measure of average change in price of a basket of representative goods and services sold by manufacturers and producers in the wholesale market. A family of three indices (finished goods, intermediate goods and crude commodities) can be used as an indicator of the rate of inflation or deflation (businessdictionary.com, 2017). This basket contains 270 items, from soft drinks to paint (Statistics South Africa, 2017). PPI is calculated from four industries:

- Agriculture, forestry and fishing
- Mining
- Manufacturing
- Water, gas and electricity

Producer prices have fluctuated greatly over the last three years, but averaged at 5.91% from 2013 to 2017. The PPI reached an all-time high of 8.80% in April 2014, and 2.61% was the all-time lowest recorded – in February 2015 (Trading Economics, 2017). According to Trading Economics (2017), the PPI forecast for 2020 will drop to 4.8%.

Prime Interest Rate – According to the Business Dictionary (2017), the prime interest rate can be defined as the interest charged by banks to their largest, most secure, and most creditworthy customers on short-term loans. This rate is used as a guide for computing interest rates for other borrowers. Even though the inflation rate has been coming down in the last three quarters from August 2016, the Reserve Bank announced on 20 July 2017 that it would cut the repo rate from 7% to 6.75%. As a result, the prime interest rate dropped by 25 basis points to offer consumers some relief. The last increase in basis points was in March 2016. Figure 2.6 shows the prime interest rate of South Africa from 2007 to 2017 (SA Reserve Bank, 2017).

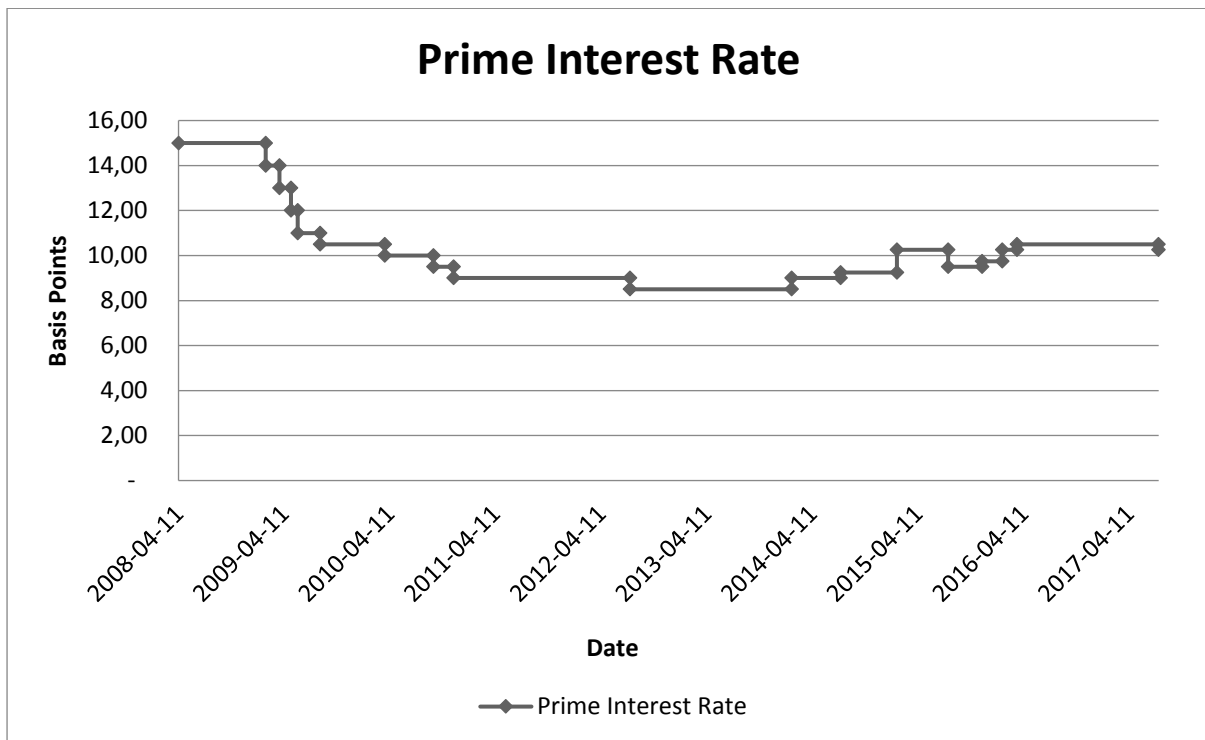


Figure 2.6: Prime interest rate, 2007 to 2017

Source: South African Reserve Bank (2017)

In Figure 2.6, it can be seen that the highest rate of 15.5% was recorded in June 2008, followed by a steady decline until July 2012, which had the lowest rate of 8.5%. In 2017 the prime interest rate was 10.25% which will have an influence on profit in terms of this feedlot research. The prime interest rate can be used as the discount rate in capital budgeting techniques such as the internal rate of return (IRR).

Tax – Corporate Income Tax (CIT) is defined by the Oxford Dictionary (2017) as a compulsory contribution to state revenue, levied by the government on workers' income and business profits, or added to the cost of some goods, services, and transactions. Corporate income tax is applicable (but not limited) to the following companies, which are liable under the Income Tax Act, 1962 for the payment of tax on all income received by or accrued to them within a financial year (South African Revenue Service [SARS], 2017):

- Public benefit companies
- Listed public companies
- Dormant companies
- Unlisted public companies
- Share block companies
- Private companies
- Body corporates
- Close corporations
- Small business corporations
- Co-operatives
- Collective investment schemes

Feedlots such as used in this research are operated in a “Listed public companies” structure (SARS, 2017).

2.5.2 FINANCIAL FACTORS

Selling Price (R/KG) – According to Cornelius (2017), in June 2017, the average producer prices of Class A2/3, B2/3 and C2/3 of mutton increased year on year by 21.5%, 20.3% and 29,1% respectively in total. The average price of all classes was 19.5% higher than the average over the period June 2014 to June 2017. The prices from 2015 to 2017 can be seen in Figure 2.7.

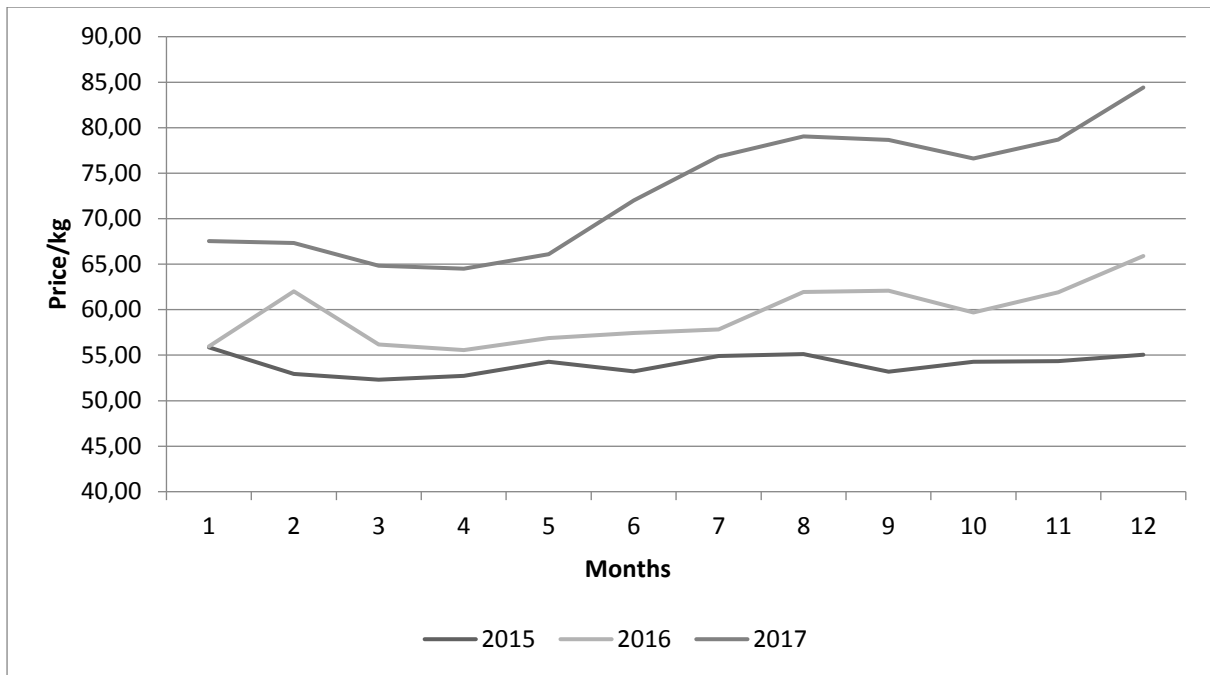


Figure 2.7: Meat prices (A2/3)

Source: Red Meat Producers Organisation ([RPO], 2017b)

It can be seen from Figure 2.7 that the difference in prices from 2016 to 2017 increased significantly more than the difference between 2015 and 2016. This is an attractive observation for feedlots, because the profit would have been influenced positively for the year 2017. The latest recorded meat price for this model of Class A2/3 traded at R84.36/kg in week 52 (RPO, 2017b). The average price/kg according to the Red Meat Producers Organization (RPO) (2017b) for the year 2017 was R71.68/kg (Value Added Tax (VAT) excluded).

Buying Price (R/KG) (live weight) – The live weight of an animal is associated with the greatest changes in slaughter percentages (Kirton, Carter, Clarke & Duganzich, 1984). In other words, the lower the weight of the animal, the lower the slaughter percentage usually is. The opposite is true as well.

According to Kirton *et al.* (1984), the slaughter percentage of weaned lambs with a live weight of 32 kg was recorded at 41%. When calculating live weight buying price/kg, the average carcass price (Class A2/3) comes into the equation.

The South African National Minimum Wage – The minimum wage from the period 1 March 2017 to 28 February 2018 can be observed in Table 2.2.

Table 2.2: Minimum wages for employees in the farm worker sector

Minimum rates for the period 1 March 2017 to 28 February 2018			
Monthly	Weekly	Daily	Hourly
R3001.13	R692.62	R138.52*	R15.39
<p>* For employees who work nine hours a day</p> <p>** The CPI to be utilised is the available CPI EOER (Consumer price index excluding owner's equivalent rent, as released by Statistics South Africa six weeks prior to the increment date). CPI EOER = 7% + 1 = 8% increase</p>			

Source: Department of Labour (2017)

The agricultural, hunting, forestry and fishing industry of South Africa supplies jobs to 881 000 workers, which represent 5.6% of the total employment in all sectors (DAFF, 2017a). The rise in the South African national minimum wage rate to R15.39 per hour was announced on 4 February 2017 by deputy president Cyril Ramaphosa (BusinessTech, 2017) (Table 2.2). According to the Department of Labour (2017), the rise in minimum wage took effect from 1 March 2017.

The new minimum wage of R15.39 per hour translates to R2 462.40 per month for labourers on a 40-hour work week, and R3 001.13 per month for those on a 45-hour work week (Table 2.2). Feedlots normally operate on a 45-hour work week. A normal week starts at 7 am on a Monday and ends at 5 pm on a Friday, with lunch breaks taking place between 1 pm and 2 pm.

2.5.3 PRODUCTION FACTORS

Feed Conversion Ratio (FCR) – As mentioned earlier, the feed conversion ratio is another critically important aspect that will be a concern regarding profitability for the producer. The rate at which the animal converts dry feed into body mass will give the farmer a competitive edge. De Wet (2015) stated that FCR or feed conversion efficiency (FCE) of sheep varies from 2 kg to 20 kg dry feed intake to produce 1 kg body mass. In FCR terms, ratios smaller than 4:5 are regarded as excellent. A sheep with an FCR of 5:1 will save the farmer 15 kg of feed per kg live body mass the sheep produces versus a sheep with an FCR of 20:1. De Wet stated that farmers strive to produce sheep with a live body mass growth rate of 300 to 450 g/day. A young (less than three months old) well-grown lamb weighing at least 25 to 28 kg has an FCR of $\pm 4.2:1$ as opposed to the 7:6 to 8:1 of an eight-month-old lamb (Vosloo, Bruwer & Naude, 1987). If feedlots do not have the necessary FCR data from their suppliers, estimated calculations should be made with the ADG and live weight data available. Measuring individual FCRs is labour intensive and requires more time, and facilities must have individual pens to feed the animals apart from the herd.

Average Daily Gain – ADG is defined by Drovers (2017) simply as the rate of weight gain per day over a specified period of time. For example, if a lamb weighs 30 kg on the 1 January and 45 kg on 30 January of the same year, then the animal gained 15 kg in 30 days, giving the animal an ADG of 0.5 kg. ADG measurements of 325 g/lamb/day and higher is seen as excellent, and ADG measurements lower than 250 g/lamb/day are indicative of a low-performing animal (Coetzee, 2017)

ADG can be affected by a great number of factors. Genetics, the diet of the animal, vitamin and mineral supplements, environment, pre-weaning diets, mothering ability of ewe, growth-promoting implants, etc. all play their specific part in the growth rate of each specific animal over a period of time. For this research, ADG is an extremely important factor because it is one of the biggest indicators of profit for the producer. Sheep feedlots are currently high-turnover, high-volume, low-margin enterprises and therefore at high risk (Jolly & Goers, 2007). In order for the producer to manage risk and remain profitable, he should focus on producing sheep with the ability to grow faster with less feed. According to Anderson (2001), the most profitable lamb is the lamb that grows quickly and can be marketed the earliest, because fast-growing lambs are the most efficient converters of feed to meat.

Dressing Percentage – The dressing or slaughter percentage is the amount of live weight that will enter the cooler in the form of a carcass (Rentfrow, 2010). Dressing percentage can be calculated as presented in the equation below (Cornell University, 2012):

$$\text{Dressing \%} = \frac{\text{Hot Carcass Weight}}{\text{Live Weight}} \quad (3.5)$$

Dressing percentage tends to differ between sexes, as higher carcass fat has been measured for females (Zgur, Cividini, Kompan & Birtic, 2003). Males have a greater percentage of liver and head, lower proportion of loin and back and greater proportion of shoulder, neck and chuck. Slaughter percentages of less than 45% can be viewed as bad, and slaughter percentages of more than 49% are regarded as excellent (Coetzee, 2017).

Statutory Levies – According to the RPO (2017a), the statutory levy for sheep and goats is R2.02 per head. The levy should be deducted from the seller and paid over to the buyer for all transactions. In terms of a feedlot, R2.02 per head should be paid at the point of slaughter by the person who offers the animal for slaughter.

Electricity Consumption – The Sheep Auto Drafter that was used in this study is powered by an external 230 V to 12 V DC adaptor. The RFID drafter uses a 2 HP 24 L compressor to operate the sliding doors. Producers can also operate the Sheep Auto Drafter off a 12 V DC battery, e.g. a car battery, if there is no conventional power supply. The RFID scale monitor will need to be powered separately (by its own batteries), as no power supply runs to it from the unit. The Eskom Ruraflex tariff guide can be seen in Table 2.3.

Table 2.3: Eskom Ruraflex tariff for 2017/2018

Active energy charge [c/kWh]											
High-demand season [Jun – Aug]						Low-demand season [Sep – May]					
Peak		Standard		Off-peak		Peak		Standard		Off-peak	
	VAT <i>incl.</i>		VAT <i>incl.</i>		VAT <i>incl.</i>		VAT <i>incl.</i>		VAT <i>incl.</i>		VAT <i>incl.</i>
288.20	328.55	87.31	99.53	47.42	54.06	94.01	107.17	64.70	73.76	41.04	46.79

Source: Eskom (2017)

Batteries supplied with the scale should be used to power the scale’s monitor during the weighing period. The Sheep Auto Drafter uses the electricity to operate the sliding gates therefore the c/kWh tariff (Table 2.3) will be needed to calculate the electricity consumption for the 2 HP 24 L air compressor. The compressor’s motor runs at 2 800 watts. Eskom’s low-demand season standard tariff, which can be seen in Table 2.3, should be used to calculate the electricity usage.

2.6 FINANCIAL ANALYSIS TECHNIQUES

In order to measure an investment, the potential investor should first conduct an analysis to see whether the investment will repay the investor. Financial analysis techniques are used to indicate the potential revenue that will be generated by the investment. In this section, various financial ratios/analyses are presented that could be used to analyse investment options for future farm investments such as in the RFID system.

Simple Payback Period (SPP) – The time it takes for the return on an investment to repay the investment (Bull, 2014). SSP is a method of dividing annual returns or savings into the initial investment (Weingartner, 1969). Problems with the calculation of the payback period are the fact that it will probably provide insufficient information to the investor as the only aspect to make a decision on. One of the problems with the payback period is that the time value of money via the discounting of future cash flows never appears in the equation (Miklovicova, Miclovicova, Ladislav & Felixova, 2013).

The payback period is an easy way to measure the risk that the investor might face by investing in the proposed project. The shorter the payback period, the better the investment will be (Weingartner, 1969). A feedlot with a bigger capacity for sheep will benefit more from the RFID investment than a feedlot with fewer sheep, because fewer animals mean total costs are divided between fewer production units (Hammer *et al.*, 2017). Peabody (2013) used the SPP method for RFID healthcare asset tracking with great success.

Discounted Payback Period – The discounted payback period can be explained as the period it will take from the beginning of an investment to achieve the equivalent input according to the output in order to deliver profit. This is according to external factors such as value for money, the period of payback and discounted payback (Keythman, 2017).

Benefits of the discounted payback period are that it allows consideration of the time value of investments in order to protect the insecurity of cash flows. There are also disadvantages that should be borne in mind: There are no built-in methods in order to make decisions that can help in the evaluation of the asset. It is important for the firm to approximate the cost of investment to estimate the payback. This method does not allow cash flows outside the discounted period (Peterson-Drake, 2016).

It is important for the firm to calculate the cost of the separate cash flows and then to estimate the term it will take to pay back on a discounted base. This should not exceed the period of requirement, normally two years. The discount payment period is the variance between the recent value and its price. The future cash flow's value should be deducted from the original investment. It will be positive to ensure that the discount payment period adds worth to the company's investment (Kumar, 2018).

Return on Investment (ROI) – Return on investment measures the gain or loss generated on an investment relative to the amount of money invested (Investing Answers, 2017). ROI measures the return the investor would earn on the investment over a given amount of time indicated in a percentage format. Hippler (2009) calculated ROI with great success on a small to mid-size container distribution company that utilises RFID in its management system.

The advantages of the ROI method are that it makes it possible to explain the business opportunity to fellow business partners in an easy-to-understand manner. ROI analysis is also a tool to compare different investments with each other. According to the Philips (2007), there are six major benefits of the ROI method: improve image, enhance relationships, build support, implement new projects, secure funding and improve projects.

ROI will give the investor a good indication of how much income his investment will generate. However, calculating the ROI of a RFID technological investment is not that simplistic because of all the variables that play a role in calculating the savings offered by the RFID technology in a feedlot.

Accounting Rate of Return (ARR) on Investment – This measure allows the firm to assess the potential of an investment to produce income, and provides the ability to reflect further investments, representing an effective use of incomes (Bragg, 2018). This can be done by finding the results of the investment by calculating all the cost of overheads that are linked to the specific investment, for example the returns that were earned without interest or income tax expenditures being deducted. The variations between the obtained income and cost of the investment are described as accounting rate of return on investments (Kappel, 2016).

Aside from the importance of the benefits of accounting return on investments, the limitations should be taken into consideration, as it overlooks the time value of the asset. It also does not improve the risk on a long-term base, as well as the improved changeability related to extended projects. It offers only a financial direction for projects. The problem occurs because different projects do not have the same variables (Anonymous, 2018a).

Accounting Rate of Return (ARR) on Assets – The purpose of total asset ratios is to supply the firm with data as an indication of efficient management in applying resources to returns. This includes the broader assets of the company, which are important to the creditor as well as the shareholders. This method allows investors to buy investments at less than their value (Faulkenberry, 2017).

The net income, as it appears on the income statement, is used as the numerator. Income is described as the total amount remaining after all the overheads are covered. On the other hand, the average total amount of resources is important, because a firm's resources might change over time. Therefore, a firm's total resources should be monitored on the balance sheet to calculate its effectiveness over time by comparison to comparable companies (Boyte-White, 2018).

The main concern about ARR on assets is to remember that these figures are subjective. It should also be taken into consideration that the companies' quantitative results are over a period of time. Unfortunately, a misinterpretation might occur because the value of assets is normally lower than the market value (Gallo, 2016).

Value at Risk (VAR) – Value at risk can be defined as the calculation of a certain amount of money with the possibility that the investment will not lose more than that specific sum of money over that specific time frame (Holton, 2017).

This financial technique can be seen as the ordinary measurement to identify financial instability. The main concern about VAR is that it does not pay attention to the direction in which an investment flow. This might lead to the instability of products because no secure systems are in place for preventing any negative impact on them. Unfortunately, VAR is based too much on common sense rather than on regulatory systems. It consists of a time frame, an assurance level and a risk percentage (Harper, 2017).

The benefit of this technique is that no postulation is unclear about the outline of the spreading of revenues. On the other hand, this method indirectly allows assumptions that future earnings will be similar to those in the past. For better control over funds, clear evidence from all documents, like statements, should be at hand as references. Because statistics are required over a long term, a lack of information will cause this method to lack accuracy (Urbani, 2004).

Net Present Value (NPV) – The net present value is the sum of the annual cash flows discounted for any delay in receiving them, minus the investment outlay (Boehlje & Ehmke, 2005). Satyasai (2009) defines the NPV method as the difference between the present value of benefits and the present value of costs, denoting the net worth of the project. A positive NPV indicates a greater return and a negative NPV indicates no return. With a positive net present value, the project is worth investing in, and vice versa. The benefits of the NPV method are: the cash flows of the project are discounted properly, where other methods overlook the time value of money; other methods use earnings, while NPV uses cash flows, which are more applicable to the capital budgeting process. Other techniques such as the SPP ignore cash flows after a specific point, while NPV uses the total cash flows of the entire project.

Adjusted Net Present Value – This can be formulated as an investigation of an investment that is funded by equity as well as the existing price based on the cash flow on hand. Tax protections that are provided by the deductibility of interest and the paybacks of other investments such as tax returns are calculated independently. This investigation is important for leveraged connections such as a leveraged takeover (Harvey, 2012).

The advantages of the adjusted net present value are that it is based on the concept that money received from later income is less important than the current money in the bank. This method shows an amount that proclaims the worth of the income the project will supply. With the net present value, the firm can estimate its cost of capital as the discount rate. The disadvantages are that the adjusted net present value is based on estimated cash flows in the future and the cost of assets. It cannot be appropriate in the case of plans that have different investment amounts. It also causes problems when comparing projects that differ in specific periods (Woodruff, 2018).

This method is seen as the most accurate capital budgeting method that can be used by any business in order to assess whether it is a good or a bad investment to finance a new project (Peavler, 2018)

Internal Rate of Return (IRR) – The percentage earned on the amount of capital invested in each year of the life of the project after allowing for the repayment of the sum originally invested (Bull, 2014). The IRR is the discount rate at which the net present value of the benefits (cash flows – positive) of the investment equals the net present value of costs (cash flows – negative) of the investment (Olivier, 2015). The IRR is an intrinsic value that is not dependent on other external factors, which is why the word “internal” has been added to the rate of return.

There are several complications from the IRR as a measure for investment evaluation (Anonymous, 2004; Cary & Dunn, 1997). Some of the problems are:

- The IRR technique can lead to inaccurate rankings of equally exclusive investments when matched to the NPV technique.
- The IRR technique assumes that future cash flows will be reinvested and lead to revenues equivalent to IRR.
- The IRR technique overlooks transformations in the size of the investment.
- Furthermore, the IRR also overlooks changes in the lifetime of the investment.

Discounted Cash Flow (DCF) Profitability Index (PI) – The discounted cash flow profitability index is recognised as the “benefit-cost ratio”. Profitability can easily be calculated by using the inputs discount rate, cash inflows and cash outflows. It is seen as positive when the PI is higher or comparable to 1. The main purpose of considering the PI is to measure the discounted cash inflow to the discounted outflow. The discounted cash inflow is the profit. All investments are considered as expenses and described as the benefit-to-cost ratio (Anonymous, 2018b). From a broader

perspective, this index expresses the ratio of the current price to further cash profits as investments in future expenses (Anonymous, 2018c).

The DCF profitability index is important, as it saves time and money. It also helps to measure all incomes in order to ensure the investors achieve their goals. On the other hand, it is not useful in deciding on capital regulation when goals have not yet been achieved. It might also appear as a negative measurement when a project with a negative PI is being used in a combination with another. The project with a low PI then has a negative influence on the results of a product with a higher IP (Anonymous, 2018d).

2.7 SUMMARY OF CHAPTER

Throughout the literature, it is evident that sheep production in South Africa plays a vital role in the economy. However, it is also clear that mutton production in South Africa is under pressure from other commodities. It is predicted that chicken consumption will rise by 23% in 2026, while sheep meat consumption is predicted to only rise by a modest 5%. This data is an indication of the pressure on the sheep industry as the demand for cheaper meats, such as chicken, grows. If the economy in South Africa can stabilise over the next three years, following the 2016/2017 drought and political instability, the demand could rise for meats like lamb, beef and mutton. It is thus important that sheep farmers keep on producing quality meat at lower input costs to stay competitive in the commodity market.

The management factors that play a role in the profitability of feedlots such as weaning weight, ADG, mothering ability, lambing rate, mortality rate and FCR and water intake. Without water, the animal's weight and feed intake will decrease, resulting in a poorly performing animal. The more water the animals drink, the more feed they consume, eventually resulting in more profit. The provision of shade, another management aspect, decreases core body temperature and, if managed correctly, can add to the animal's performance.

The technological methods used to increase profitability in livestock are more important than presented by the research. The literature on the scientific benefits of mobile applications and new feeding systems is insufficient to provide information regarding profitability data. The research on implants, zilpaterol chlorhydrate supplementation (Zilmax) and antibiotic supplementation is of great value to this study, because it provides relevant information on ways to increase daily gain in sheep and, eventually, profit in feedlots. Implants are the most beneficial to feedlots, as they increase feed efficiency by 8% to 12% and increase the average daily gain by 15% to 20%. Sub-therapeutic antibiotics increase feed efficiency by 7% and improve daily gain by 7%. Zilmax supplementation increases a farmer's net profit by R113.04 per head at current prices (2017 averages). The above-mentioned methods contribute to a better, more efficient animal, but it is necessary to ensure that the management and animal science factors are correct before RFID technology is implemented in the feedlot. If used together correctly, the benefit will be much greater.

Feedlot factors influencing feedlot profit were discussed to gain an indication of what would influence the analyses. The many factors were divided into three smaller sections, namely economic, financial and production factors.

To estimate the profitability of investing in a RFID system, the different types of measurement were studied, such as return on investment (ROI), the DCF profitability index (PI), net present value (NPV), adjusted net present value, value at risk (VAR), accounting rate of return (ARR) on assets, accounting rate of return (ARR) on investment, and discounted payback period. The different types of capital budgeting techniques are described in the literature review. The literature on RFID technology in livestock is limited because of the current stage of the technology and because companies that conduct successful analyses want to hide their results from their competitors.

This concludes Chapter 2, in which the literature relating to the applications and components of a RFID management system, as well as the tools to evaluate the viability of RFID systems in sheep feedlots, is described as the foundation of the research. This information is used in Chapter 3 to present a solid description of the quantitative methodology used in this research to achieve the aim stated in Chapter 1.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 INTRODUCTION

Chapter 3 presents the methodology used to build the financial model that was used to evaluate investment in RFID technology in a South African sheep feedlot. The chapter firstly focuses on the study area, followed by the assumptions of the model, the two scenarios that are tested in the model and, lastly, the different financial analysis techniques that form part of this study are discussed.

3.2 STUDY AREA AND DATA COLLECTION

A total of 508 sheep in three batches from 34 different suppliers were involved in this study, with one sheep being supplied by an undefined supplier. Eight different breeds were used, one of which was an undefined breed. The first animal in the study was weighed on 1 February 2016 and the last on 10 June 2016. The total duration of recording data in the feedlot was 131 days.

The holding yard from which the data was collected is located on a farm in the Western Cape province of South Africa. The farm has its own wholesale butchery, lamb feedlot and abattoir. The abattoir, butchery and feedlot are a family business. The feedlot has a capacity of up to 7 500 head of sheep.

Each animal was tagged with a RFID tag and weighed on a RFID scale on arrival at the feedlot. Once the animals had entered the feedlot they were weighed after a week, at 14 days and again after they had reached slaughter weight. The animals that arrived on the farm from the different suppliers were not all adapted to feedlot rations, and this had an influence on the performance of the different suppliers, which was evaluated at a later stage. Due to the use of the RFID tags and scale, it was possible to measure each animal's performance after 14 days in the feedlot and their performance for the entire feedlot period. The feedlot employees were mainly responsible for the data collection and were willing to provide the data that was collected for the three batches of sheep, which contained 228, 134 and 146 animals respectively.

Slaughter data was provided for each batch and served as an indication of what the performance was in terms of dressing percentage and grading (classification).

The following information was provided for each individual animal:

- Unique EIDs
- Breed
- Supplier name (sheep producer)
- Start date
- End date
- Start weight
- End weight

- ADG
- Day 14 weight

3.3 ASSUMPTIONS

In order to build a model, assumptions must be made on which the calculations are based. The assumptions made for the model are presented here and each is discussed briefly.

- **RFID ear tag lifespan** – It is difficult to predict the productive lifespan of the RFID ear tags. Manufacturers such as the one used in this research predict a lifespan of two years under feedlot conditions (RFID-Experts, 2017). In some cases, lifespan can vary from one year to three years. For the purpose of this research, the price of the RFID ear tags (male and female) is assumed to increase annually by the assumed inflation rate, the ear tags will have to be replaced fully after two years and will have no value after three years. It was further assumed that there will be no maintenance cost for the RFID tags and system over the period of their lifespan.
- **Daily feed intake** – According to Duddy *et al.* (2016), the daily feed intake of lambs varies between 3% and 5 % of their live body weight. Bell and Greenwood (2016) state that older lambs grow slower and fatten faster. They eat more and therefore have poor feed conversion efficiency. Therefore, in order to make a scientifically correct assumption, Equation 3.1 was used and the average feed intake of lambs per day for this model was calculated, using 3.65% of average body weight in the feedlot (Bell, Alcock & Cashburn, 2016).

$$Feed\ intake = \frac{AVG\ BW\ in\ feedlot}{3.65\% \ of\ BW} \quad (3.1)$$

- **Feed conversion ratio** – The most important factor determining profitability in an intensive finishing system is the animal's ability to efficiently convert feed to live weight. Unfortunately, individual feeding of animals in own individual pens is unpractical in an intensive finishing system, such as under the conditions of the feedlot used in this study. Therefore, in this research, the ADG will be the major profit driver and FCR will be assumed at an average of 1:6.508. This means that, for every 6.508 kg of feed eaten, the animal gains 1 kg in live weight. The assumption is made on the basis of the fact that lambs eat 3% to 5% of their body weight per day (De Wet, 2015). The percentage of 3.65% was used for all the feed intake calculations. An average weight in the feedlot is then calculated for every lamb, followed by the average feed intake/day/lamb according to the 3.65%, with the assumption of the FCR can be calculated.

If the percentage intake/LW/day is too high, e.g. 4.5%, the average FCR for the three batches would be calculated at 1:8, which in fact is not a realistic ratio to work from for four-month-old lambs. The ADG of 249 g/day for the three batches is in relationship with the FCR of 1:6.508.

- **Slaughter percentage** – A summary of slaughter results from the abattoir was not provided for every individual EID, as it works on averages for every batch involved. From the data collected, the slaughter percentage varied from 44.79% to 46.57%. Therefore, an average slaughter percentage of 45.55% was used across the three batches.
- **Feeding costs** – The data received from the feedlot was calculated at R3 750/ton (R13.32 = 1 US dollar – 19 April 2017). The feedlot produces its own high-energy, high-protein, well-balanced ration formulated to enhance growth under feedlot conditions (Louw, 2017).
- **Growth curve** – It was assumed that the growth curve of the lambs in the feedlot remained linear throughout the recorded time under feedlot conditions until slaughtered. The model was modified further to take the growth curve for every unit into consideration. For this current model, the growth curve was calculated by using only the data that was collected from the feedlot. ADG was used to calculate the growth curve.
- **Meat price** – In the equation used to calculate the monetary value of feed saved by the RFID system, it was assumed that all the meat would be graded as A2/3 in the abattoir.
- **Selling price** – The average price/kg according to the RPO, (2017b) for the year 2017 was R71.68/kg (VAT excluded). Due to the financial implications of using only one week or day's trading price, the average for the year (R71.68/kg) was used to give the potential investor a more accurate projection of revenues during the production year.
- **Buying price** – The purchasing price of a lamb is a function of the weight of the lamb and the price paid per kilogram. The average starting weight for this model was recorded at 31.495 kg for the 508 animals involved. According to Kirton *et al.* (1984), the slaughter percentage of weaned lambs with a live weight of 32 kg was recorded at 41%. When calculating live weight buying price/kg, the average carcass price (Class A2/3) comes into the equation. The 2017 average Class A2/3 carcass price (R71.68/kg) was used as an indicator of weaner price/kg. A total of 41% of the 2017 average of Class A2/3 carcass price/kg was used in this research model.

Taking into account that the selling price used in the model was R71.68/kg, the set live weight buying price for this model was R29.39/kg (41% of R71.68), as calculated. Day 14 live weight selling price was also calculated at R29.39/kg, bearing in mind the buying price can be adjusted for future analysis purposes.

- **Transportation costs** – According to the transportation data received from the feedlot, the assumption was made that transportation costs amounted to R10/head (VAT included) for this model. The R10/head includes labour, fuel, and wear and tear of the vehicle.

- **Veterinary costs** – Veterinary costs for the study included hormone-free growth stimulant for improved body mass gain and feed conversion, broad-spectrum internal parasiticide treatment, antibiotics and external parasite treatment. The veterinary price/lamb for this research was calculated at R16.40/lamb, as can be seen in Table 3.1.

Table 3.1: Total veterinary costs

Product	Purpose	Price/lamb
Ralgro	Growth stimulant	R7.25
Enterotect P100	Antibiotic	R5.40
Pro Dip Cyp 20%	External parasites	R1.20
First Drench	Broad spectrum parasites	R2.55
TOTAL		R16.40

- **Tax structure** – No data was received regarding the tax structure according to which the feedlot business operates, so it was assumed that the feedlot operates in the “listed public companies” structure and therefore the company would use the current corporate tax rate of 28% (SARS, 2017). The tax structure and income tax rates of the feedlot participating in this study remained constant over the time frame of this model (28%).
- **Culled animals** – Animals that were culled on day 14 because of gross profits being higher than the predicted end-of-cycle gross profit were finished off on farm pastures, which are cheaper sources of feed. For the purpose of the calculations in this study, the value of the culled animals stayed as it was on day 14.
- **Feedlot numbers** – The assumption was made that the calculations on the feedlot numbers were made as if the feedlot was full all year round. E.g. for a 7 500-head feedlot, with an average of 47.821 days/head in the feedlot, the feedlot will have 7.6 cycles (365/47.821) of 7 500 animals, resulting in a year total of 57 245 head/year. In a practical sense, this will not be the case for all sheep feedlots, because every feedlot has its own unique management system. For this model, with a 7 500 head-sized feedlot, it was assumed that the feedlot supplied the abattoir with 1 098 lambs per week.
- **Wool** – The wool length on a feedlot-finished lamb will be approximately 2 to 3 cm. For this research, wool income was not considered, given the fact that the different suppliers’ animals will enter the feedlot with different lengths of wool and differ in breed of sheep, resulting in inaccurate results.

- **Water consumption** – According to Markwick (2014), the average water consumption of weaner lambs is between two and four litres per day, depending on variables such as temperature, salinity, age and condition of stock, breed differences and pasture composition. This model used an average water consumption of three litres per day per animal under feedlot conditions in the Western Cape when any significant water charges come into consideration. As the drought of 2016/2017 continued in the Western Cape, the increasing water price could have a slight effect on profits if municipalities are forced to increase the price of water. The current model did not take water costs into consideration, but these could be incorporated for future purposes.
- **Inflation** – An inflation rate of 5.91% was used in the model. This inflation rate was decided on based on the literature in Chapter 2.
- **Prime interest rate** – The prime interest rate involved in the capital budgeting techniques was the prime interest rate for South Africa in 2017 (10.25%) (BFAP, 2017).
- **South African national minimum wage** – The new minimum wage of R15.39 per hour translates into R2 462.40 per month for labourers on a 40-hour work week and R3 001.13 per month for a 45-hour work week. The feedlot operates on a 45-hour work week. A normal week starts at 7 am on a Monday and ends at 5 pm on a Friday, with lunch breaks taking place from 1 pm to 2 pm. The feedlot employs five permanent employees who work 45-hour work weeks. One labourer is appointed on Saturdays for two hours (morning and afternoon) and one on Sundays for two hours. On Saturdays, a 1.5 increased rate applies for labourers, and on Sundays double the minimum amount is paid.

The monthly labour cost for the feedlot was calculated as follows:

$$A = (E * S) + (W * K) + (V * L) \quad (3.2)$$

where:

E = Number of employees

W = Number of hours worked on Saturdays per month

V = Number of hours worked on Sundays

K = Labour/hour on Saturdays

L = Labour/hour on Sundays

S = Salary per month

A = Monthly labour costs

The labour price per animal/day was calculated as follows:

$$D = \frac{A}{F \cdot M} \quad (3.3)$$

where:

F = Number of animals in feedlot

M = Number of days in a month

A = Monthly labour costs

D = Labour cost per animal/day

The total labour cost based on Equation 3.1 and Equation 3.2 was included in the model.

- **Feed conversion ratio** – The feedlot chosen for this study did not have the necessary FCR data from their suppliers, therefore calculated estimates regarding FCR were made which can lower the accuracy of the FCR value calculated for each animal. Measuring individual FCRs is more labour intensive and requires more time, and facilities must have individual pens to feed the animals apart from the herd, which would have made the process challenging. FCR estimates were calculated as follows (Wurts, 2015):

If feed intake were calculated with Equation 3.1, the estimated FCR would then be calculated as follows (thepigsite.com, 2014):

$$FCR = \text{Feed intake} / \text{ADG} \quad (3.4)$$

- **Dressing percentage** – The dressing percentage was calculated using the average of the three batches involved in the study. The average dressing percentage of the three batches was calculated as 45.55%.
- **Statutory levies** – According to the RPO (2017a), the statutory levy for sheep and goats per head is R2.02. This was used as the levy in the study.
- **Electricity consumption** – The RFID scale was used 2 075 times during the data-capturing period. Batteries supplied with the scale were used to power the scale's monitor during this period. The Sheep Auto Drafter used the electricity to operate the sliding gates, therefore the c/kWh tariff (Table 2.3) was needed to calculate the electricity consumption for the 2 HP 24 L air compressor. Eskom's low-demand season standard tariff, which can be seen in Table 2.3, was used to calculate the electricity usage. The weighing and drafting of lambs took an

average duration of 10 s/lamb, and it took batches A, B and C 5 080 seconds (1.41 hours) to be drafted on day 14. The compressor's motor ran at 2 800 watts. Only active energy charges were included in the research because, regardless of the RFID system, the feedlot should by all means have electricity. The electricity usage was calculated as follows:

$$A = \frac{W * T}{1000} * E \quad (3.5)$$

where:

W = Compressor's power consumption (Watts)

T = Running time of compressor (h)

E = Eskom low-demand season standard tariff

A = Cost of electricity usage

- **Projected end-of-cycle gross profit** – Gross profit is defined as a required income statement entry that reflects total revenue minus cost of goods sold. Gross profit is a company's profit before operating expenses, interest payments and taxes (InvestingAnswers, 2018). The projected end-of-cycle gross profit calculations was aided by using the weight data from every animal. The ADG was added for each day to project the number of days the animal would be present in the feedlot until slaughter weight was reached. With the end weight data and the costs of goods sold available, the projected end-of-cycle gross profit could be calculated.

3.4 DATA PROCESSING AND ANALYSIS

In the process of designing a financial model to evaluate the viability of RFID technology, the composition of the RFID system in the feedlot has to be taken into consideration. The function to capture the data needed for this model forms the basis of this study.

RFID Experts Africa Company was used to supply the ideal system to provide the electronic weight scores and grading information. The equipment was used to record the data from the 508 participating animals. The animals were weighed from day 1 until the last day. The average number of days spent in the feedlot was 48. The following equipment was incorporated to record the data for this research:

- Sheep scale and drafter from RFID Experts Africa
- APR500 Handheld RFID reader
- XR500 TruTest indicator
- RFID animal tags
- Retractable applicator
- 2 HP 24 L air compressor

3.4.1 DETERMINING THE CAPITAL OUTLAY

An indication of the capital investment cost involved in the study can be seen in Table 3.2. Cheaper options are available but, for this study, first-class equipment was used to give the investor a clear indication of the capital outlay for an electronic identification (EID) system if investing in the best quality.

Table 3.2: Capital investment cost on a 7 500-head sheep feedlot

	R/Unit	Units	Sum (R)
Fixed costs			
Scale	R146 750	1	R146 750
Drafter	R23 000	1	R23 000
APR500 handheld RFID reader	R17 825	1	R17 825
XR500 TruTest indicator	R28 188.80	1	R28 180.80
Retractomatic applicator	R737.50	1	R737.50
2 HP 24 L air compressor	R1 699	1	R1 699
Installation costs	R0	0	R0
Variable costs			
RFID tags: Male print 1 side	R2.65	7 500	R19 875
RFID tags: Female HD X 30 mm open cap + button set	R27.75	7 500	R208 125
Total			R446 191.50

Source: Adapted from Hippler (2009)

It can be seen in Table 3.2 that the scale is the most expensive investment to make in terms of fixed costs, but taking the lifespan of the scale into consideration, it is not much compared to the tags that have to be replaced every second year. If looked after well, the scale can be used for more than 10 years (RFID-Experts, 2017).

3.4.2 FACTORS AFFECTING CAPITAL OUTLAY

The factors that will affect capital outlay calculations are described in the following section.

- The feedlot already uses a computer, which can be made available for the analysis and processing of feedlot data.

- The costs of infrastructure improvements in the form of rebuilding measures and new constructions were not included.
- This RFID system had no installation costs.
- As can be seen from Table 3.2, the scale (R146 750), and particularly the female tags (R208 125), makes up the largest part of the purchase costs. To the advantage of the farmer, he/she can integrate the system technology into their existing scales to reduce investment costs by a fair amount.
- Although the variable costs could come down in the near future due to an increased number of South African farmers investing in the product, for the purpose of this study the variable cost increased every year by 5.91% inflation, which influenced the yearly cash flow.
- The tags, male and female, were replaced every second year, which also affected yearly cash flows.

3.4.3 DETERMINING THE SAVINGS

The benefits of this research are limited to the point of view of the feedlot business, although farming and abattoir benefits will be discussed to identify the influence the system has on the entire value chain in terms of meat traceability. Increased profitability of the feedlot should be the main focus for the investor wanting to invest in management information systems (MIS) such as RFID. Difficulties arise in determining the annual savings potential of the MIS, because the influence of MIS on farm performance is unclear. The benefit of MIS is defined as the difference between the benefits of the best alternative decision under availability of certain information and the benefits of the best alternative without the availability of this information (Verstegen, Huirne, Dijkhuizen & Kleijnen, 1995). The benefit categories of using RFID systems in production systems can be seen in Table 3.3.

Table 3.3: Observed benefit categories in using RFID systems

Benefit category	Evaluation
Aspects focused on in the study	
Save on feed	Monetary
Availability of supplier data	Monetary
Aspects not focused on in the study	
Predict diseases according to body temperature meters*	Monetary
Save on time	Monetary
Save on labour	Monetary
Better decision making according to changing market needs	Non-monetary
Improved animal welfare	Non-monetary
Less stress on animals	Non-monetary
Less danger for working personnel	Non-monetary
Tag reading errors are non-existent	Non-monetary

*Body temperature measurements are not included in this study

Source: Adapted from Hammer *et al.* (2017)

According to Hammer *et al.* (2017), the benefits of the RFID system (Table 3.3) should be divided into monetary and non-monetary benefits. It is the role of the researcher to identify these benefits and place a value on the monetary benefits by means of specific calculations using the collected data. For this research, only the money saved on feed and availability of supplier data will be focused on. The feedlot used in this research did not have the necessary body temperatures to predict diseases therefore it was not included. The time and labour the feedlot save benefits will be communicated with the feedlot manager. Figure 3.1 offers an alternative representation of the benefits offered by the use of RFID in a sheep feedlot.

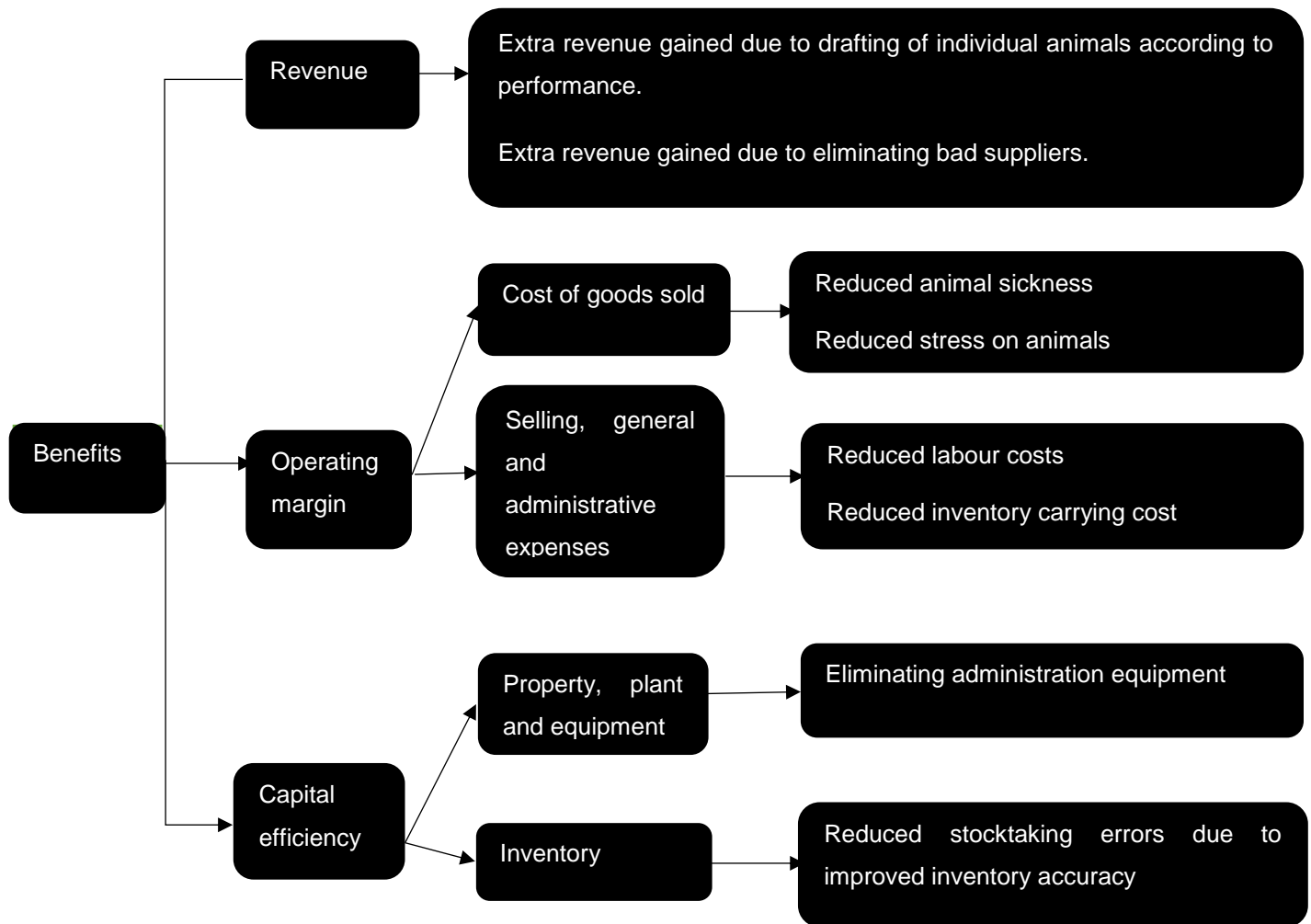


Figure 3.1: Formulating the benefits of implementing RFID technology in sheep feedlots

Source: Sarac, Absi and Dautère-Pérès (2010)

The different benefits that can be measured from the use of RFID systems are shown in Table 3.3. while Figure 3.1 shows the benefits of implementing RFID systems in sheep feedlots. In the scope of this study, two of the monetary benefits will be investigated (Table 3.3) when RFID systems are used in a sheep feedlot – the money saved on feed and the availability of supplier data.

According to Sarac *et al.* (2010), these benefits fall under revenue benefits (Figure 3.1). To investigate these benefits, two scenarios were created for the study, as follows:

- Scenario 1: Investigated revenue saved by drafting lambs according to performance. In this scenario, the input costs saved, such as for feed, by culling non-performing lambs was investigated. The performance of lambs was captured by the RFID system on an individual basis from the first day in the feedlot to day 14 of feeding. Lambs that were proven to have unfavourable measurements during this period were then removed.
- Scenario 2: Determined additional revenue generated by eliminating the purchase of lambs from non-performing suppliers. These suppliers were identified from the data captured by the RFID

system, which showed the performance of individual animals as well as the supplier of each lamb. In this scenario, a one-year period was used during which the performances of the different lambs from the different suppliers were collected. After this period, the suppliers of non-performing lambs were removed from the model to represent a situation in which lambs were only bought from suppliers whose animals showed better feedlot performance in the first year.

3.4.4 PRACTICES APPLIED TO REACH OBJECTIVES

The structures first had to be in place to reach the objectives of the study. The structure of this study is illustrated in Figure 3.2.

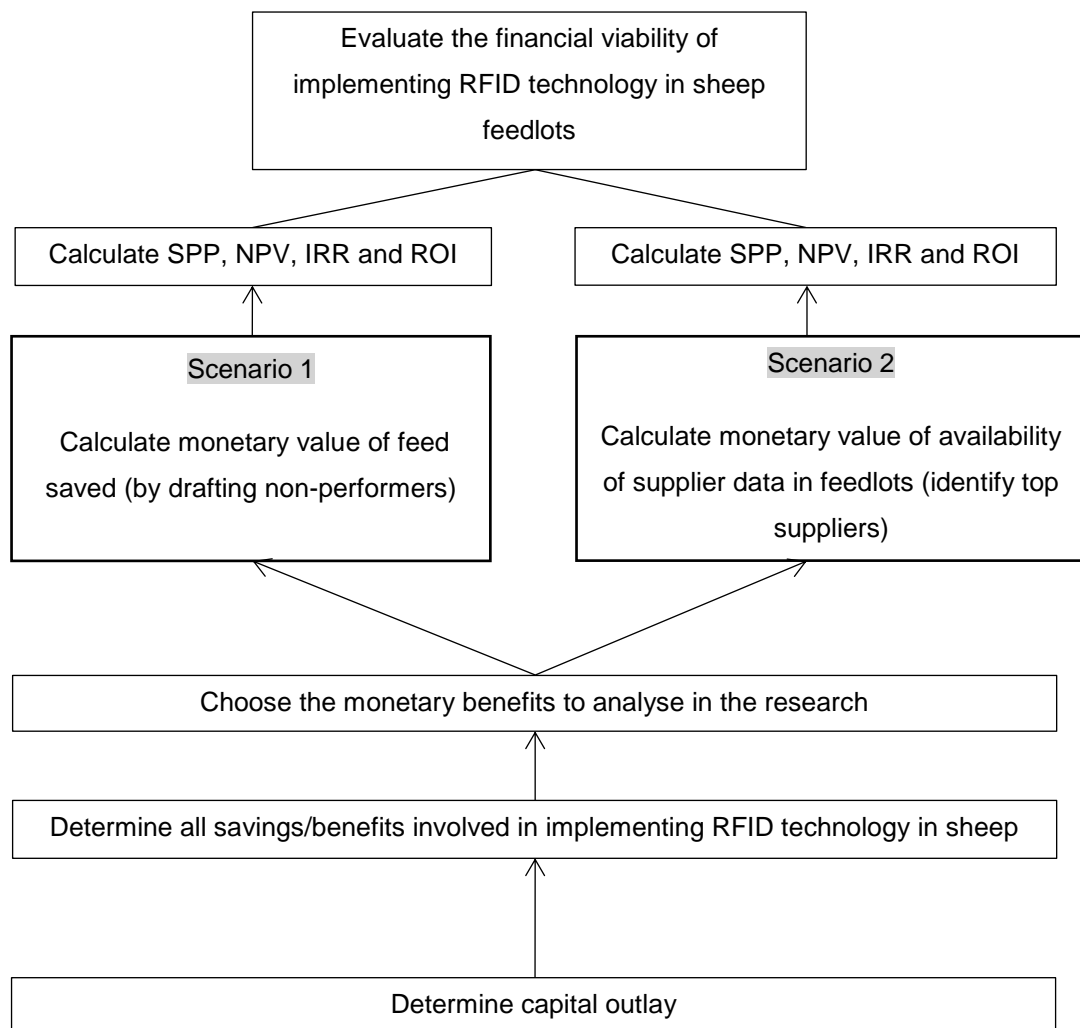


Figure 3.2: Description of practices applied to achieve objectives

Source: Author's deductions

3.4.5 SELECTION PROCESS

The different selection processes used for each of the scenarios are as follows:

Scenario 1: The calculation of the feed saved only by animal drafting was done as follows: Animals from various suppliers were weighed on arrival, after one week and on day 14. During the two weeks under feedlot conditions, the ADG was measured and, on day 14, the animals were drafted according to their predicted end-of-cycle gross profit (described in Section 3.3, Assumptions) and day 14 gross profit. If the day 14 value was higher than the end-of-cycle value, the animal was drafted. This meant that it was no longer financially viable to keep the animal in the feedlot because it would most likely result in a lower gross profit at the end of the cycle. If the highest value was the end-of-cycle value, the animal was kept in the feedlot until it reached the predicted end-of-cycle gross profit. The culled animals were rounded off on pastures. A visual explanation of the animal-drafting methodology is provided in Table 3.4.

Table 3.4: Visual explanation of drafting methodology

EID	Day 14 Gross Profit	Predicted End of Cycle Gross Profit	Highest Drafted Value
900002000288818	R -31,60	R 162,59	R 162,59
900002000388958	R -5,54	R -26,79	R -5,54

In Table 3.4, it can be seen that the first animal was allowed to complete the full cycle under Scenario 1 conditions, because its predicted end-of-cycle gross profit was higher than the current, day 14 gross profit. The second animal was culled because its end-of-cycle gross profit was lower than its current, day 14 gross profit.

Scenario 2: The value of the data the farmer receives by implementing the RFID system has to be given a monetary value to provide the potential investor with an indication of what he could gain by making informed financial decisions. The monetary value of the availability of management data in feedlots was calculated using the weight data received from the feedlot. The suppliers were ranked from best to worst according to their animals' average end-of-cycle predicted gross profit.

For functional purposes, the first year would act as a trial period to identify which are the feedlot's best performing suppliers. During the second year, the feedlot manager only bought lambs from the top two-thirds of the evaluated suppliers. For the purpose of this study, the drafted suppliers' (one-third) animals were replaced in year two with the average animals according to the top suppliers. In other words, for each animal that was culled because of its supplier not being in the top range of suppliers, an average replacement animal from one of the top performers was added. By doing this, the numbers were kept the same and the feedlot operated at full capacity (7 500).

Besides only purchasing lambs from the top-performing suppliers from year two onwards, the system kept on drafting non-performing animals based on day 14 calculations. The same day 14 gross profit and end-of-cycle predicted gross profit as described in Table 3.4 were used. This allowed non-performing animals bought in from proven performing suppliers to be removed to improve profits.

The following calculations were developed and used to determine the day 14 and end-of-cycle gross profit/head:

$$A = B - (C + D + E) \quad (3.6)$$

where:

A = Gross profit/head

B = Selling price/head

C = Total input cost/head

D = Statutory levy

E = Buying price/head

The selling price/head was calculating with the following equation:

$$B = F * G * H \quad (3.7)$$

where:

B = Selling price/head

F = Selling price/kg

G = Weight

H = Slaughter percentage

The total input costs comprised VAT-deductible input costs and VAT zero-rated input costs. The VAT-deductible input cost was calculated using the following calculation:

$$I = \frac{(J+K+L)*100}{114} \quad (3.8)$$

where:

I = VAT-deductible input cost/head

J = Electricity cost/head

K = Transport cost/head

L = Veterinary cost/head

The VAT zero-rated input cost was calculated using the following calculation:

$$M = N + O \quad (3.9)$$

where:

$M = \text{VAT zero-rated input cost/head}$

$N = \text{Labour cost/head}$

$O = \text{Feed cost/head}$

Buying price per head was calculated using the following calculation:

$$P = Q * R \quad (3.10)$$

where:

$P = \text{Buying price/head}$

$Q = \text{Start weight}$

$R = \text{Buying price/kg}$

Besides calculating the profit for the two presented scenarios, each of the scenarios was also evaluated with selected financial indicators to determine the feasibility of investing in a RFID system.

3.4.6 CALCULATIONS OF FINANCIAL INDICATORS

The methods that were selected for the study include NPV, IRR, SPP and ROI. These indicators were calculated for both of the scenarios on an after-tax basis over a 10-year period. The period of 10 years was chosen because the suppliers of RFID equipment (RFID Experts Africa) give a 10-year warranty on their products. Because it is hard to precisely predict all benefits and financial costs over such a long period, certain assumptions needed to be made, as described in Paragraph 3.3. Based on the outcomes of the NPV, IRR, SPP and ROI calculations, the financial viability of implementing RFID technology in a sheep feedlot was calculated.

3.5 FINANCIAL ANALYSIS TECHNIQUES

Various techniques have been used around the world to determine the economic profitability of a capital investment. The three techniques that were chosen to be used with the return on investment (ROI) method for this study were the simple payback period (SPP), internal rate of return (IRR) and the net present value (NPV) methods. Literature confirms that these evaluation techniques stand out from the rest and are used predominantly in capital investment analyses (Arnold & Hatzopoulos, 2000; Freeman & Hobbes, 1991; Graham & Harvey, 2001; Kester *et al.*, 1991; McMahon, 1981; Payne, Heath & Gale, 1999; Truong, Peat & Partington, 2007). The ROI method was added because it has gained a considerable amount of popularity in recent years. The reason why ROI analysis is so important for capital budgeting is that it will determine whether the investment will repay the investor, which is what the feedlot manager wants to achieve by investing in RFID technology (Sarac *et al.*, 2010). The four methods that were utilised in this study are discussed in the next section.

3.5.1 THE SIMPLE PAYBACK PERIOD

Academic writers have almost unanimously condemned the use of the payback period in capital budgeting, but it continues to be one of the most widely applied quantitative concepts in making investment decisions (Femi, Olawale & Ogundele, 2008). The payback period is often misleading or worthless for some investors, but people keep on using it because of its simplicity. The payback period is a favourite tool for investors, but the reason for its popularity needs to be clearly understood.

The payback period is the time in which it is expected that an investment project will recoup its initial cost (Weingartner, 1969). In this case, the investment was in the RFID system that was incorporated in a sheep feedlot. The investment cost consisted of ear tags, scales, drafters and monitors.

The payback period is an easy way to measure the risk that the investor might face by investing in the proposed project. The shorter the payback period, the better the investment will be (Weingartner, 1969). A feedlot with a bigger capacity for sheep will benefit more from the RFID investment than a feedlot with fewer sheep, because fewer animals mean total costs are divided between fewer production units (Hammer *et al.*, 2017).

The formula for the payback method is not difficult to understand: Divide the cash outlay (the investment cost at the beginning of the project: drafter, ear tags, scales, etc.) by the amount of net cash flow generated by the project per year (more or less R1000 000) (this amount is calculated in terms of management data the feedlot manager receives about the different suppliers' products and how they perform in the feedlot).

A problem with this method is that it does not take into consideration any other cash flows generated by the system after the investment is paid back (Weingartner, 1969). If the lifespan of the RFID system ends immediately after the initial investment was paid off, then there is no reason to invest in the RFID system because it will not have that same ability to generate cash flows at that point in time. Unfortunately, the payback method does not provide the investor the above-mentioned information (Groppelli & Nikbakht, 2006). Another problem with the payback period is that the time value of money via the discounting of future cash flows does not appear in the equation (Miklovicova *et al.*, 2013). That is why this study has not provided the investor with only the payback method but uses it in combination with the ROI method and other methods that take the time value of money into consideration, such as the NPV and IRR. The payback period is only one calculation to give the investor more information to regulate his/her decisions and to see how many years it would take to get the initial outlay back (Miklovicova *et al.*, 2013). The formula expressed in Equation 3.11 is used to calculate SPP (Bull, 2014):

$$SPP = \frac{\text{Investment Cost}}{\text{Annual Net Cash Flow}} \quad (3.11)$$

The main reason for selecting the payback method to calculate the risk of the investment is that it is easy to use and very easy to understand (Miklovicova *et al.*, 2013), and most South African farmers will be able to understand and apply it.

3.5.2 THE RETURN ON INVESTMENT METHOD

A few decades ago, the ROI method was still fairly new in the investment business but, since 2006, ROI has moved from a hot topic to a recognised process within many organisations. ROI can be a valuable tool for investors, but the difficulty lies in developing the actual monetary benefits of the RFID system in a credible way (Philips, 2007).

The reason why ROI analysis is so important for capital budgeting is that it will determine whether the investment will repay the investor (Sarac *et al.*, 2010). In any RFID project, the investor will first look at the benefits the system will provide the business. In the feedlot industry, RFID systems can provide a large number of benefits for the farmer, such as being more time efficient, reducing labour expenses, simplifying stock taking, reducing stress on the animals, improving the traceability of the system, eliminating tag reading errors, classing efficiently according to changing market needs, and ensuring improved genetics through scientific drafting of the animals. In order to use the ROI analysis for RFID projects in the feedlot, the investor must first decide on which benefits he/she will focus and what benefits he/she wants to include in the analysis.

The formula to calculate ROI in its purest format is as follows: divide the gain from investment minus the cost of investment by the cost of investment (Sarec, *et al.*, 2010). According to Sarac *et al.* (2010), the formula to calculate ROI is:

$$ROI = \left(\frac{\text{The final monetary yield of the project}}{\text{The investment required by the project}} - 1 \right) * 100 \quad (3.12)$$

It is important for organisations to first understand the technology, then understand how the RFID system will work within their unique feedlot, then understand the financial analysis and, finally, decide how to make the investment (Goel, 2007). A positive ROI will indicate a profitable investment. With this information available, the company must decide whether or not the project will be feasible (Fleisch & Telkamp, 2005). To get a positive ROI, the investor should focus on the direct and indirect benefits the system can provide to the specific business. Direct benefits can be explained as objects that can be observed and quantified (Sarac *et al.*, 2010). In the feedlot, a direct benefit will be the identification and measurement of the performance of the different suppliers' stock in the feedlot. Indirect benefits will be non-financial benefits, such as the simplification of the feedlot management system and improved animal welfare. The indirect benefits are difficult to measure by a direct economical amount, but they can improve direct benefits further along the line (Sarac *et al.*, 2010). They can also be described as intangible benefits, and include measures that cannot be credibly converted to monetary values (Philips, 2007). Hammer *et al.* (2017) state that the benefits of information technology systems in agriculture should be divided into monetary (direct) and non-monetary (indirect) benefits.

The big advantage of the ROI method is that it can explain the business opportunity to fellow business partners in a simplistic manner. ROI analyses are critical for feedlots, farmers and businesses to determine whether the RFID investment will repay the investor (Hammer, *et al.*, 2017).

In RFID projects, ROI is calculated by the final monetary yield of the project divided by the investment required by the project (Equation 3.12). This will give the investor a good indication of how much profit his investment will generate. However, calculating the ROI of a RFID technological investment is not that straightforward because of all the variables that play a role in calculating the savings provided by the RFID technology in a feedlot. It is difficult to put a financial value on every benefit the RFID technology provides (Hammer *et al.*, 2017). For this study, savings from drafting the low-performing animals and the lowest 33.3% of suppliers and their low-performing animals were calculated to represent the benefits necessary for the ROI calculations.

3.5.3 NET PRESENT VALUE METHOD

The NPV method is the meat of most capital budgeting textbooks and lies at the core of what financial academics think they have to offer chief financial officers, corporate treasurers, investment bankers, and practitioners of all stripes. As stated, the importance of the NPV method can never be underestimated in the world of finance and is regarded among the top three capital budgeting techniques (Truong *et al.*, 2007).

The definition of NPV is the difference between the present value of cash inflows and the present cash outflows (Investopedia, 2017). If the NPV of the investment is positive, it indicates the earnings generated by the investment or project will surpass the predicted costs, and this can be regarded as a profitable investment option. Investment options with a negative NPV will indicate the probability of a net loss and that the project will not be financially viable.

Throughout the literature, it was seen that the benefits involved in this study need to be accurately measured and applied to the capital budgeting techniques. As Gordon and Loeb (2006) state, how precisely the benefits will be measured will be a key ingredient to fully utilise the NPV method. The NPV can be calculated using the following formula (Finance Formulas, 2017):

$$NPV = -C_0 + \sum_{i=1}^T \frac{C_i}{(1+r)^i} \quad (3.13)$$

where:

$C_0 =$ Initial investment

$C =$ Cash flow

$r =$ Discount rate (Prime Interest Rate)

$T =$ Time (Duration of project)

3.5.4 INTERNAL RATE OF RETURN METHOD

The IRR only depends on the cash flows generated by an investment. The IRR is an intrinsic value that is not dependent on other external factors, which is why the word “internal” has been added to

the rate of return (Ross, Westerfield & Jaffe, 1999). By using this technique, the merits of the investment are only determined on the basis of the discounted cash flows generated by the investment. The rule of thumb: advance with the project if the discount rate is less than the IRR and reject the project if the discount rate is greater than the IRR (Ingersoll, Ross & Ross, 1992). The same rule can be applied to the NPV method, and both the NPV and IRR methods take the time value of money into consideration. The IRR and the NPV rely on the same formula (see 3.5.3).

3.6 SUMMARY OF CHAPTER

Chapter 3 presents the financial model, which was built on precise and complete data, and acknowledged financial techniques were used to evaluate an investment in RFID technology in a sheep feedlot. This concludes Chapter 3, in which the study area, assumptions of the model, variables, capital outlay, savings of benefits and financial techniques used were presented. Cash flow calculations can be observed in Appendix A1 and B1 on page 82 and 83. The next chapter focuses on the results obtained from the study data.

CHAPTER 4: RESEARCH RESULTS

4.1 INTRODUCTION

This chapter focuses on the results of the analyses and is divided into two sections according to the two scenarios created in Chapter 3. Firstly, in the results for Scenario 1, the reduction in feeding costs are investigated to identify the true financial potential of the RFID system within the feedlot by culling the poor performers from the herd. Secondly, the benefit of having supplier information available in Scenario 2 are investigated in the case where non-performing suppliers were identified and lambs were only bought from the top two-thirds of suppliers.

4.2 SUMMARY OF STATISTICS

The calculations and analyses conducted are based on the data collected from the three batches in the chosen feedlot. The summary of the raw results is presented in Table 4.1.

Table 4.1: Batch A, B and C summary of statistics

Batch	A	B	C
Number of Animals	134	228	146
Average Start Weight (kg)	33.5	32.5	28.08
Total Start Weight (kg)	4489.5	7410	4100
Average End Weight (kg)	44.34	42.06	43.33
Total End Weight (kg)	5941	9590.6	6326
Average Total Gain (kg)	10.83	9.56	15.25
Total Gain (kg)	1451.5	2180.6	2226
Average Days In Feedlot	48.1	48.8	46

The following observations can be made from Table 4.1:

- Batch A contained 135 animals and represents 26.57% of the total number of animals used for this research. This first animal of Batch A was weighed on 1 February 2016 and the last animal on 16 May. The time spent by Batch A in the feedlot was 116 days until slaughter on 17 May 2016. The batch contained eight breeds from 24 different suppliers. The RFID scale weighed 450 times during the 116 days the batch spent in the feedlot.
- Batch B consisted of 228 animals and was the largest batch in this research. It represented 44.88% of all the animals used for the study. This first animal of Batch B was weighed on 1 March 2016 and the last animal on 10 June 2016. The time spent by Batch B in the feedlot was 102 days until they were slaughtered on 11 June 2016. The batch contained six breeds from 24 different suppliers, of whom one supplier was undefined. During the 102 days under feedlot conditions, the RFID scale was used 843 times.
- Batch C contained 146 animals and represented 28.74% of the total number of animals included in this research. This first animal of Batch C was weighed on 14 April 2016 and the last animal on 30 May 2016. The time spent by Batch C in the feedlot was 46 days until

slaughtering on 31 May 2016. The batch consisted of only Merino sheep from two different suppliers, of whom one supplier was undefined. The RFID scale was used 843 times during the 46 days.

4.3 JOINT DATA RESULTS FROM FEEDLOT

In total, 508 animals were used and the average results of the group were recorded as they went through the full feedlot cycle. Not all of the animals were in the feedlot in the same period, although feedlot conditions were kept constant for research purposes. The average results of the group as a whole are summarised in Tables 4.2 to 4.4.

Table 4.2: Production averages of sample population

Production Averages	Average
Start Weight (kg)	31,5
Day 14 Weight (kg)	35,0
AVG Weight in 14 Days (kg)	33,2
Estimated AVG Feed intake/day for 14 days (kg)	1,2
Last Weight (kg)	43,0
Total Gain (kg)	11,5
Total Days	47,8
Total ADG (g/day)	249,7
AVG Weight in Feedlot (kg)	37,3
Estimate AVG Feed Intake kg/day	1,4
Percentage Of feed intake/day/body weight	3,65
Slaughter percentage	45,55
Estimated FCR	6,5

*Results were calculated on a year-round full feedlot basis

The production averages are shown, and the following observations can be made from Table 4.2:

Across all the sampled animals, the average starting weight proved to be 31.5 kg, while the average last weight was 43 kg and an ADG of 249.7 g/day was recorded. The average start weight of the group may be a few kilograms too high according to the literature in Chapter 3. The suppliers may have held back their lambs to get some benefit from price fluctuations. A starting weight of between 25 kg and 28 kg is seen as ideal, because the FCR of heavier animals increases. An increase in FCR will result in less revenue because of more feed being consumed and less body weight being added.

The average ADG in the feedlot was not particularly high. ADG values of lower than 250 g can be regarded as poor. This indicates the need for the feedlot to identify non-performing animals that can be removed. The slaughter percentage (45.55%) of the group was also lower than would be expected from the literature. Lower slaughter percentages lead to lower revenue.

All the input cost averages of the group are presented in Table 4.3.

Table 4.3: Input cost averages of sample population

Input Cost Averages	Average
Labour Cost Day 14	R 0,98
Input Costs Day 14 (VAT deductible)	R 23,16
Input Cost Day 14 (VAT Zero rated/No effect)	R 64,68
Total Input Cost/head Day 14	R 87,84
Veterinary Costs/head	R 16,40
Labour Costs/head/day	R 0,07
Labour Cost/animal	R 3,35
Electricity Cost/head)	R 0,01
Transport Cost/head	R 10,00
Estimated Feeding Costs/head at End of Cycle	R 238,60
Statutory Levy/head	R 2,02
Input Cost (VAT deductible)	R 23,16
Input Cost (VAT Zero rated/No effect)	R 241,95
Total Input cost/head at End of Cycle	R 265,11

The average cost for the whole group is shown in Table 4.3. The average input cost/head at day 14 was calculated at R87.84, while the average total input cost/head at the end of cycle was calculated at R265.11. Each animal completing the feedlot period had a feeding cost of R 238.60, which made up 89% of the total input costs at the end of the cycle. Input costs at day 14 were calculated at R87.84/head, which is significantly lower than the end-of-cycle input cost and advocates the saving of feeding cost by removing non-performing animals. Besides feeding cost, day 14 costs also include the veterinary cost of R16.40 for the treatment of animals on arrival. A description of the revenue averages of the group can be seen in Table 4.4.

Table 4.4: Revenue averages of sample population

Revenue Averages	Average
Buying Price R/kg Excluding VAT (LW)	R 29,39
Buying Price/head Excluding VAT (LW)	R 925,64
Day 14 Selling Price/kg Excluding VAT (LW)	R 29,39
Day 14 Selling Price/Head Excluding VAT (LW)	R 1 028,38
Gross Profit after 14 Days Excluding VAT	R 14,89
End of Cycle Selling Price A2/3 R/kg Excluding VAT	R 71,68
End of Cycle Selling Price/Head A2/3 Excluding VAT	R 1 404,83
End of Cycle Gross Profit/head	R 212,06

The average gross profit at day 14 of the feedlot period (Table 4.4) for the group as a whole was calculated at R14.89, while the average end-of-cycle gross profit was R212.06.

These costs (Table 4.3) and revenues (Table 4.4) formed the basis for the two scenarios investigated in the study.

4.4 RESULTS FOR SCENARIO 1 – DRAFTING OF NON-PERFORMERS

This section presents the results for a feedlot with a capacity of 7 500 sheep based on the test population statistics. Non-performing lambs were identified based on their performance during the first 14 days in the feedlot. Non-performing lambs are those lambs for which an unfavourable end-of-cycle value is projected based on individual performance. The performance of these lambs was measured by making use of a RFID system that identified and weighed animals individually.

4.4.1 EFFECT OF ANIMAL DRAFTING ON FEEDLOT PROFIT

To indicate the monetary value of the RFID system, the difference in feedlot profit for a feedlot invested in the RFID drafting system should be compared to a feedlot that did not invest in such a system. The calculated feedlot gross profit/year for a feedlot that invested in a RFID drafting system is shown in Table 4.5 and is compared to the values for a feedlot that does not make use of a RFID system (AVG End of Cycle Gross Profit).

Table 4.5: Feedlot gross profit/year

Current Suppliers' Animals							
	AVG Gross Profit Day 14		AVG End of Cycle Gross Profit		AVG of Highest Drafted Values		Difference
AVG/Head	14,89	R	212,06	R	213,71	R	1,65
Feedlot Year Total	852 627,26	R	12 139 429,51	R	12 233 832,98	R	94 403,47

Note: Income tax was not included in this gross profit/year calculation

In Table 4.5, the feedlot gross profit/year without the system can be seen under 'AVG End of Cycle Gross Profit' and was calculated at R12 139 429.51. This can be seen as the profit the feedlot makes annually without investing in a RFID system or culling non-performing animals. A difference of R1.65 per head and R94 403.47 gain in feedlot profit can be seen by culling the poor performers at day 14. The number of animals that were culled on day 14 was eight out of 508 animals, or 2% of the lambs bought. The 'AVG End of Cycle Gross Profit' column indicates the full cycle gross profit for all the animals. In other words, the profit without culling the weaker animals was R212.06 per head, while the profit was R213.71 per head when culling the low performers.

The column, 'AVG of Highest Drafted Values' can be described as the annual gross profit for a feedlot that invested in a RFID system. This shows the profit the feedlot will generate when non-performing lambs are culled.

Under the 'Difference' column, the additional revenue generated by investing in the RFID system and making use of the provided information in management decisions is shown. On a per-head basis, the system would allow for a profit increase of R1.65 per head. The feedlot that invested in the RFID system will generate an additional R 94 403 per year. According to the prices and assumptions, the average animal with a negative gross profit of R47.00 on day 14 will correlate with a negative gross profit at the end of the feeding cycle.

4.4.2 SENSITIVITY ANALYSIS

A sensitivity analysis was done to supply the potential investor with an indication of how the value of the RFID system in terms of its management capabilities can be used to increase feedlot profit. Because input prices and output prices continuously fluctuate, the sensitivity analysis will provide an indication of how these changing prices will influence feedlot profit. Management of the feedlot can also be adjusted according to these price changes.

The first two analyses were done to see how the feed (Table 4.6) and meat price (Table 4.7) influenced the feedlot profit, and what the optimum culling percentages should be on day 14 to maximise profitability. The next two analyses were done to determine how much of an effect the feedlot variables, such as ADG (Table 4.8) and FCR (Table 4.9), had on feedlot profit and where the optimum percentages of culling should be.

The feedlot profit shown in the different sensitivity analysis tables was conducted on the data of the 508 animals and the nett profit shown in the table only represents these 508 animals. Income tax deductions are not included in the sensitivity analyses. All other variables for the different sensitivity analyses were kept constant, as described in Chapter 3. The sensitivity analysis of feed price can be seen in Table 4.6

Table 4.6: Sensitivity analysis of feed price/t

	Feed Price/t							
	R2500/t	R3000/t	R3500/t	R3750/t	R4000/t	R4500/t	R5000/t	R5500/t
0%	148150	131989	115827	107747	99666	83505	67343	51182
0,50%	148340	132258	116176	108135	100094	84012	67930	51848
1%	148318	132303	116287	108280	100272	84256	68241	52226
2%	148020	132142	116265	108327	100388	84511	68634	52757
4%	147069	131404	115739	107907	100075	84410	68745	53081
6%	145928	130599	115271	107606	99942	84613	69284	53956
8%	144570	129492	114415	106876	99338	84260	69183	54105
10%	143115	128319	113524	106126	98729	83933	69138	54343
12%	141723	127181	112640	105369	98099	83557	69016	54475
14%	140184	125917	111651	104518	97385	83118	68852	54585
16%	138601	124629	110657	103672	96686	82714	68742	54770
18%	136886	123148	109411	102542	95673	81935	68197	54459

The sensitivity analysis on feed price/ton (Table 4.6)¹ shows the following:

- The feed price used in this study was R3 750/t. As can be seen in the R3 750/t increment, the optimum culling percentage was determined at 2% of the animals used in the study, with a profit of R108 327. The difference between culling 2% and 0% of 508 animals was R580. In

¹ The animal data used in the sensitivity analyses were sorted from high to low according to their ADG.

other words, R580 can be saved through the use of the RFID system. Of this nett profit, R65 465 is generated by saving on feed on a one-year basis with a feedlot capacity of 7 500 head.

- It is evident through this analysis that the higher the feed price, the more value the farmer can acquire through the use of the RFID system, because less animals will show a positive net profit after a full feedlot cycle, resulting in more animals culled and, ultimately, more money in the investor’s pocket. In Table 4.6, in the R5 500 increment, the difference between the optimum (16%) and 0% is R3 588. This results in an amount of R404 320 that can be saved on feed on a one-year basis with a feedlot capacity of 7 500 head.
- The opposite can be said for a lower feed price. As can be seen in the lowest increment of R2 500/t, only 0.5% will be culled, which in fact has no reasonable effect on the feedlot profit. This is because such a high percentage of the lambs show potential on day 14 to make a positive net profit after a full cycle of approximately 48 days.

The effect of the difference in the A2/3 meat price and the percentage culled on feedlot profit can be seen in Table 4.7.

Table 4.7: Sensitivity analysis of meat price/kg

	Meat Price/kg						
	R50/kg	R55/kg	R60/kg	R65/kg	R70/kg	R75/kg	R80/kg
0%	34114	51096	68077	85059	102041	119023	136004
0,50%	34570	51536	68502	85468	102434	119400	136537
1%	34825	51766	68706	85647	102587	119528	136523
2%	35179	52049	68919	85789	102658	119528	136365
4%	35381	52107	68834	85560	102287	119013	135651
6%	35950	52476	69002	85528	102054	118579	135008
8%	36026	52366	68706	85046	101386	117726	133961
10%	36159	52296	68432	84568	100705	116841	132884
12%	36221	52168	68116	84064	100011	115959	131796
14%	36265	52006	67747	83488	99229	114970	130584
16%	36358	51883	67407	82931	98455	113980	129341
18%	36114	51434	66754	82074	97394	112714	127841

The sensitivity analysis of meat price/kg² for the feedlot used (Table 4.7) shows the following:

- According to the data, the optimum percentage of animals culled at the lowest price/kg in Table 4.7 (R50/kg) was 16%. This is due to more animals that indicated at the 14-day stage that they would generate a net loss if kept in the cycle until slaughter weight was achieved. As seen in the previous table, the value of the RFID system is more evident when the economic variables are against the farmer (high input costs and low meat prices). This can in fact be a

² The meat price used in this study was R71.68/kg.

tool to manage risk in a feedlot business, but the more favourable the level at which the prices trade, the less value the farmer will receive from his investment.

- Conversely, the highest price/kg (R80/kg) resulted in the least percentage culled bracket, because 99.5% of the animals showed potential to make a profit after 48 days under feedlot conditions.
- The increment nearest to the 2017 average of A2/3 meat prices (R71.68) that was used in this study is that of R70/kg. The optimum culled percentage bracket was 2%, and as the price increases, the optimum percentage culled decreases. This indicates that the investor can save up to R617 on feed on the 508 animals, and this result in a one-year saving of R69 528 on a 7 500-head feedlot capacity.

The sensitivity analysis on ADG is shown in Table 4.8. The columns represent the average of the group, whereas the rows represent the percentage culled. It is important for the feedlot manager to consider the financial implications if the animals do not gain weight under feedlot conditions.

Table 4.8: Sensitivity analysis of ADG (g/day)

		Average Daily Gain							
		125g/day	150g/day	175g/day	200g/day	225g/day	250g/day	275g/day	300g/day
Percentage Culled	0%	19664	37324	54984	72645	90305	107966	125626	143287
	0,50%	20557	38531	55675	73234	90793	108353	125912	143471
	1%	21048	38758	56027	73517	91007	108496	125986	143476
	2%	21822	39278	56510	73854	91198	108542	125886	143230
	4%	22547	39667	56776	73890	91005	108119	125234	142348
	6%	24007	40784	57560	74336	91112	107888	124664	141440
	8%	24676	41149	57638	74119	90600	107081	123562	140043
	10%	25563	41770	57869	74021	90174	106327	122479	138632
	12%	26072	42021	57870	73769	89668	105567	121466	137365
	14%	26710	42301	57910	73511	89111	104711	120312	135912
	16%	27339	42529	57948	73252	88557	103861	119166	134470
	18%	27433	42587	57551	72610	87669	102728	117788	132847
	20%	27847	42577	57297	72022	86747	101472	116197	130922
	22%	27584	42503	57455	72391	87326	102262	117197	132133
	24%	28291	42368	56542	70668	84793	98919	113045	127170
	26%	28218	42014	55894	69732	83569	97407	111245	125083

- When comparing the results of the ADG analysis (Table 4.8) to the first two sensitivity analysis tables (Tables 4.6 and 4.7), it can be seen that, when the x-axis values (ADG) weaken from a feedlot economic point of view, the y-axis, which is the percentage culled, increases. The ADG is a massive influencer of feedlot profit. The difference between the optimum point of 125 g/day and culling 24% of the sheep increment (R28 291) compared to the optimum point of 300 g/day and culling 1% of the sheep increment (R143 476) is R115 185 for 508 animals. If calculated on a yearly basis for the 7 500-head full feedlot

capacity, it results in a significant difference of R12 979 827. In saying that, the average ADG recorded in this study was 249.69 g, which is not particularly good.

- The 250 g/day increment was the closest to the study average of 249.69 g, and the optimum point of culling was 2% with a feedlot profit amount of R108 542, which is an increase of R576 per cycle when compared to a feedlot not making use of the system (0% culling).

The effect of FCR on feedlot profit can be observed in Table 4.9.

Table 4.9: Sensitivity analysis of FCR

Percentage Culled	Feed Conversion Ratio										
	2	3	4	5	6	7	8	9	10	11	12
0%	206602	184634	162666	140698	118731	96763	74795	52827	30859	8891	-13077
0,50%	207040	185062	163083	141105	119127	97148	75170	53192	31213	9235	-12743
1%	207112	185149	163186	141223	119260	97297	75334	53371	31408	9445	-12518
2%	206922	185008	163095	141182	119269	97356	75443	53530	31617	9704	-12209
4%	206044	184227	162411	140594	118777	96960	75143	53326	31509	9692	-12124
6%	204776	183162	161549	139936	118322	96709	75096	53482	31869	10256	-11357
8%	203286	181832	160379	138925	117472	96018	74565	53111	31657	10204	-11250
10%	201494	180260	159025	137791	116556	95322	74087	52853	31618	10384	-10851
12%	199939	178872	157806	136739	115672	94606	73539	52473	31406	10340	-10727

The sensitivity analysis of FCR (Table 4.9) for the feedlot used in this study shows the following:

- ADG is an important factor regarding feedlot economics, but if FCR data is available, it is definitely the primary profit driver for a feedlot business. If the animal can gain more live weight with less feed consumed, the animal is more efficient and more profitable. The management aspects of the feedlot are important to maximise profits, as discussed in this research, but the scientific aspect should not be ignored because it can be seen as the foundation from which to work. Table 4.9 highlights the fact that FCR is an important profit driver. The difference in feedlot profit for 508 animals from 1:2 FCR to 1:12 FCR is a considerable R219 679.
- Based on the data in Table 4.9, it is clear that an FCR of > 1:11 will result in a negative feedlot profit, therefore the feedlot manager should consider the estimate FCR at day 14 to decide whether the animal should be culled or not. Unfortunately, in this study only an estimated FCR could be calculated due to the fact that individual pens were not available to feed animals individually to monitor their feed intake. The average estimated FCR recorded for this study was 1:6.5.

The decision to cull certain animals was made on the basis of their ADG values on day 14. Figure 4.1 indicates the feedlot profit curve in accordance with the percentage culled.

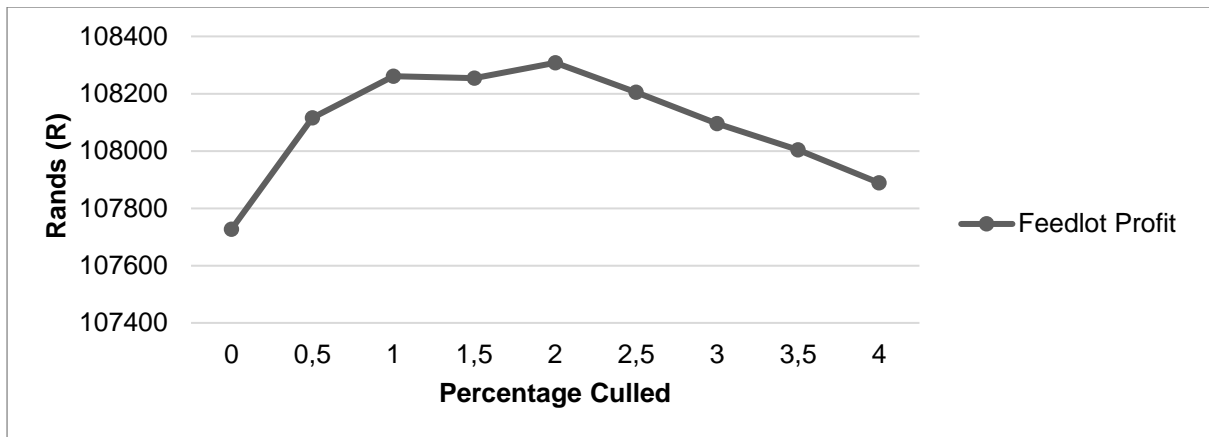


Figure 4.1: Feedlot profit vs. percentage culled according to ADG

The feedlot profit vs. the percentage culled shows the following:

- The optimum point of feedlot profit is at a 2% culling rate for the feedlot used in this research. Some farmers cull the weakest one-third of their animals, but this is in fact not the best method to use if the data in Figure 4.1 is analysed. A drop in feedlot profit occurs after the pinnacle (2%) is reached. Culling 33% would result in profits lost because of unnecessary culling of animals based on these results.

4.5 RESULTS FOR SCENARIO 2 – IDENTIFYING TOP SUPPLIERS

This section first provides an overview of the performance measures for each supplier before presenting feedlot results for scenario 2. The results presented in this section are those for which the non-performing suppliers of lambs were identified from the first year's data. Lambs for the feedlot were only bought from the top two-thirds of suppliers from the second year onwards. Despite purchasing lambs from only the top two-thirds of suppliers, non-performing lambs were still drafted at the weighing on day 14.

4.5.1 SUMMARY OF SUPPLIER DATA

Data obtained for the different suppliers from the RFID system was used to calculate the average gross profit per head of sheep from each supplier. Suppliers were ranked from highest to lowest gross profit per head of sheep and are shown in Table 4.10.

Table 4.10: Supplier data ranked in descending order according to gross profit/head

Rank	BuyRef	Start Wght(kg)	AVG Wght (kg)	End Wght (kg)	Total Days	ADG (g/day)	Estimated FCR	Breed	Gross Profit:Day 14	Gross Profit/head End of Cycle
1	II	28,088	35,662	43,237	47	328	4.28	Merino	R 52.48	R 330.55
2	AA	27,417	36,183	44,950	70	253	5.28	SA Mutton Merino	R 24.03	R 291.40
3	U	29,839	36,564	43,290	46	303	4.32	Dohne Merino	R 39.28	R 281.62
4	I	36,000	43,000	50,000	56	250	6.28	Dohne Merino	R 6.38	R 215.77
5	GG	32,500	37,000	41,500	31	290	4.65	Merino	R 29.14	R 215.46
6	X	26,000	32,200	38,400	57	218	5.42	Dohne Merino	R 12.63	R 209.24
7	Q	29,200	35,650	42,100	60	215	6.23	Dohne Merino	R 5.48	R 194.23
8	A	36,727	41,377	46,027	39	250	6.62	Mix	R 4.79	R 185.72
9	CC	21,667	29,167	36,667	87	172	6.52	Dorper X	R 2.97	R 181.80
10	B	25,000	30,800	36,600	60	193	5.81	Merino	R 4.91	R 177.92
11	W	37,500	43,000	48,500	47	234	6.71	Dohne Merino	R -2.84	R 176.31
12	M	41,563	45,094	48,625	27	262	7.45	SA Mutton Merino	R 0.33	R 172.37
13	O	29,667	34,342	39,017	43	217	6.09	Merino	R 5.56	R 171.69
14	FF	31,647	36,488	41,329	44	220	6.43	Dohne Merino	R 2.80	R 171.29
15	Z	28,815	33,988	39,362	53	207	6.53	Dorper	R 3.26	R 167.40
16	E	26,750	35,175	43,600	92	184	7.63	Dohne Merino	R -2.19	R 165.75
17	P	38,500	43,250	48,000	42	226	6.98	Dohne Merino	R -7.88	R 158.94
18	S	36,174	40,822	45,470	44	220	6.34	Merino	R -5.84	R 157.21
19	DD	39,298	43,925	48,551	42	220	7.82	Merino	R -11.76	R 149.59
20	D	35,286	40,093	44,900	47	206	7.39	Mix	R -9.63	R 142.52
21	V	27,559	32,044	36,529	49	190	6.83	Merino	R -1.22	R 141.60
22	C	40,375	44,188	48,000	38	223	8.51	Mix	R -12.71	R 140.33
23	Y	27,310	32,421	37,533	58	176	7.17	Undefined	R -6.31	R 136.22
24	K	35,500	38,750	42,000	38	171	8.90	Dohne Merino	R -24.08	R 98.57
25	N	34,556	37,756	40,956	38	167	10.09	Merino	R -23.97	R 95.22
26	F	32,833	37,000	41,167	53	157	9.23	SA Mutton Merino	R -24.47	R 81.83
27	EE	27,294	32,203	37,112	74	133	10.85	Merino	R -23.41	R 66.95
28	L	31,625	36,900	42,175	75	140	9.84	Dohne Merino	R -29.06	R 48.22
29	G	28,000	34,000	40,000	88	136	9.10	Dorper X	R -23.52	R 42.22
30	T	34,750	36,325	37,900	32	98	14.86	Merino	R -51.55	R 29.62
31	HH	32,500	38,250	44,000	82	140	9.95	Undefined	R -30.60	R 21.20
32	R	42,333	45,917	49,500	56	128	13.52	SA Mutton Merino	R -54.32	R -9.04
33	H	35,500	40,000	44,500	89	101	14.44	Merino	R -51.92	R -109.10
34	J	27,333	30,667	34,000	101	66	24.59	Dohne Merino	R -50.25	R -149.42
35	BB	36,500	37,950	39,400	65	45	31.05	Undefined	R -76.33	R -153.68

*Results are calculated per head

These calculations (Table 4.10) could serve as a basis from which feedlots can select producers of better-performing lambs. Unfortunately, there are no data on the historic entry weights of the suppliers, hence specific circumstances on a farm could have forced the supplier to once-off provide lambs of a certain weight at this specific time. The RFID system will however enable the feedlot to build up a database of the entry weights of specific suppliers over time. The following observations can be made from the calculations:

Firstly, producer II measured the best results according to the calculations and made an average of R330.55 per head, as opposed to producer BB, who produced the worst results, with a loss of R153.68 per head.

In terms of end-of-cycle gross profit, only four of the 35 suppliers made a gross loss. It is evident that the monetary value of the RFID system can be seen from these four suppliers. If supplier BB's non-performing animals were culled automatically by the RFID system at day 14, the feedlot would have saved R77.35 on each of his/her animals. The difference between the best and worst supplier after the average 48 days under feedlot conditions was R484.23.

4.5.2 RESULTS OF SUPPLIER AND ANIMAL DRAFTING

Another way to indicate the monetary value of the RFID system is the ability of the system to rank the suppliers from best to worst. The approach here is that the feedlot wants to work only with the best suppliers' animals, therefore, this model calculated the gross profits of the top 66.6% suppliers. Table 4.11 indicates the gross profit from making use of all the current suppliers, while Table 4.12 indicates the gross profit from buying only from the top 66.6% of suppliers.

Table 4.11: Feedlot gross profit/year with current suppliers

Current Suppliers' Animals							
	AVG Gross Profit Day 14		AVG End of Cycle Gross Profit		AVG of Highest Drafted Values		Difference
AVG/Head	14,89	R	212,06	R	213,71	R	1,65
Feedlot Year Total	852 627,26	R	12 139 429,51	R	12 233 832,98	R	94 403,47

*Income tax was not included in this gross profit/year

Table 4.11³ shows the gross profit of the feedlot from buying lambs from the current suppliers under the conditions of Scenario 1. The table shows the gross profit for a situation in which animals are drafted at 14 days in the feedlot compared to not drafting any animals. Without investing in a RFID system, the average end-of-cycle gross profit was calculated at R12 139 429.51. When investing in the system, the gross profit value (average of highest drafted values) was calculated at R12 233 832.98.

Table 4.12 shows the gross profit when only purchasing lambs from the top 66.6% of suppliers.

Table 4.12: Feedlot gross profit/year from top 66.6% of suppliers' lambs

Top 66,6% Suppliers' Animals							
	AVG Gross Profit Day 14		AVG End of Cycle Gross Profit		AVG of Highest Drafted Values		Difference
AVG/Head	20,11	R	237,65	R	238,09	R	0,44
Feedlot Year Total	1 151 256,41	R	13 604 363,53	R	13 629 484,51	R	25 120,99

*Income tax was not included in this gross profit/year

Presented in Table 4.12 are the gross profits generated by purchasing lambs from only the top two-thirds of suppliers. The average gross profit per head showed an improvement compared to scenario 1 (R 20.11 vs. R 14.89), as did the average end-of-cycle gross profit per head (R237.65 vs. R212.06). When comparing the numbers for the feedlot at full capacity, the profit per year increased from R12 233 832.98 to R13 604 363.53, or by 11.2%. By also drafting lambs purchased from the top suppliers at day 14, an additional R0.44 per head of sheep, or R 25 121 for the whole feedlot per year, was generated. In terms of these calculations the investment in RFID is viable.

4.6 FINANCIAL ANALYSIS

This section focuses on the results based on the financial model that determines the feasibility of investing in a RFID system. The financial model used to calculate the investment also calculated different financial indicators. The inputs and financial information are summarised in Table 4.13.

³ Table 4.5 is repeated as Table 4.11 to improve the illustration of the difference between gross profit with and without the RFID system.

Table 4.13: System and financial inputs of the RFID system

System information	
Life expectancy of scale	10 years
Life expectancy of tags	2 years
Life expectancy of drafter	10 years
Financial information	
Capital outlay	R450 000
Prime interest rate	10.25%
Inflation rate	5.91%
SARS tax rate	28%

The information described in Table 4.13 was used to calculate the financial indicators used in the research. The expectancy of the scale and drafter agrees with the time span of the investment. All calculations were done for the 10-year period until the scale needed to be replaced. RFID ear tags were replaced after every two years. The financial information was discussed in Chapter 3.

4.6.1 RESULTS OF FINANCIAL MODEL – SCENARIO 1

These results are based on the assumptions of Scenario 1, in which non-performing animals were drafted. Calculations were done for a 7 500-head sheep feedlot fully stocked year-round and analysed accordingly. Capital outlay was included in the calculation, and variable costs were added. All animals were fed the same rations and were weighed weekly. After the full cycle was completed, the extra profit was calculated from the weaker animals that were culled. The investment span of 10 years and cash flow calculations can be observed in Table 4.14.

Table 4.14: Cash flow of feedlot without drafted animals

Feedlot Cash Flow					
Years	Variable cost	Profit from Investment	Year End Cash Flow		Accumulative Cash Flow
0			R	-450 000,00	R -450 000,00
1		R 67 970,50	R	67 970,50	R -382 029,50
2		R 71 987,55	R	71 987,55	R -310 041,95
3	R -255 745,96	R 76 242,02	R	-179 503,94	R -489 545,90
4		R 80 747,92	R	80 747,92	R -408 797,98
5	R -286 868,41	R 85 520,12	R	-201 348,29	R -610 146,27
6		R 90 574,36	R	90 574,36	R -519 571,91
7	R -321 778,23	R 95 927,30	R	-225 850,93	R -745 422,83
8		R 101 596,61	R	101 596,61	R -643 826,22
9	R -360 936,32	R 107 600,97	R	-253 335,35	R -897 161,57
10		R 113 960,19	R	113 960,19	R -783 201,39

From the cash flow (Table 4.14) it can be seen that the variable costs (replacement of tags) outweigh the additional profit from the investment. The accumulative cash flow shows that the investment did not make any revenue during the 10-year lifetime of the scale. The calculation shows a loss of R783 201.39 generated from investing in the system. This indicates that the investment is unviable for the investor. The capital outlay of R450 000 plus the variable costs (ear tags, scale, etc.) were too

high to justify the investment for the profit made from the investment. The financial indicators for the first analysis as described in Chapter 3 were calculated based on the financial results of Scenario 1 and are shown in Table 4.15.

Table 4.15: Financial indicators for Scenario 1

Method	Value	Accept or Reject
Net Present Value (NPV)	R -611 438,01	Reject
Internal Rate of Return (IRR)	-	Reject
Simple Payback Period (SPP)	>10	Reject
Return on Investment (ROI)	-47%	Reject

The financial results in Table 4.15 show that the investment has an NPV of -R611 438.01, which indicates an unviable investment. All negative NPV values should not be considered. The same can be applied to the internal rate of return, which was also negative. The SPP value indicates that the payback period could not be met within the 10-year lifetime of the scale. The ROI also indicates a negative value of -47%, resulting in an unviable investment. According to all the financial indicators, this investment is not worth carrying out.

The benefit that was focused on in this analysis was only the drafting ability of the RFID system, in terms of which non-performing animals are identified and removed from the feedlot. If this is the only benefit provided by the RFID system to the investor, the investor should not invest in such a system.

4.6.2 RESULTS OF FINANCIAL MODEL – SCENARIO 2

This section shows the financial indicators for Scenario 2, in which the top suppliers were identified after year 1 and their non-performing animals were removed on a continuous basis. After the one-year trial period for the suppliers, the top 66.6% were selected and only lambs supplied from them were bought. Again, the calculation was done for a feedlot filled with 7 500 head of sheep all year. The animals of the culled suppliers were replaced by average values for the animals of the top 66.6% of suppliers. After two weeks, all animals were evaluated to determine whether each animal would make more profit if it was kept in the feedlot for the full cycle. If not, it was culled. The cash flow for the feedlot was calculated and the results are shown in Table 4.16.

Table 4.16: Cash flow of feedlot without drafted suppliers and animals⁴

Feedlot Cash Flow				
Year	Variable cost	Profit from Investment	Year End Cash Flow	Accumulative Cash Flow
0		R -	R -450 000,00	R -450 000,00
1		R -	R -	R -450 000,00
2		R 1 136 244,42	R 1 136 244,42	R 686 244,42
3	R -255 745,96	R 1 203 396,47	R 947 650,51	R 1 633 894,93
4		R 1 274 517,20	R 1 274 517,20	R 2 908 412,13
5	R -286 868,41	R 1 349 841,16	R 1 062 972,75	R 3 971 384,88
6		R 1 429 616,78	R 1 429 616,78	R 5 401 001,66
7	R -321 778,23	R 1 514 107,13	R 1 192 328,90	R 6 593 330,56
8		R 1 603 590,86	R 1 603 590,86	R 8 196 921,42
9	R -360 936,32	R 1 698 363,08	R 1 337 426,76	R 9 534 348,18
10		R 1 798 736,34	R 1 798 736,34	R 11 333 084,52

From the cash flow (Table 4.16) it can be seen that the RFID system generated more additional profit in scenario 2 than in scenario 1. In this analysis, the profit from the investment outweighs the investment and variable costs. The reason for this improvement in revenue is that the worst performing suppliers were removed after year 1. The results highlight the benefit of having management data, which is captured by the RFID system and can be used in the management of the feedlot. The accumulative cash flow at the end of the 10-year period was calculated at R11 333 084.52, which is the direct result of investing in the RFID system. This can also be seen as the additional cash flow resulting from the investment. To realistically determine the feasibility of the investment, financial indicators must be used. The financial indicator results for scenario 2 are shown in Table 4.17.

Table 4.17: Financial indicators without drafted suppliers and animals

Method	Value	Accept or Reject
Net Present Value (NPV)	R 6 073 706,90	Accept
Internal Rate of Return (IRR)	115%	Accept
Simple Payback Period (SPP)	1,5	Accept
Return on Investment (ROI)	676%	Accept

The financial results in Table 4.17 show that the investment has an NPV of R6 073 706.90 and an IRR of 115%. Any IRR value higher than the prime interest rate (10.25%) indicates a viable investment. The prime interest rate was used as the discount rate of the calculations and the reason are stipulated in section The NPV and IRR values indicate that the investment should be carried out. The SPP indicates that the investment should break even after one year and five months, which is a relatively short period. An investment with a ROI greater than 150% is regarded as excellent. This analysis indicates a ROI of 676%, which is an above-average investment.

⁴ Operation costs from year one were added in year two.

4.7 EVALUATION OF FINANCIAL MODELS

The results of the ROI, SPP, IRR and NPV calculations for the feedlot are discussed in the next few paragraphs.

Firstly, when observing the financial indicators of Scenario 1 regarding the drafting of only the animals, it showed that not one financial indicator indicated that the investment should be carried out. In contrast, when observing the financial indicators for Scenario 2 in Table 4.17, regarding the drafting of suppliers and their animals, it appears that there should be no reason why the investor should not invest in this RFID technology. All the values present in Table 4.17 are in favour of the investment. When NPV is analysed specifically, the value shown in Table 4.17 indicates the value of future cash flows presented in today's value. The return on the initial investment would be valued at R6.1 million, making it a good choice to invest in the RFID technology, because every project with a positive NPV should be carried out and projects with a negative NPV should be rejected.

IRR is a metric used in capital budgeting techniques to measure projects with different lifetimes against each other. The IRR is a discount rate that makes the NPV of all cash flows equal to zero. If the IRR is more than the discount rate, as in this case, the project should be carried out. Any IRR less than the prime interest or discount rate should be rejected. In the case of this research, the IRR for Scenario 2 was 115%, while the first scenario had a negative IRR value. The IRR values for Scenario 2 are a positive indication, because the higher the IRR, the more desirable it is to undertake the project.

When observing Scenario 2 in terms of SPP, it is quite evident that the initial capital outlay can be recovered in less than two years (1.4 years). In fact, it can be recovered even quicker if the trial or supplier-sorting period (the period in which the feedlot filters its top 66.6% suppliers from the rest) is dealt with in a shorter time. An infinite contributor to why the SPP value is after one year is the fact that the trial or sorting period in the feedlot took a year to be completed. For this model to be practically correct, the trial or sorting period needed to be longer than six months to allow every supplier to trial his animals at least once per year, as it is not practically correct to start from year one with only the top 66.6% of suppliers. This period could in fact be taken care of in a shorter space of time, resulting in a faster SPP. Scenario 1's SPP analysis proved not to be viable. An amount of R783 201.93 was still outstanding after the 10-year period.

A ROI greater than 100% is seen as good and a ROI greater than 150% is regarded as excellent, although a ROI greater than 150% should never be the aim. In Table 4.17 it can be observed that the ROI for the second analysis was 676%, making it an outstanding opportunity for investment.

4.8 SUMMARY OF DISCUSSION

Two scenarios were tested in this chapter, followed by the calculation of NPV, ROI, IRR and SPP for each analysis. In the first scenario, it was determined that the capital outlay and variable costs

outweighed the profit of the investment. According to the analysis, it was not a financially viable investment if only the non-performing animals were drafted at day 14.

In scenario 2, suppliers were sorted from best to worst according to their animals' average predicted end-of-cycle gross profits after the one-year period. Lambs were no longer bought from the worst third of suppliers from year two onwards. Financial indicators (NPV, IRR, SPP and ROI) based on the financial calculations for scenario 1 in Table 4.15, all showed that the investment in RFID technology for sheep feedlots in South Africa is viable.

The difference in lamb performance was significant amongst the different suppliers. The feedlot manager should aim to buy animals only from suppliers who have good track records in the feedlot. With the RFID system it is easy to measure which suppliers perform better than others. It should be a priority to buy only from the top 66.6%, if possible, to increase revenues as shown in the analysis of Scenario 2.

The RFID system proved to be a "method" to decrease risk in the feedlot environment. It was clear that the less favourable the markets, the more value the RFID system contributed to the farmer. The sensitivity analysis indicated, for example, that when the meat price is low and input prices are high, the system will cull more animals because of their day 14 value being higher than their end-of-cycle predicted value, resulting in more feed saved.

One of the biggest factors influencing the gross profit calculations was not knowing which the good and bad animals were on arrival. These animals were all injected, tagged and dosed on arrival. This resulted in a negative net profit per animal on the first day because of the money spent before the animals had even entered the feedlot gates. According to the data, the money spent on arrival of animals that showed a negative predicted gross profit after a full feedlot cycle, will never be recovered. In saying that, the data indicated that some animals only start to show a positive gross profit as late as day 47. It was found that it is difficult to place a monetary value on each of the benefits, but if the researcher uses successful methods of analysis in the system, it proves to be an outstanding investment if utilised correctly.

This concludes Chapter 4, in which the results obtained from the study's data were presented, evaluated and discussed. Chapter 5 focuses on the conclusion of the study, in which recommendations, limitations and further suggestions for research on this topic are discussed.

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

5.1 INTRODUCTION

Precision farming is a trend that is evident in agricultural sectors worldwide. This focus on precision agriculture has led to a wide range of new technologies that have made available in the market. The majority of these technologies, such as drones, UGVs and apps, focus only on the crop industry, with little attention being paid to the livestock industry. It is evident that the domestic demand for food, which includes red meat, is increasing in accordance with the population of South Africa. Local farmers should ensure that production is increased and that this demand is met by the local agricultural sector. RFID technology is one of the latest technological advancements in the livestock industry of South Africa, but it has not enjoyed much research as of yet to determine the viability of investing in such a system. This study contributes to the information available on investing in a RFID system and how this system should be placed within the management decisions of a sheep feedlot.

5.2 MEETING THE AIM OF THE STUDY

The aim of the study was to evaluate the financial viability of implementing RFID technology in a South African sheep feedlot. To this end, a financial model was developed to determine the financial viability of implementing RFID technology in a South African sheep feedlot. This model was applied to two scenarios to determine how a RFID system and the information gathered using the system should be incorporated into a sheep feedlot.

5.2.1 DETERMINING THE FINANCIAL VIABILITY OF A RFID SYSTEM

Previous research has indicated that the benefits of using a RFID system can be divided into monetary and non-monetary benefits (Hammer *et al.*, 2017). This study focused specifically on two of the monetary benefits to ensure that the viability of such a system could be determined. The monetary benefits focused on in the study were the feed saved and the availability of supplier data, which is categorised as a revenue benefit when using RFID systems (Sarac *et al.*, 2010). A scenario was created to test each of these benefits.

In order to determine the viability of investing in a RFID system, the following financial indicators were used – NPV, IRR, SPP and ROI. By using these indicators, an accurate investment decision could be taken.

- **Scenario 1 – Removal of non-performing lambs**

This scenario, which is based on the benefit of feed saved by removing non-performing lambs from the feedlot at day 14, showed an R 94 403 increase per year in gross profit. This was for the 7 500-head sheep feedlot completing seven cycles of 48 days per year. By using the RFID system, the gross profit per animal was increased by R1.65 for each animal finished in the feedlot. Financial indicators for the investment in the RFID system under the assumption of Scenario 1 (Table 5.1) all

showed that the investment is not viable. The NPV and the IRR were negative, which indicates the project should be rejected. The SPP indicator showed that the investment would not be repaid within 10 years from the additional revenue generated by the investment in the RFID system, and that it should be rejected. The ROI should exceed 100% to be seen as a good investment option, and in Scenario 1 it does not, thus it should not be considered.

Lots of money is spent on the arrival of the animals, as the investor does not know which the good and bad performers are at that stage. These animals were all injected, tagged and dosed. This resulted in a negative gross profit per animal on day 1 because of the money spent before they even entered the feedlot gates. According to the data, the money spent on arrival of an animal that shows a negative gross profit after a full cycle will never be recovered.

Table 5.1: Financial indicators for Scenario 1

Method	Value	Accept or Reject
Net Present Value (NPV)	R -611 438,01	Reject
Internal Rate of Return (IRR)	-	Reject
Simple Payback Period (SPP)	>10	Reject
Return on Investment (ROI)	-47%	Reject

- **Scenario 2 – Selecting top suppliers**

This scenario investigated the benefit of having supplier data available that was captured by the RFID system. In this scenario, the top two-thirds of lamb suppliers were identified after a one-year test period. From year 2 onwards, lambs for the feedlot were bought only from these top suppliers. Under this scenario, investment in the RFID system increased the gross profit by 11.2% (R12 233 832.98 to R13 604 363.53) and, if the non-performing lambs bought from the top suppliers were continuously removed from the feedlot at day 14, the profit further increased by R25 121 per year. Financial indicators for this scenario are shown in Table 5.2, and all indicators proved to be favourable towards investing in the system. The investment showed an NPV of more than R 6 million. Any IRR values less than the prime interest (10.25%) or discount rate should be rejected. In the case of this research, the IRR was calculated at 115%, which is more than the prime interest rate. This indicator suggests that the investment should be accepted.

When observing the second feedlot scenario in terms of SPP, it is quite evident that the initial capital outlay can be recovered in less than two years from the additional profit generated by the investment. The capital outlay and variable costs of the investment will be recovered in one year and approximately five months. An investment that reaches break-even between two and three years is regarded as a good investment and therefore this investment should be considered. A ROI greater than 100% is regarded as good, and a ROI greater than 150% is regarded as excellent. In this scenario, the ROI exceeds the 150% mark (676%), making it in an outstanding opportunity for investment. In conclusion, the results suggest that this project should be carried out.

Table 5.2: Financial indicators for Scenario 2

Method	Value	Accept or Reject
Net Present Value (NPV)	R 6 073 706,90	Accept
Internal Rate of Return (IRR)	115%	Accept
Simple Payback Period (SPP)	1,5	Accept
Return on Investment (ROI)	676%	Accept

Some conclusions can be drawn from the model that was developed and the financial indicators that were used to test the investment in the RFID system. It can be concluded that, if the only benefit of investing in a RFID system is the feed saved when non-performers are removed on day 14 (Scenario 1), the investment should not be made.

It can be concluded that, when the focus of the RFID system is to identify top suppliers, after a test period in which the performance of the different suppliers' lambs is measured individually (Scenario 2), an investment in a RFID system should be made. The system will increase the profit of the sheep feedlot and repay the investment in less than the required time.

5.2.2 OBSERVATIONS FROM THE STUDY

A number of factors came to light during the study that future researchers should consider when undertaking future studies:

The difference in start weight between the top suppliers and the lower ranked suppliers was seen as a significant factor influencing gross profit. The average start weight among the top five suppliers was 4 kg lighter than that of the bottom five suppliers. This observation is echoed in the literature as stipulated in Chapter 3; lower starting weight equals lower FCR values, resulting in higher gross margins (Vosloo *et al.*, 1987).

It is evident that ADG is one of the most, if not the most, influential variable in a sheep feedlot. Since the value of ADG and live weight are used to calculate an estimated FCR for this model, the value is largely dependent on the ADG; therefore, the FCR cannot be used to draw broad conclusions, although it can be used to give the researcher an indication of the performance of the animal.

The differences in supplier performance were quite evident (Table 4.10), and this had an immense influence on the outcome of the study. The contribution it made to this research can be seen in Table 4.14, illustrated in the difference in gross profit of the top 66.6% compared to the gross profit of the unfiltered group. This highlights the value that RFID technology offers to a sheep feedlot. Not only can it measure the performance of individual animals, but it also allows the identification of better suppliers.

The number of days spent in the feedlot can also be a contributing factor to gross profit per animal. According to the findings of the study, the longer the animal is in the feedlot, the more the gross profit per animal decreases. This is similar to the findings in the literature and proves that animals achieve an optimum growth rate, after which the performance of the animal decreases in the feedlot and the

gross profit ultimately suffers (Jolly & Goers, 2007). To feed an animal for a period that is too long does not make economic sense. The difference in average total days between the top third and bottom third was 14 days. This is quite a long time in a feedlot, especially if the animal's ADG is as low as 45 g/day.

A one-year test period was used in this study and the SPP was calculated at 1.5 years. It should be mentioned that this indicator would be different if the test period differed in length. Drought may also influence the SPP because, in some cases, after a drought period where suppliers have held back more of their weaned lambs, the feedlot can be desperate for stock and allow in any of the available weaner lambs that are left in the market. In a typical feedlot, such as used in this study, the feedlot can use contracts to stipulate the amounts taken into the feedlot and specify weights (or age) of lambs to be supplied to reduce risk.

5.3 LIMITATIONS OF THE STUDY

While all the methods used to develop this research model were applied successfully with the data available, there are still many limitations that, if overcome, could contribute to a more accurate model. The capital budgeting techniques used had set equations to work with, but the cash flow calculations relied on assumptions that were made and the skill of the researcher. In determining the benefit that the RFID system holds for a sheep feedlot, feed consumption was a critical factor that influenced the profit of the producer. If the model was to be more accurate, the daily feed intake should have been measured to give the researcher a precise FCR. The model included a feed consumption estimate, by using the animal's body weight times the assumed percentage feed eaten per day (3.65% of LW). Feed in itself is a big expense for producers and has a big impact on profit margins.

While transport costs for feedlots in general have a relatively small impact on input cost per unit, the effect is still observable in the profit margins. The data received did not include supplier distance from the feedlot, and therefore a constant value was assumed. If the precise distance and transport cost are added to the model it would improve the accuracy of the results.

The carcass grading and slaughter percentage data were not individually graded and needed to be processed to obtain the average that was used in the model. If the model were supplied with individually graded data, the calculations would have been more accurate. Another benefit would have been the ability to trace the different suppliers' animals from the feedlot through to the abattoir. This would have given the researcher a better indication of who the top two-third suppliers were. Although data received from the abattoir was processed to averages, the data received from specifically the feedlot, gave the researcher a good indication of who the top suppliers were.

When the NPV technique was used in the analysis, there were a few drawbacks involving the calculations, such as the fact that the technique relies heavily on various assumptions and estimates, so there is room for inaccuracy resulting from inaccurate values. Nevertheless, if used accurately, NPV can be a valuable capital budgeting tool.

The high ROI percentages can be due to the fact that the research was based on feedlot conditions, where animals were substituted instantly after completing the feedlot cycle. This can have a minor influence on NPV, IRR and SPP as well.

5.4 RECOMMENDATIONS

Based on the results in Chapter 4, it is recommended that sheep feedlots make management data they receive from the RFID system a priority. This data should be used to determine their better suppliers of lambs, as well as to determine the performance of all animals in the feedlot in order to identify non-performers.

South African producers have limited control over most of their input costs (such as feed prices) and are price takers when selling their product (producer price of meat). However, RFID technology offers sheep feedlots the ability to apply these inputs more effectively and control input costs by removing poorly performing producers and non-performing lambs.

The model that was developed in the study provides sheep feedlot producers with a valuable tool to evaluate new management information systems (MIS) available to them, such as RFID technology. As policy changes take place and technology develops (e.g. longer lifespan of ear tags), the model can be adapted to new assumptions to direct investment decisions.

Sheep feedlots that buy their lambs from many suppliers and only want to measure the performance of all their animals are not advised to invest in a RFID system. The costs of such an investment do not justify the additional returns generated by the investment. If only the initial tag costs involved (R2.03/head) are observed, which is greater than the additional returns generated from the investment (R1.64/head), it can be confirmed that the investment is unviable. However, when the focus of the feedlot is to make use of supplier data captured from the RFID system and to base its decisions on this information, the system will be a worthwhile investment.

The RFID system should not be invested in if the investor only wants to reduce labour costs and time saved on operations. Louw (2017) stated that this is the case with the RFID technology because the attachment process of the tags onto the animals are time and labour consuming.

5.5 SUGGESTIONS FOR FURTHER RESEARCH

In terms of further research in the area of RFID systems, the following suggestions can be made:

- Studies should investigate what the financial benefit of the RFID system would be across three sections of the meat value chain, e.g. primary producer, feedlot and abattoir.
- A comprehensive analysis of the financial benefits of the RFID system for the primary producer should be conducted. This research should include an analysis of the influence the system has on second and third lambing seasons by using the data provided by the system to select appropriate replacement ewes.

- Additional analysis can be done on the RFID system in terms of analysing other monetary and non-monetary benefits of the system, such as better decision making according to changing market needs and time saved by using the system.

In terms of further research to be undertaken in the feedlot industry, the following suggestions are made:

- Investigating how RFID body temperature meters can be used to predict diseases.
- For further research on the cost-benefit analysis of RFID technology, the full growth curve estimates should be implemented for full cycle body weight predictions to make the model even more accurate.
- The effect of different test periods during which top suppliers are identified should also be investigated.
- Analysis of the welfare impact of RFID technology on sheep.
- The effect of the different suppliers' performance in the feedlot and abattoir can be investigated.
- The same research can be investigated but with more accurate data such as measured FCR values for each animal.

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Appendix A1: Scenario 1 Cash Flow Calculations

Current Suppliers' Animals				
	AVG Gross Profit Day 14	AVG End of Cycle Gross Profit	AVG of Highest Drafted Values	Difference
AVG/Head	14,89	R 212,06	R 213,71	R 1,65
Feedlot Year Total	852 627,26	R 12 139 429,51	R 12 233 832,98	R 94 403,47
Top 66,6% Suppliers' Animals				
	AVG Gross Profit Day 14	AVG End of Cycle Gross Profit	AVG of Highest Drafted Values	Difference
AVG/Head	20,11	R 237,65	R 238,09	R 0,44
Feedlot Year Total	1 151 256,41	R 13 604 363,53	R 13 629 484,51	R 25 120,99
Years	Day 48 Gross Profit/head - Tax	Best value between Day 14 & End of Cycle - Tax	Difference	
Unfiltered				
1	8740389,248	8808359,743	67970,49536	
2	9256946,253	9328933,804	71987,55163	
3	9804031,776	9880273,792	76242,01594	
4	10383450,05	10464197,97	80747,91908	
5	10997111,95	11082632,07	85520,1211	
6	11647041,27	11737615,63	90574,36025	
7	12335381,41	12431308,71	95927,30494	
8	13064402,45	13165999,06	101596,6087	
9	13836508,63	13944109,6	107600,9682	
10	14654246,29	14768206,48	113960,1855	
Top 66,6%				
1	9795141,738	9813228,849	18087,11105	
2	10374034,62	10393190,67	19156,05932	
3	10987140,06	11007428,24	20288,18242	
4	11636480,04	11657967,25	21487,214	
5	12324196,01	12346953,12	22757,10835	
6	13052555,99	13076658,05	24102,05345	
7	13823962,05	13849488,54	25526,48481	
8	14640958,21	14667993,31	27035,10007	
9	15506238,84	15534871,71	28632,87448	
10	16422657,56	16452982,63	30325,07736	

Scenario 1: Cash Flow											
Years	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Variable Cost	R -	R -	R -255 745,96	R -255 745,96	R -286 868,41	R -286 868,41	R -321 778,23	R -321 778,23	R -360 936,32	R -360 936,32	R -360 936,32
Cash Flows	R -450 000,00	R 67 970,50	R 71 987,55	R -179 503,94	R 80 747,92	R -201 348,29	R 90 574,36	R -225 850,93	R 101 596,61	R -253 335,35	R 113 960,19
Feedlot Cash Flow											
Years	Variable cost	Profit from Investment	Year End Cash Flow	Accumulative Cash Flow							
0	R -450 000,00	R -450 000,00	R -450 000,00	R -450 000,00							
1	R 67 970,50	R 67 970,50	R 67 970,50	R -382 029,50							
2	R 71 987,55	R 71 987,55	R 71 987,55	R -310 041,95							
3	R -255 745,96	R 76 242,02	R -179 503,94	R -489 545,90							
4	R 80 747,92	R 80 747,92	R -98 756,02	R -588 291,92							
5	R -286 868,41	R 85 500,12	R -201 348,29	R -789 640,21							
6	R 90 574,36	R 90 574,36	R -110 773,93	R -900 414,14							
7	R -321 778,23	R 95 927,30	R -225 850,93	R -1 126 265,07							
8	R 101 596,61	R 101 596,61	R -124 254,32	R -1 250 519,39							
9	R -253 335,35	R 107 600,97	R -145 734,38	R -1 396 253,77							
10	R 113 960,19	R 113 960,19	R -131 773,19	R -1 528 026,96							
Years	Cash Flow	Amount left to pay	Investment cost	Profit from investment							
0	R -450 000,00	R 382 029,50	R 450 000,00	R 89 970,50							
1	R 67 970,50	R 310 041,95	R -333 201,39	R -165 230,89							
2	R 71 987,55	R 489 545,90	R -783 201,39	R -303 213,84							
3	R -179 503,94	R 408 797,98	R -1 116 981,23	R -408 183,25							
4	R 80 747,92	R 610 146,27	R -1 727 127,50	R -528 375,58							
5	R -225 850,93	R 519 571,91	R -2 246 700,39	R -677 127,47							
6	R 90 574,36	R 745 422,83	R -2 992 122,75	R -867 549,39							
7	R -225 850,93	R 643 826,22	R -3 635 949,07	R -1 024 123,17							
8	R 101 596,61	R 897 161,57	R -4 533 110,64	R -1 121 641,64							
9	R -253 335,35	R 783 201,39	R -5 316 312,03	R -1 304 843,03							
10	R 113 960,19	R -	R -6 149 514,22	R -1 418 803,22							
NPV	R -611 438,01		R -333 201,39	R 892 127,53							
IRR	R -783 201,39		R -783 201,39								
SPP	R -783 201,39		R -783 201,39								
ROI %	-47%										

Appendix B1: Scenario 2 Cash Flow Calculations

Current Suppliers' Animals				
	AVG Gross Profit Day 14	AVG End of Cycle Gross Profit	AVG of Highest Drafted Values	Difference
AVG/Head	R 14,89	R 212,06	R 213,71	R 1,65
Feedlot Year Total	R 852 627,26	R 12 139 429,51	R 12 233 832,98	R 94 403,47
Top 66,6% Suppliers' Animals				
	AVG Gross Profit Day 14	AVG End of Cycle Gross Profit	AVG of Highest Drafted Values	Difference
AVG/Head	R 20,11	R 237,65	R 238,09	R 0,44
Feedlot Year Total	R 1 151 256,41	R 13 604 363,53	R 13 629 484,51	R 25 120,99
Years	Day 48 Gross Profit/head - Tax	Best value between Day 14 & End of Cycle - Tax	Difference	
Unfiltered				
1	8740389,248	8808359,743	67970,49536	
2	9256946,253	9328933,804	71987,55163	
3	9804031,776	9880273,792	76242,01594	
4	10383450,05	10464197,97	80747,91908	
5	10997111,95	11082632,07	85520,1211	
6	11647041,27	11737615,63	90574,36025	
7	12335381,41	12431308,71	95927,30494	
8	13064402,45	13165999,06	101596,6087	
9	13836508,63	13944109,6	107600,9682	
10	14654246,29	14768206,48	113960,1855	
Top 66,6%				
1	9795141,738	9813228,849	18087,11105	
2	10374034,62	10393190,67	19156,05932	
3	10987140,06	11007428,24	20288,18242	
4	11636480,04	11657967,25	21487,214	
5	12324196,01	12346953,12	22757,10835	
6	13052555,99	13076658,05	24102,05345	
7	13823962,05	13849488,54	25526,48481	
8	14640958,21	14667993,31	27035,10007	
9	15506238,84	15534871,71	28632,87448	
10	16422657,56	16452982,63	30325,07736	

Appendix C1: Summary of Suppliers

Rank	Start Weight (kg)	Purchase Price (€/kg)	Price/head*	14 Days Weight (kg)	AVG Weight in 14 Days	Estimate AVG Feed Intake (kg) for 14 days	Estimate feed cost/head after 14 days	Gross Profit 14 days	Last Weight (kg)	Total Gain (kg)	Total Days	Total ADG (kg/day)	Total ADG (kg)	Total ADG (%)	AVG Weight in Feedlot	Breed	Buyer	Days from 14 to last weighed	Estimate AVG Feed Intake (kg/day)	% Of feed intake (kg/body weight)	Feed (kg)	Estimate Feeding Cost/head	Slaughter %	Selling Price (€/kg)	Veterinary Costs/head*	Estimate FCR	Labour Costs/Head (day)*	Labour cost/animal	Electricity cost	Statutory Levy	Gross Profit/Head*	Highest Value	
1	20,0076234	29.39	125,495261	33,753259	30,3039401	1,0823008	58,2072553	52,4763795	45,3270229	15,1493365	46,6280703	327,7045249	0,327074525	55,9549208	36,6623766	Merino	II		32,6280703	1,31075325	0,0865	3,75	227,2054952	4,4555	71,68	16,4	4,20830715	0,07	3,8409909	0,057	2,02	330,550124	330,550124
2	27,4566667	29.39	105,779333	30,907727	29,1077972	1,0633577	55,9196571	24,1086362	44,9500083	17,5333346	69,6666667	253,0075785	0,253007578	68,21424993	36,1033334	SA Mutton Merino AA			55,6666667	1,32092499	0,0865	3,75	340,9202589	4,4555	71,68	16,4	5,20047075	0,07	4,9766667	0,057	2,02	291,407485	291,407485
3	29,8989035	29.39	176,367719	34,0066208	31,9590226	1,06633524	61,2493099	39,2774045	45,2898385	13,4508473	44,47657627	302,9770733	0,302877073	47,0138478	36,5440671	Dohne Merino U	U		32,47467627	1,32400845	0,0865	3,75	226,4024989	4,4555	71,68	16,4	4,319489757	0,07	3,5220339	0,057	2,02	281,6163288	281,6163288
4	36	29.39	1168,04	39,5	30,75	1,377075	72,3384375	6,30366778	50	14	56	280	0,25	38,0000891	40	Dohne Merino I	I		42		0,0865	3,75	239,395	4,4555	71,68	16,4	6,278	0,07	3,92	0,057	2,02	215,774053	215,774053
5	32,5	29.39	955,175	36,5493599	34,532269	1,36147147	65,1724938	29,1407806	41,5	9	31	290,323700	0,290323701	27,69330843	37	Merino GG	GG		17		0,0865	3,75	156,99525	4,4555	71,68	16,4	4,63172238	0,07	2,17	0,057	2,02	215,4614483	215,4614483
6	26	29.39	764,4	29,0453195	27,5228688	1,04630495	52,74657807	12,8271246	38,3999962	12,8999962	57	217,549538	0,217549538	47,6933862	32,1099980	Dohne Merino IX	IX		43		0,0865	3,75	251,220375	4,4555	71,68	16,4	5,42082276	0,07	3,99	0,057	2,02	209,393953	209,393953
7	29,2	29.39	859,188	32,2099996	30,7499998	1,07070499	58,6984521	5,40247788	42,1	12,9	60	214,9999969	0,214999957	44,3680786	35,65	Dohne Merino Q	Q		46		0,0865	3,75	292,77925	4,4555	71,68	16,4	4,2320754	0,07	4,2	0,057	2,02	194,228349	194,228349
8	36,1272723	29.39	1079,49546	40,2202947	38,473781	1,04242901	70,7523728	4,78136316	46,0272266	9,29999201	38,549495	246,507671	0,246507671	28,8338945	41,37727289	Min	A		34,549495	1,31074453	0,0865	3,75	209,784793	4,4555	71,68	16,4	6,62497228	0,07	2,6800808	0,057	2,02	185,712375	185,712375
9	21,6666667	29.39	636,383333	24,0049977	22,8755622	0,89489357	49,0514951	2,6701896	36,6666667	15	87	172,437929	0,172437929	71,7004144	29,1666667	Dorset X	CC		73		0,0865	3,75	347,320325	4,4555	71,68	16,4	6,51751025	0,07	6,09	0,057	2,02	181,789321	181,789321
10	25	29.39	794,75	27,7669638	26,5323319	0,91899661	50,4957473	4,9045448	36,5999947	11,5999947	60	191,333313	0,191333313	46,399999	30,7999924	Merino B	B		46		0,0865	3,75	254,449937	4,4555	71,68	16,4	5,04488254	0,07	4,2	0,057	2,02	177,300857	177,300857
11	37,5	29.39	1102,125	40,7625679	39,1302979	1,40547073	74,9874635	-3,40510777	48,5	11	47	234,043588	0,234043578	29,3333333	49	Dohne Merino W	W		33		0,0865	3,75	176,649375	4,4555	71,68	16,4	6,70849532	0,07	3,29	0,057	2,02	176,314978	176,314978
12	44,5625	29.39	1221,32075	45,2164568	43,955049	1,50363425	81,5328291	0,53154229	48,625	7,025	27	261,57407	0,26157407	17,8911589	45,09375	SA Mutton Merino M	M		13		0,0865	3,75	166,949388	4,4555	71,68	16,4	7,44949652	0,07	1,89	0,057	2,02	172,375504	172,375504
13	29,6666667	29.39	871,399333	32,7088275	31,1887591	1,03888791	59,7646079	5,50073321	39,7666673	9,50000064	43	217,4418627	0,217441863	31,71001256	34,3416667	Merino D	D		29		0,0865	3,75	202,122721	4,4555	71,68	16,4	6,08802144	0,07	3,01	0,057	2,02	172,685326	172,685326
14	31,6476982	29.39	930,107698	32,7070753	31,18749308	1,03134311	63,9541802	2,80499174	41,5294119	9,882953076	20,054709	220,054709	0,220054709	31,0007400	36,4882536	Dohne Merino FF	FF		30		0,0865	3,75	219,793975	4,4555	71,68	16,4	6,42887711	0,07	3,08	0,057	2,02	171,249865	171,249865
15	28,6159862	29.39	841,081538	31,5077938	30,147692	1,07474808	57,8052562	3,2594439	38,36152652	10,7461528	52,9247892	206,6101543	0,206610154	37,6644978	33,38946157	Dorper	Z		38,3219432	1,31074453	0,0865	3,75	247,271493	4,4555	71,68	16,4	6,5372985	0,07	3,70495285	0,057	2,02	167,398862	167,398862
16	26,75	29.39	786,1825	29,3231679	28,019386	1,02337801	52,7211956	-2,88797571	45,000008	16,8300008	91,5	182,494536	0,182494534	76,3497493	35,1750019	Dohne Merino E	E		77,5		0,0865	3,75	440,025734	4,4555	71,68	16,4	7,62489512	0,07	6,405	0,057	2,02	165,749239	165,749239
17	38,5	29.39	1126,515	41,6666666	40,0823333	1,46346666	76,8898749	-7,88424923	48	9,5	42	226,180475	0,226180475	24,6752539	42,25	Dohne Merino P	P		28		0,0865	3,75	245,649375	4,4555	71,68	16,4	6,97818233	0,07	2,94	0,057	2,02	158,940378	158,940378
18	36,1791204	29.39	1063,151384	39,257821	37,71482113	1,37678971	72,7123598	5,88949561	45,4666235	9,26652307	44,1384788	220,129762	0,220129762	27,96177279	40,8217981	Merino S	S		30,1384788	1,48999481	0,0865	3,75	235,361491	4,4555	71,68	16,4	6,33732008	0,07	3,0893485	0,057	2,02	157,207489	157,207489
19	39,2804561	29.39	1154,97459	42,3024519	40,048939	1,49673308	78,3882041	-11,7883883	48,5887735	9,2363174	42	220,30754	0,22030754	23,7883742	43,9345048	Merino DD	DD		28		0,0865	3,75	232,513228	4,4555	71,68	16,4	7,82327632	0,07	2,94	0,057	2,02	149,388146	149,388146
20	35,2871429	29.39	1037,147149	38,17423916	36,7291672	1,3484415	70,3881789	-9,62366647	44,8999989	9,61426605	47,42857143	206,323161	0,206323161	20,0465603	40,0826718	Min	D		37,42857143	1,46388834	0,0865	3,75	257,520273	4,4555	71,68	16,4	7,39826917	0,07	3,32	0,057	2,02	142,5175075	142,5175075
21	27,5588253	29.39	809,953835	30,22246571	28,8965462	1,05438894	55,3671691	-1,21590203	36,5294154	8,97058011	48,6470582	198,2615841	0,198261584	34,4821738	32,0441753	Merino V	V		34,6470582	1,16861029	0,0865	3,75	212,558058	4,4555	71,68	16,4	6,82972996	0,07	3,46239418	0,057	2,02	141,595217	141,595217
22	41,375	29.39	1186,82125	43,49827056	41,9966258	1,51687788	80,36107795	-12,71181937	48	7,625	37,5	223,887542	0,223887542	22,729762	44,10075	Min	C		23,5		0,0865	3,75	212,456641	4,4555	71,68	16,4	8,33014671	0,07	2,625	0,057	2,02	140,267112	140,267112
23	27,2495281	29.39	802,619488	29,7773398	28,5494918	1,04183561	54,8625219	-6,3101941	37,53333301	10,2238892	58	176,278707	0,176278707	30,8899842	32,4214284	Undefined	Y		44		0,0865	3,75	257,386148	4,4555	71,68	16,4	7,1715788	0,07	4,16	0,057	2,02	136,219154	136,219154
24	35,5	29.39	1043,345	37,8947388	36,6758495	1,33943948	70,2323229	-74,00293975	42	6,5	38	170,0536352	0,170053635	10,0275286	38,75	Dohne Merino K	K		24		0,0865	3,75	201,549375	4,4555	71,68	16,4	8,90288697	0,07	2,66	0,057	2,02	98,5737476	98,5737476
25	34,5555556	29.39	1015,58778	36,8874871	35,7214813	1,31884907	68,4548361	-19,36628734	40,8555548	6,39999936	38,4444444	166,788934	0,166788939	19,1939497	37,7555551	Merino N	N		24,4444444	1,37807777	0,0865	3,75	198,520794	4,4555	71,68	16,4	10,8010253	0,07	2,81111111	0,057	2,02	95,2141511	95,2141511
26	32,8939393	29.39	944,971667	35,0493916	33,9396824	1,20838962	60,0295916	-14,47880248	41,6666667	8,33333333	53	157,2327016	0,157232702	25,6239608	37	SA Mutton Merino F	F		39		0,0865	3,75	208,410375	4,4555	71,68	16,4	9,2319621	0,07	3,71	0,057	2,02	81,8261206	81,8261206
27	27,2841765	29.39	802,174176	29,1955548	28,2288666	1,01027855	54,0067356	-24,9751449	37,1117484	9,80374749	47,6470582	133,2455382	0,133245539	41,2736036	32,2024122	Merino EE	EE		59,6470582	1,17947058	0,0865	3,75	312,043888	4,4555	71,68	16,4	10,87014256	0,07	5,15284118	0,057	2,02	66,939421	66,939421
28	31,625	29.39	939,49075	39,3895407	38,6247085	1,19053986																											