Strategies in the Beaufort West region to mitigate the negative financial impacts of a drought

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Declaration

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Abstract

Droughts are a frequent occurrence in South Africa's arid and semi-arid rangelands and can have severe ecological and economic consequences. Most of the agricultural land area of South Africa is not conducive to crop production. These regions can get as little as 400 mm of rain annually. A deficit of 25% of normal annual rainfall is considered a severe drought. Droughts pose an increasing challenge to rangeland users as the global climate changes. Gaining access to relief from government in the form of subsidization grants has proved to be a lengthy and difficult process. The research aims to identify and evaluate whole farming strategies that a farmer in the Beaufort West region can employ to mitigate the negative financial impacts of a drought on a typical sheep farming enterprise.

This study makes use of participatory research to acquire data for the farming models. To understand the effect of a strategy e.g. a feeding program in a whole farm system, requires a method that integrates, rather than ignores the effect of such a factor on the performance of the whole farm. The identification and construction of a typical farm model for the area provided a basis for comparison of the strategies identified to mitigate a drought. Whole farm modelling is an analysis of the current state of the farm, determining the available land, labour, capital and management resources.

An incremental budget model in the traditional sense is a financial model in which budget proposals and allocations are based upon the funding levels of the previous year. Only new revenue is allocated to the expenses of the budget model.

The research identified and evaluated four whole farming strategies that a farmer in the Beaufort West region can pursue to mitigate the negative financial impact of a drought on a sheep farming enterprise. The strategies are stated below.

Feed through the drought at cost.

Shrink breeding stock during drought and rebuild after (protect genetic material).

Relocate the entire enterprise to area not experiencing drought.

Sell off the entire enterprise, invest in the capital market and buy back at the end of the drought

The strategy to shrink breeding stock during a drought proved to be the most financially feasible. The advantage of implementing this strategy is that genetic material of the farming livestock is protected through the period of the drought. Furthermore, the long run effect of the strategy is easily rectified post drought merely by adjusting the rate at which livestock are sold and retained on the farming enterprise.

Opsomming

Droogte kom gereeld voor in Suid-Afrika se dorre en halfdorre weivelde en kan erge ekologiese en ekonomiese gevolge dra. Droogte veroorsaak toenemende uitdagings vir weiveld gebruikers en wêreldklimaat verandering. Die navorsing mik om algehele boerdery strategieë vir n boer in Beaufort Wes omgewing te identifiseer en evalueer en om negatiewe finansiële gevolge van droogte op n skaap boerdery te voorkom. Die studie maak gebruik van deelnemende navorsing om inligting te verkry van boerdery modelle. Om die effek van die strategie te verstaan bv. N foedsel program in n algehele boerdery vereis n integreerde metode, eerder as om die optrede effek te ignoreer van die algehele boerdery. Die identifikasie en konstruksie van n boerdery model vir die gebied gebaseer op n vergelyking van strategieë kan droogte implikasie verlig.

Algehele boerdery model is n analise can die huidige staat van die plaas, bepaling van die beskikbare land, arbeiders, kapitaal en bestuur hulpbronne.

N inkrementele begroting model op die tradisionele manier is n finansiële begroting voorstel en allokasies is gebaseer op befondsing vlak van vorige jare. Slegs die nuwe jaar se inkomste word geallokeer na die uitgawe begrotings model.

Die navorsing identifiseer en evalueer vier algehele strategieë van die boerdery in Beaufort Wes omgewing om negatiewe finansiële impakte van droogte op n skaapboerdery.

Strategieë

Voor deur die droogte teen koste

Verminder teelvoorraad tudens droogte en herbou daarna

Verplaas die hele onderneming na n gebied wat nie droogte ervaar nie.

Verkoop die hele onderneming, belê in die kapitaalmark en koop die onderming weer aan na die droogte.

Die strategie om teelvoorraad te verminder gedurende die droogte tydperk het finansiele haalbaarheid getoon. Die voordeel om die strategie te implementer is dat die genetiese material van die vee beskerm sal bly tydens die droogte tydperk, in die lang termyn is die effek van die strategie maklik omkeerbaar na die droogte typerk deur die aanpassing en verbanging van die strategie.

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Chapter 1 – Introduction

1.1 Introduction and background

Droughts are a frequent occurrence in South Africa's arid and semi-arid rangelands and can have severe ecological and economic consequences. Droughts pose an increasing challenge to rangeland users as the global climate changes. Finding ways to reduce ecological and economic impacts of drought should thus be a major research drive (Vetter, 2009).

In the most general sense, a drought originates from a deficiency of precipitation over an extended period of time, resulting in a water shortage for some activity, group or environmental sector. Its impacts result from the interplay between the natural event and the demand people place on water supply (National Drought Mitigation Center, 2017). While these may be short term and followed by recovery during subsequent years of higher rainfall, in some cases droughts can trigger substantial and irreversible ecological and socio-economic changes (Ellis and Swift, 1988).

South Africa is recognized as a country subjected to recurring droughts of varying spatial and temporal dimensions. Southern Africa was struck by particularly severe droughts in the 1980s and summers at the beginning of the 1990's (Harsch, 1992), which led to a decrease in crop and livestock production (Vogel, 1994). Droughts are a regular feature of the weather pattern of South Africa with a notable part of the country having been declared a disaster drought area over a 30-year period (National Drought Task Team, 2015). As a result of global climatic changes, the Western Cape expectedly faces a warmer future. This poses serious threats to agricultural commodities in the province (BKS Pty Ltd, 2004). The Central Karoo is characterised by summer rainfall and a typically dry winter. Annual rainfall is very low across the region. The area is primarily suited to extensive production of sheep, goats and beef cattle (BKS Pty Ltd, 2004).

Currently, the only form of drought relief available to South African farming entities is through government subsidization. The process, further explained in Chapter 2, to apply for and receive funding is time consuming and complicated. This reactive approach to dealing with the negative financial effects during a drought is not sufficient to aid a farming entity in mitigating the harsh financial impact of a drought.

The need for a proactive approach over the 2016 to 2025 calendar period is eminent. The farming community of Beaufort West is situated in the arid Great Karoo of South Africa. The area is predominantly a sheep farming community. The effects of droughts on a practical farming level as well as the economic impact of droughts are relatively well known. There are also some strategies that farmers follow with regards to financially overcome droughts. There is however a lack of knowledge regarding the financial implications of the strategies available to producers to manage or negate a drought. The central research question is what are the expected financial implications of strategies available to a farmer to mitigate a drought in the Beaufort West area of the central Karoo?

1.2 Research aim and objectives

The research aim to identify and evaluate whole farming strategies that a farmer in the Beaufort West region can pursue to mitigate the negative financial impacts of a drought on a typical sheep farming enterprise. The focus is on identifying suitable methods that can be employed to mitigate financial losses of the enterprise prior to applying to government for financial support. A typical farming enterprise, representative of the area as a whole was identified by consulting with various professionals in the Beaufort West farming community. In support of the main aim a number of research objectives were identified to achieve this aim. These are:

- To assess the climatic conditions and farming patterns typical to the Beaufort West farming community.
- To identify and construct a typical sheep farm for the area to serve as basis for comparison of the alternative strategies.
- To identify strategies a farming enterprise can employ to mitigate the negative financial impact of a drought.
- To evaluate the strategies in terms of financial feasibility in terms of positive cash flow and profitability at the whole farm model.

1.3 Proposed research method

To identify and assess the alternative strategies of drought on the whole farm level requires the study of a rather complex and multifaceted physical/biological as well as socio/economic system, the farm. The object of study is thus the typical farm. The leading expert regarding understanding the processes and interrelated factors forming the system is the farmer. This study makes use of participatory research to acquire data for the farming models. Participatory research methods are geared towards planning and conducting the research process with those people whose life-world and meaningful actions are under study (Bergold and Thomas 2012).

The purpose of participatory research is to converge the perspective of science and that of practice. The most efficient farming techniques employed by farmers during a drought scenario will differ somewhat with what is theoretically stated as best practice. The common aim of participatory research is to collaborate the insights of scientists, practitioners and service users alike (Bergold and Thomas, 2012).

Information and data are gathered by conducting interviews with various agricultural and farming experts from around the Beaufort West area.

To understand the effect of a strategy e.g. a feeding program in a whole farm system require a method that integrate, rather than ignore the effect of such a factor on the performance of the whole farm. Whole farm modelling is an analysis of the current state of the farm, determining the available land, labour, capital and management resources. This process answers the questions of who, what, where, and why of the farming enterprise. This analysis should determine the physical, financial and personnel status of the farming business. This analysis should also examine the operation's efficiency and identify any available resources that are not currently being utilized optimally. The farm's profitability, enterprise structure, operating procedures and employee management should also be incorporated. It is also helpful for farm management to identify the external influences that could impact the enterprise in the future (in this case a drought). These influences could include any governmental, political, economic, environmental, social or technological elements (Ohioline, 2006).

1.4 Layout of the rest of the thesis

The research paper is categorised into five chapters.

Chapter 2 provides a literature review on the background of droughts in South Africa and the economic, environmental and social impacts caused by a drought. The notable characteristics of the South African mutton industry are addressed to provide context to the subject matter. The chapter continues to provide a background on the weather conditions typical to the Beaufort West community and outlines the conditions required for a drought to be declared. Finally, the chapter identifies and discusses the role of government in mitigating the financial losses caused by a drought (The current available response).

Chapter 3 focuses on providing an understanding of the different terminology used in financial budgeting, leading onto discussing the methodology for acquiring and modelling the financial data used in the research. The chapter continues to outline and explain the four financial strategies identified to mitigate the negative financial impact caused by a drought and the sample. The focus of the chapter revolves around discussing how the base budget model was designed and modified; incorporating the four identified farming strategies stated above. In total, five financial models were designed.

Chapter 4 tabulates, illustrates and discusses the results produced by the five financial models. The advantages and shortcomings of each strategy are identified and explained in this chapter. Chapter 5 outlines the conclusions drawn, based on the critical analysis of the research data, and confirms whether the stated hypothesis is proven.

Chapter 2–Literature and Background

2.1 Introduction

The main aim of this research project is to identify and financially analyse different strategies that Karoo sheep farmers have to mitigate a drought in the Beaufort West area. The purpose of this chapter is to provide a brief background and history on droughts that have occurred over the years in South Africa. The chapter starts with a brief overview of the South African mutton industry to illustrate the importance of the industry and show the risk of financial drawbacks. The section provide insight into what weather conditions are required to declare a region as drought disaster status and further show the weather conditions typical to the Beaufort West area.

Currently the government has a provisional plan of action in place to deal with mitigating the negative financial effects of a drought. These actions and requirements are shown and explained in the following sections of Chapter 2. The chapter will continue to Whole farm modelling as an approach to measuring the financial impact externalities have on a farming enterprise is elaborated on. The process of acquiring information and data used in the research is described. This is put into perspective with findings from previous literature to the proposed actions of the research project.

2.2 Characteristics of the South African Mutton Industry

Most of the agricultural area of South Africa is not conducive to crop production. In these areas that are known for low rainfall extensive livestock farming is the only financially viable option in terms of agriculture. Within the livestock industry mutton is an important component and is a key industry in many rural areas and municipalities throughout South Africa. This section highlights the characteristics of the South African mutton industry with special focus on the economic importance thereof.

2.2.1 National Sheep Herd Size

Based on the available information from the national Department of Agriculture, total sheep number (excluding goats) amounted to approximately 24.06 million in 2015. Figure 2.1 shows the total South African sheep herd size experiencing a gradual decrease from 2001 to 2015.

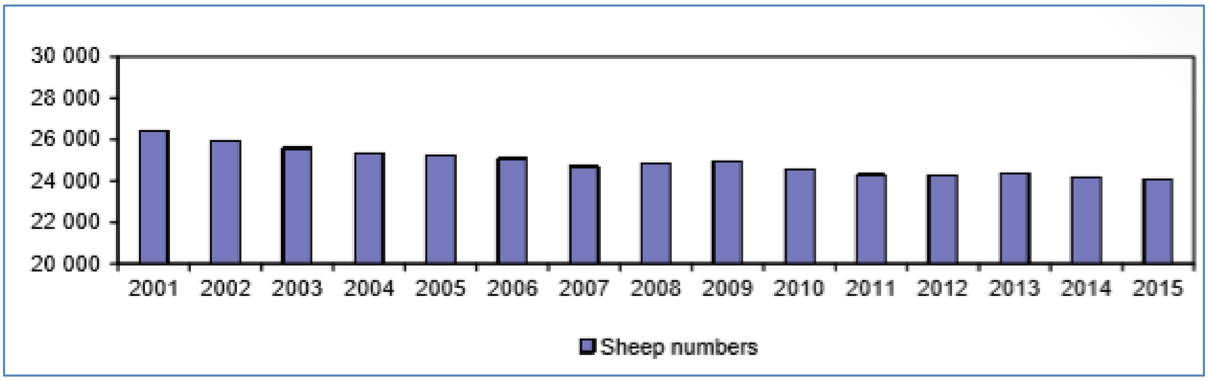

Figure 2.1: National Sheep Herd 2001 to 2015

Source: Cornelius, Mutton Outlook Report March 2017, 2017.

The outlook is that sheep numbers are set to decline with the high occurrence of organized theft and the trajectory of meat prices over the last three years (Cornelius, 2017). Theft of sheep in the producing areas is one of the main factors that have a negative effect on the growth of the national herd of the past years.

2.2.2 Trends in the Slaughter of Sheep

Figure 2.2 indicates that the average price of mutton (Class A2/A3) increased from February 2014 to February 2017. The slaughter of sheep in South Africa shows a downward trend from November 2014 to November 2016.

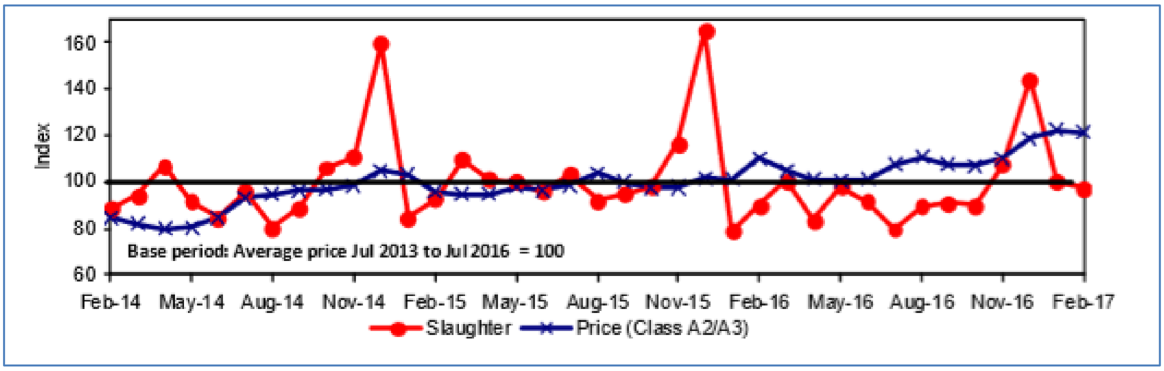

Figure 2.2: Index of Monthly Lamb and Mutton Slaughter and Producer Price

Source: Source: Cornelius, Mutton Outlook Report March 2017, 2017.

The outlook is that the severe drought in 2016 in the mutton producing areas in the North Western areas of South Africa had an effect in the size of the national herd and consequently on the slaughter numbers (Cornelius, 2017).

2.2.3 Consumption per Capita of Mutton in South Africa

Figure 2.3 shows the total consumption of mutton increased from year 2012/13 to 2014/15 and the per capita consumption remained constant during this period. Figure 2.3 also indicates that consumption of mutton remains a preferable food source in the South African market. The evident decline in consumption in the period 2006/07 to 2010/11 correlates to the period of the financial crisis and the recovery period of the global economy.

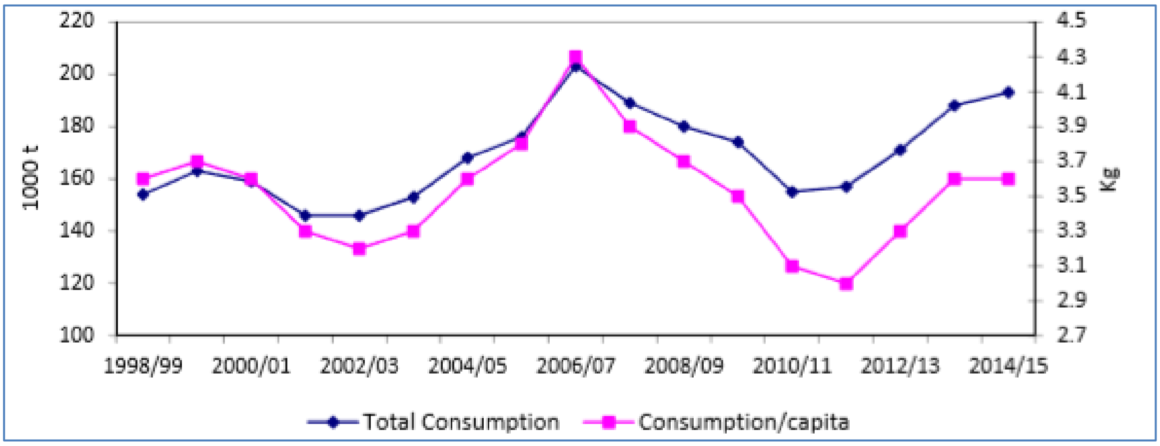

Figure 2.3: Total Consumption and per Capita Consumption of Mutton

Source: Cornelius, Mutton Outlook Report March 2017, 2017.

2.3 Droughts and their importance in South Africa

South Africa has long been recognized as a country subjected to recurring droughts of varying spatial and temporal dimensions. Droughts are a regular feature of the weather pattern of South Africa with a notable part of the country being declared a disaster drought area over a 30-year period (National Drought Task Team, 2015).

The droughts of the 1980's and 1990's, which in many areas were the worst since 1921, highlighted significant shortcoming's in the local drought policy. It further revealed an inability of the government to respond timeously and effectively to the declaration of a drought (National Drought Task Team, 2015).

The period between 2001 and 2005 again saw drought episodes that affected most parts of the country. The consequences of the following years helped identify the need for a proactive approach in responding to a drought (National Drought Task Team, 2015).

Droughts have many economic, environmental and social effects on the economy (National Drought Mitigation Centre, 2017). Economic impacts are those impacts of drought that cost people (or businesses) money. The following list, modified from the Drought Disaster Relief Scheme 2011, states a few of the economic, environmental and social impacts of a drought that directly relate to a decline in agricultural practice. The three lists are organized in an order to illustrate the potential snowball effect.

2.3.1 Economic Impacts:

- Unavailability of water and fodder, which leads to high livestock mortality rates.
- Disruption in reproduction cycles in animals.
- Loss of dairy and livestock production.
- Damage to crop quality and reduced food production.
- Loss of economic growth and development due to a decline in agricultural producers.
- Increase in food prices.
- Increase in unemployment.
- Loss to industries directly dependent on agricultural production (e.g.: fertilizer manufacturers).

2.3.2 Environmental Impacts:

- Increased desertification.
- Leads to inferior crop and poor veld conditions.
- Leads to a reduction in the yield of surface water and groundwater supply systems and general water shortages.
- Reduction and degradation of animal habitats.
- Lack of feed and drinking water.
- Decrease in water quality.
- Increase in disease outbreaks and increased vulnerability to predation.
- Increased fire danger.
- Increased risk to soil erosion

2.3.3 Social Impacts:

- Public dissatisfaction with the government's response.
- Inequity in the distribution of drought relief.

The above factors are interlinked and jointly contribute to a holistic decline in total agricultural operation and output. The above statements accumulate from one another, providing emphasis to the importance of preventing a disaster scenario from the early stages.

2.4 Localised make-up of the Beaufort West area

Beaufort West is located centrally within the Beaufort West Municipal Area, with Nelspoort to the North-East and Merweville to the South-West. The Beaufort West area is relatively hilly, with the Nuweveld mountain range stretching from east to west, just north of Beaufort West town. This mountain range forms the escarpment that divides the Great Karoo from the Succulent Karoo. The Leeu and Gamka rivers traverse the area with the Gamka Dam located to the South-West of Beaufort West town. The Springfontein Dam located to the north of Beaufort West provides water to the area (BKS Pty Ltd, 2004).

2.4.1 Weather conditions typical to the Karoo and Beaufort West area

The Karoo is the central high plateau of South Africa. A large range of mountains, which span the area, surrounds the Karoo.

The rain, brought by the humid sea winds, goes down over the weather side of the mountain slopes, so that the lee side stays dry. Therefore, the endless grassland of the Karoo gets as little as 400 mm of rain annually, which falls mainly in summer. The winter months are almost completely dry. Precipitation gets even lighter towards the north-west. In the upper Karoo it rains on average less than 200 mm per year, which makes it an arid, semi-desert zone (meaning that precipitation is less than the rate of evaporation).

Due to the average altitude of 1200 m on the central high-plateau, temperatures in summer are usually bearable, although the thermometer reading can sometimes exceed 35 degrees Celsius. Towards the north-west, in the direction of the Kalahari basin, due to the lower elevation, temperatures are even higher (The Great Karoo, 2017).

2.4.2 Veld types typical to the Central Karoo and Beaufort West area

The Western Cape largely falls within the Cape Floral Kingdom, which includes a number of biomes, namely the “Fynbos”, Forest, “Nama-Karoo”, Succulent Karoo and Thicket Biomes.

The Beaufort West Municipal area falls within the Karoo macro biogeographical region. Beaufort West is further categorized under the “Nama-Karoo” Biome and is described as grassy dwarf shrub-land.

John PH Acocks devoted most of his working life to surveying and characterising the vegetation types of South Africa. One region which he surveyed intensively is now known as the Nama-karoo Biome (Cowling, 1999). Acocks identified and classified 15 veld types that occur in the Nama-karoo, of which 7 were identified to be “false” veld types. A large number of similarities were identified between veld types given in Acock’s study and a more recent report released by the Western Cape Department of Agriculture. For this study the classification used by the Department of Agriculture was used.

The Western Cape Department of Agriculture divided the Beaufort West area into various farming regions with similar geographical characteristics.

Table 2.1 lists the different farming regions in the Beaufort West area, the veld types prevalent in these regions and states where they are located around the Beaufort West Municipal area.

Table 2.1: Farming regions surrounding Beaufort West and the veld types prevalent in these areas

Name of Farming Area in Beaufort West	Location surrounding Beaufort West	Veld Types Present
The Koup	West and South-West	Karroid Broken Veld
Nuweveld Berge	North and North-West	Sour Veld (Renosterbos and Harpuisbos), Danthonia Mountain Veld and Central Upper Karoo
Nuweveld Berge Plateau	North	Central Upper Karoo and Loxton Soetveld
Nelspoort Veld	North, North-East and East	Nelspoort Veld, Danthonia Mountain Veld, Central Lower Karoo Veld and Karroid Broken Veld
Rietbronvlakte	South and South-East	Central Lower Karoo Veld and Karroid Broken Veld

Source: Mucina et al., Nama-karoo veld types revisited: A numerical analysis of original Acocks field data, 2002.

Figure 2.4 shows a map of the Beaufort West Municipal area and labels the farming regions stated by the Western Cape Department of Agriculture.

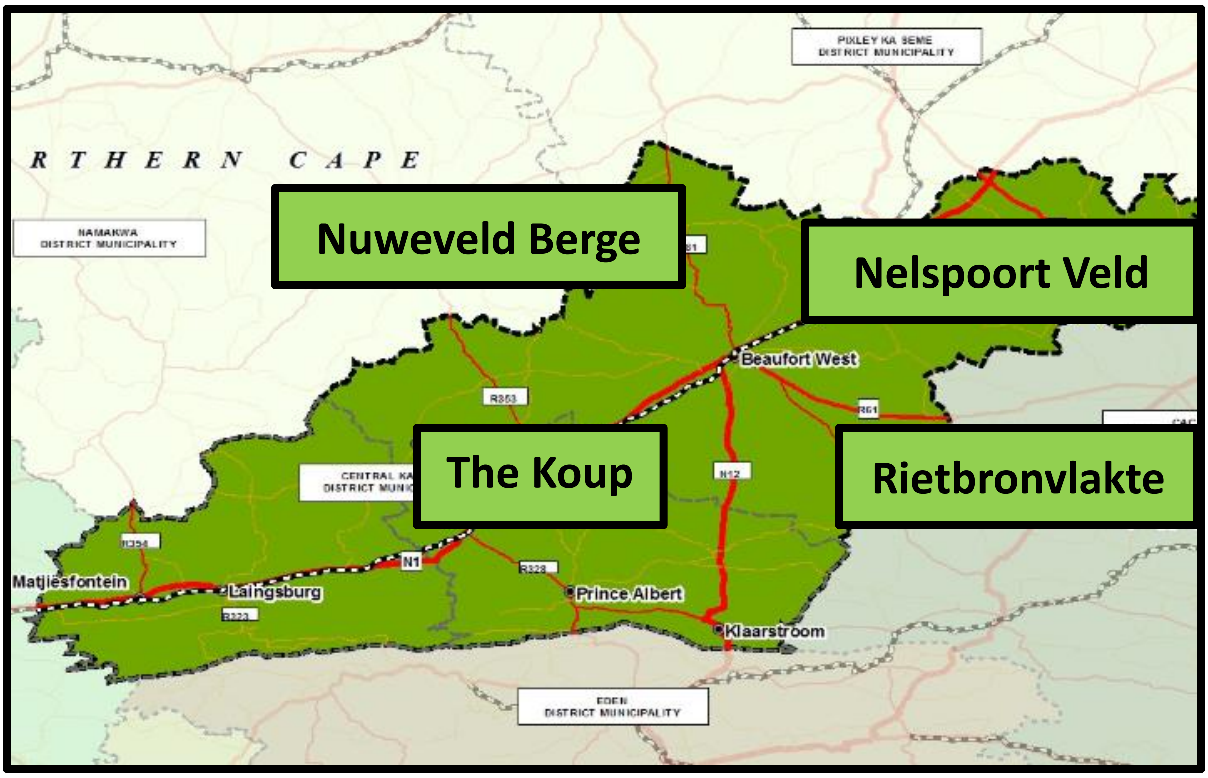

Figure 2.4: Map of the Beaufort West Municipal area and the surrounding farming regions
Source: Madumbo and Weyers Central Karoo District Municipality Spatial Development Framework: Status Quo Report 2014

The Nelspoort farming region to the East and North East of Beaufort West is regarded as the best farming district in the Great Karoo. The mountainous areas of the region are environmentally sensitive and the farming area should be rehabilitated to ensure sustainable farming practice in the future (Beaufort West Municipality, 2004).

The Nuweveld Berge region to the North and North West of Beaufort West consists primarily of shrubs, in particular Renosterbos and Harpuisbos. Renosterbos is regarded as one of South Africa's rarest vegetation types. The Nuweveld Berge should be demarcatedas a conservation site to preserve these shrub types.

2.5 Conditions required for the declaration of a drought

The South African climate is highly variable. Between July 1960 and June 2004, there have been eight summer-rainfall seasons, where rainfall for the period has been less than 80% of normal. A deficit of 25% is normally regarded as a severe meteorological drought but it can be safely assumed that a shortage of 20% from normal rainfall will cause crop and water shortfalls in many regions (South African Weather Service, 2017).

2.6 Declaration of a drought disaster in the Western Cape Province

In specific geographical areas, the Western Cape has been experiencing prolonged dry conditions. The focus on drought risk management should be on improving the coping capacity and reducing its severity and impacts. If drought occurs and the severity and magnitude is such that communities cannot cope by using their own means and resources, a state of disaster is declared in terms of Section 23 of the Disaster Management Act No. 57 of 2002 (Strauss, 2014).

Figure 2.5 illustrates the reporting flows when declaring a region as a drought disaster area.

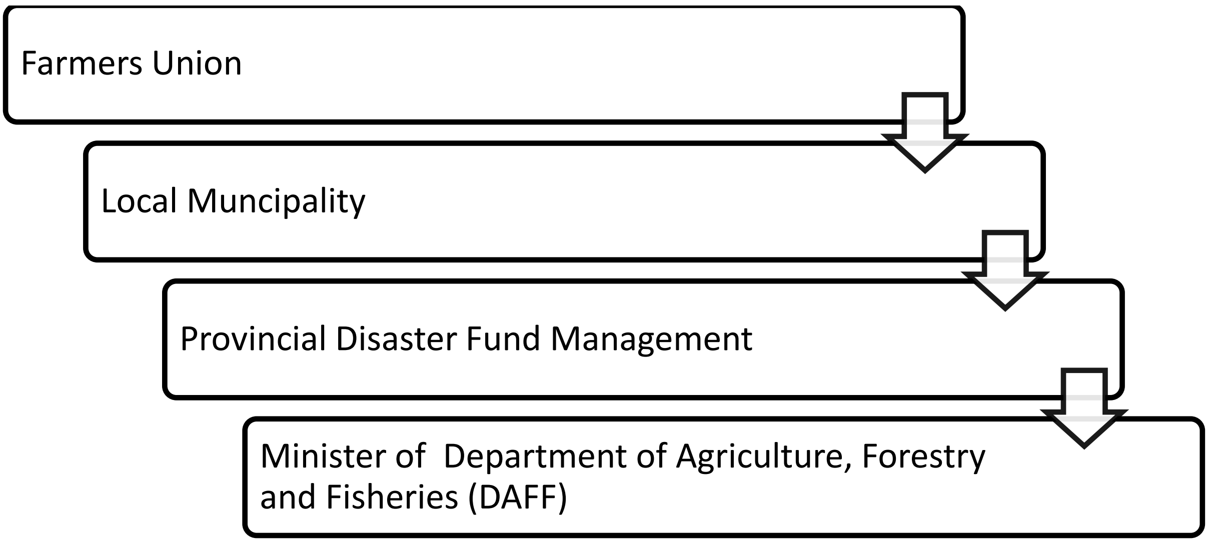

Figure 2.5: Reporting flows when declaring a region as a drought disaster area

Source: National Drought Task Team, National Drought Action Plan for South Africa, 2015.

2.7 National Drought Action Plan (NDAP)

The NDAP is not intended as a substitute for the specific operational drought disaster risk management plans of the country. The purpose of the NDAP is to improve coordination and communication among the concerned parties and to facilitate aid to the parties in need (National Drought Task Team, 2015).

The following section indicate the role players in drought disaster risk management. It also shows their objectives and describe the current institutional arrangements and actions for these role players for addressing drought conditions

2.7.1 Role Players

- The National Department of Agriculture, Forestry and Fisheries (DAFF)

The DAFF facilitates the coordination and communication among the various stakeholders and provide suitable outreach plans to participants severely affected by drought. The DAFF provides further support and guidance by conducting drought assessments, continued evaluation of the drought disaster throughout its duration and support provinces with funding requests for the implementation of allocated drought relief schemes.

- DAFF Provincial Offices: Veld Fire and Oversight

The DAFF Provincial Offices coordinate the control of veld fires and increase the awareness of provincial departments during dry seasons. The Provincial Office also assists with the digesting the DAFF's overall strategic plan into an organizational strategy.

- Provincial Departments (PDA's)

In short, The Provincial Departments fulfil the role of a work engine. PDA's are tasked with enforcing the implementation of risk reduction measures, leading education and awareness campaigns, conducting drought assessments set forth by the DAFF, ensuring staff and budget capacity constraints are met, preparing drought management action plans and implementing drought assistance schemes for affected farming communities.

- Local Government

The local government will collaborate with provincial departments and participate in the structures set forth by the provincial offices. Local government further advise and manage water scarcity within the province.

- Organised Agriculture (OA), Private Sector and Non-Governmental Organisations (NGO)

Organized agriculture act in a proactive manner by advocating risk reduction measures through advisory sessions. OA will assist by ensuring various farming communities are adopting risk reduction measures. OA further assist by acting as a vector of information between stakeholders.

- Department of Cooperative Governance (DCOG)

The Department of Cooperative Governance receive, and process relevant drought claims from farming stakeholders. The DCOG consider the submissions addressing drought issues, assess the claims and determine the merit for drought declaration. The DCOG will further request emergency funding for immediate implementation of a drought assistance scheme.

- Department of Water and Sanitation (DWS)

The Department of Water and Sanitation provide emergency drinking and livestock water through water tankers. The DWS further monitor dam levels and underground water supply and advise on water restrictions.

- National Treasury

The responsibility of the National Treasury is to assess the scheme request and manage the relief in line with the national budget availability. The National Treasury will disburse approved funds and conditional grants to government departments (PDA's) to be provided as assistance to local farming communities during drought periods.

2.7.2 Objectives of NDAP

The specific objectives of the NDAP are to:

- Monitor and evaluate the current drought by collecting and analysing drought related information in a timely and systematic manner.
- Assess the state of drought against the natural resources, environment and socio-economic development.
- Coordinate drought response and contingency plans of affected parts of the country.
- Communicate accurate drought and/or related information to decision makers and other relevant stakeholders.
- Take actions to reduce the adverse impacts of drought and assess the effectiveness of mitigation actions being taken on the current drought condition.
- Develop actions to reduce the country's vulnerabilities to the next drought.

The above list of objectives was taken from the National Drought Task Team, 2015.

2.7.3 Short-term and Long-term actions for implementing the National Drought Action Plan

Table 2.2, illustrates the short-term actions that need to be taken and which role players are responsible for the actions as outlined in the National Drought Action Plan.

Table 2.2: National Drought Action Plan - Short-term actions

Short Term Measures 2 – 3 Year		
Action	**Responsibility**	**Time Frame**
Assessments (Monitoring and Evaluation) of the current condition	PDA, OA, DAFF, DWS and farmers	Immediate
Dissemination of early warning information	PDA, DAFF, OA, farmers	Continuously during the period of drought
Water shortages to be addressed by providing "through trucking" and provision of fodder	PDA, DAFF, OA, DWS, farmers	Continuously during the period of drought
Live Stock Management: Destocking, health services, livestock feeds/supplements	PDA, DAFF, OA, farmers	Continuously during the period of drought
Veld Management: Veld grazing, carrying capacity, rotational grazing	PDA, DAFF, OA, farmers	Continuously during the period of drought

Source: National Drought Task Team, National Drought Action Plan for South Africa, 2015.

Table 2.3, illustrates the long-term actions that need to be taken and which role players are responsible for the actions as outlined in the National Drought Action Plan.

Table 2.3: National Drought Action Plan – Long-term actions

Long Term Measures – 5-10 Years		
Action	**Responsibility**	**Time Frame**
Awareness Campaigns on current conditions and overall sectoral disaster risk management	PDA, DAFF, OA, farmers	During the current drought period and continuous
Multi Peril Crop Insurance Scheme	DAFF, OA, National Treasury, DCOG	Continuous
Case by case participation in carry over debt scheme	DAFF, OA, National Treasury, DCOG	During the current drought period
Interest rate subsidy on new production credit on a case by case basis for the current production season	DAFF, National Treasury, DCOG, OA, farmers	During the current drought period
Provision of small and developing farmers with production inputs	PDA, DAFF, OA, farmers	During the current drought period

Source: National Drought Task Team, National Drought Action Plan for South Africa, 2015.

The primary responsibility of dealing with a climate disaster lies with the government, as they must play the overall role in managing disasters. To do that, they must call upon all the role-players and the support structures stipulated above, however these have proven to be insufficient to negate the effects of a drought crisis. A lot of work must be done if South Africa is to become more resilient to climate crisis and to mitigate its effects (Moubray, 2019).

South African producers are ultimately left to fend for themselves, which creates the need for proactive measures to mitigating the effects of a drought at farm level. South Africa boasts resilient, adaptable animals, a competitive meat market and very well-developed feeding schemes, which are progressive, but depend on farmers receiving soft financial aid from government (Moubray, 2019). This gives rise to the need for budget modelling within the livestock sector. Allowing farmers access to maximize their marginal gains through a process of financial modelling can provide the much-needed financial alleviation that government is lacking to provide.

2.8 Whole Farm Modelling as a Method of Simulation

The farm as a business is inherently complex and multi-faceted. The farm system is a physical/biological system that by design transform inputs into outputs. Simultaneously the system also consists of a financial facet within which the producer tries to make a profit. To study systems thus requires firstly a thorough understanding of the system being studied and secondly a method of research that can accommodate the complexity and show the expected implications of alterations to the system. In this case a drought with various possible strategies to negate the effects of the drought as best as possible. To study the effect by direct observation is time consuming and expensive as this would require an actual farm that represent the farms in the study group and the circumstances. The alternative is to make use of models, which are representations of reality (Legay, 1997).

Different types of modelling can be used in research and livestock farming uses both conceptual and implementation modelling to analyse and support changes within livestock farming.

Modelling requires data as an input. To develop a financial plan, the methodology of budgeting is a key foundation to determine financial impact on an enterprise. The development of spreadsheet software has made a significant impact in the use and application of budgeting methods, resulting in budgets being used for optimal planning and decision-making. This led to the conclusion that budgets, based on accounting principles are simulation models, and not exclusively models based purely on mathematical calculations (Pannell, 1996). Used with caution, alongside other holistic methods, budgets can be useful tools in assessing needs, aiding planning and undertaking participatory research and decision-making (Dorward et al., 1997).

Agricultural economic related research uses budgeting as one of the research methods. Using standard accounting principles, comparative information is generated, which act as benchmark information. As budgeting approaches are relatively simplistic and extensively used outside of the academic environment, it received little acknowledgement as a research method.

Whole-farm budget models can thus be defined as simulation models. Information technology has developed programs, simplifying complex spreadsheets for use during budget modelling. The sophistication of budget models lies in the ability to allow for detail, adaptability and user-friendliness (Keating & McCown, 2001).

Whole farm budgets incorporate physical as well as financial parameters and usually produce profitability criteria such as net farm income or cash flow (Dillon & Hardakar, 1984). Whole farm budgeting differs from other quantitative techniques in that it quantifies and subtract overhead and fixed costs from gross value of production to determine the net farm income value. Net farm income is used for making financial comparisons between different farming units. Models can be adapted to provide information related to return on capital investments and to calculate profitability on capital investments and/or Net Present Value (NPV), over a longer period of time than one financial year.

Simulation models, including budget models, all share similar criticisms; it does not provide a best solution or optimal solution. Budgeting as a simulation technique requires an expert understanding of the system being modelled, as the accuracy of outcomes are directly linked to the number and accuracy of relationships identified and linked between the elements in the model. The requirement to have an in depth understanding of the system being modelled, is a major advantage in using this research method. Despite criticism of using whole farm modelling as a research method, it allows for a comprehensive view of farming problems enabling a multidisciplinary approach in addressing farm management issues.

2.8.1 Origin of Whole Farm Modelling focused on livestock systems in South Africa

There are many existing models designed to represent the operation of livestock farming systems (Gibon et al., 1999). The study by Grove (2011) introduces the origin of whole farm modelling and its progression.

The whole-farm simulation model approach to analysing farming profitability started with the research done by Oosthuizen and Meiring (1996) who developed a decision support system to enhance risk efficient decision making in irrigation farming. Follow up funding resulted in the development of the FARMS system of models (Meiring et al., 2002) comprising of computer based programs to calculate irrigation cost, generate enterprise budgets, simulate cash flows and to incorporate risk into the analyses, with the ultimate aim of providing whole farm decision support to irrigation farmers (Grove, 2011).

The main objective with the development of FARMS (Oosthuizen and Meiring, 1996) was to establish reliable and relevant information using well-established budgeting principles (Boehlje and Eidman, 1984) to enhance decision-making at the enterprise and whole farm levels (Grove, 2011).

2.8.2 Background on Whole Farm Modelling

Livestock farming has recently come under scrutiny, in response especially to environmental issues (Steinfeld et al., 2006). A trend has developed for on-going technological and structural development, which has caused a substantial rise in productivity over the last half century (Gouttenoire et al., 2011). Undertaking systematic innovation by switching to new forms of operation in farming systems requires certain transition processes (Lamine and Bellon, 2009).

Both expressions “system redesign” and “input substitution” stem from the ESR (extended semantic realism) model (Hill and McRae, 1995). According to this model, there are three ways of managing a transition from conventional to sustainable agriculture.

(i) Improving input efficiency. This involves improving the efficiency of conventional practices without reducing the dependence on external inputs.
(ii) Input substitution. This involves substituting inputs out, thus replacing conventional strategies to suit the environment.

(iii) System redesign aims achieve fertility, productivity and resilience of the farming system.

To study livestock farming systems, modelling has proved an efficient tool to gain an understanding of how the systems operate, to identify knowledge gaps, to predict evolution and to assist the systems' managers in their decision processes. (Malezieux et al., 2001).

Livestock farming systems are particularly complex insofar as they are made of interacting entities (vegetal and animal). The production cycles of livestock production systems also do not refer to constant time scales, such as the annual campaign for crop production versus a several-year lifetime of a productive animal. A high degree of management skill is therefore required (Russelle et al. 2007).

A livestock farming system relies on specific and complex consistencies in the management of animal and vegetation resources to serve the farmers' goals. Redesigning a livestock farming system requires redefining these consistencies and may have strong implications at the farm level and in the long term (Gouttenoire et al., 2011). To use models to support these redesigning processes require the ability to model at farm scale, to address the long-term perspective and to address in-depth changes that may question the system's consistencies. The considered changes may have severe consequences on the whole farm. It would consequently be particularly relevant to directly support the farmers in these redesigning processes.

The farmers 'decision making processes' can also vary greatly among models (Mathieu, 2004). For example, farmers can be seen as entrepreneurs willing to maximize their profit, with an objective of finding the most economically satisfying solution, or they can be considered actors who implement livestock practices (Grove, 2011).

The responsibility of a farm manager is to integrate information regarding the various farming subsystems to allocate scarce resources on a whole farm level in order to maximize its utility. The way a farmer manages the farming system may furthermore aggravate the risk they are exposed to.

2.8.3 Criteria for selecting a model

A livestock farming system is a set of dynamically interacting entities managed by farmers to transform resources (animals) into various outputs (meat, wool etc.) or to serve another set of goals (Landais, 1987).

Livestock whole farm models generally abide by the following set of criteria:

(i) The model needs to explicitly represent the system as managed by the farmer.
(ii) The model needs to deal explicitly with farm animals. Models including crop systems are excluded from exclusive livestock research (Keating et al., 2003).

Livestock farming systems can be defined with different boundaries (Landais, 1987), from production units within the farm to communities of farmers making use of a common pool of resources over a given geographic location.

2.8.4 Use of a Whole Farm Model

A modelled system is the result of a modeller’s choice to answer a particular question as relevantly as possible. A system is defined on the basis of its boundaries, the time scale associated with the phenomena to be analysed and the types of viewpoints on the system.

Four possible viewpoints of models were suggested: Biotechnical, economic and technological, ecological and geographical and finally societal (Bonnemaire and Osty, 2004). The viewpoint addressed in this research paper is that of economic and technological.

A model is intended to be used as a support mechanism as oppose to that of collaborating content (Gouttenoire et al., 2011). The type of use of a model is essential to understanding how the model can contribute to supporting changes in livestock farming.

The hypotheses made when designing a whole farm model will differ according to a farmer’s decision making process, however whole farm models need to incorporate a farmers preferences in order to accurately predict a future outcome.

2.9 Participatory Research as a Method of Acquiring Data

The unity and justification of participatory research are to be found not so much on the level of concrete research methods. Participatory research can be regarded a method in favour of possibility, significance and usefulness in the knowledge production process (Bergold, 2007).

2.9.1 Fundamental Principles of Participatory Research

Free participation is a precondition for participatory research. Research calls for social conditions that are conducive to the topic and approach in question. Participation of different demographic groups is only possible if there is an institutional framework that allows for it.

There is a need for “Safe Space” where the participant can share knowledge confidentially. Participatory research requires a willingness on the part of participants to disclose their personal views of the situation. In everyday life, such openness is displayed toward good and trusted friends, but not in institutional settings or towards strangers. In order to facilitate sufficient openness, a “safe space” is needed, in which the participants can be confident that their statements will not be used against them, and that they will not suffer any disadvantages if they express critical or dissenting opinions.

Who participates in participatory research? "Participation" is understood more as the involvement of groups of people who are not professional researchers, but rather professional practitioners and service users. The declared aim of participatory research is to access and harness different types of knowledge. By doing so, the different types of knowledge can be related to each other with a view to achieving a possible practical use. This notion highlights the importance of including practicing farmers in the research. Farmers should play an integral part of the research and be included from the design phase of research. This brings about the notion of research “with” instead of “for” producers (Attonaty, *Et al*., 1999 and Doll and Francis, 1992).

2.9.2 Prerequisites of Participatory Research

The fundamental decision is not to treat the research partners as objects of research, but rather as co-researchers and knowing subjects with the same rights as the professional researchers (Bergold and Thomas, 2012). One of the challenges of participatory research is to ensure that the researcher is, as far as possible, neutral or ‘invisible’. Anything else may lead to a distortion or even threaten the validity of the research.

In participatory research, all participants are involved as knowing subjects who bring their perspectives into the knowledge-production process. Different perceptions can be compared to each other. Accordingly, reflection on the research situation and the research process is important.

Methods of data collection should focus on the participants’ everyday experiences, as this makes it easier for the participant to understand and contribute positively.

In participatory research, the various contributions to the results must be clearly visible. Participants must be given a chance to voice their opinions and positions.

It is to be expected that in participatory research the participants will have different views on the quality of the research process and its results.

Participatory researchers are required to make ethically sound decisions when dealing with participants, for example, how data should be collected, documented and interpreted in such a way that the participants are not harmed and their privacy is ensured.

The participatory research methodology was deemed to be the most practical and efficient method of researching and dealing with the research question.

2.10 Conclusions

Droughts are relatively common in South Africa and farming in the extensive live production areas are especially susceptible. The aim of this thesis is to determine the financial implications of strategies to negate the impact of droughts in such areas. The mutton industry is not only important at the farm level as mutton production and consumption with all value adding activities is an important contributor to the South African economy. This economic effect is accentuated within municipalities in the dyer areas of South Africa.

There are some support systems in place for groups (not necessarily farmers) affected by droughts. Various institutions at different levels of government in South Africa along with organised agriculture have various mandates regarding drought declaration and management. The role of each of these institutions are at a specific level of support. Despite the institutional arrangements farmers are, due to practical implementation issues, ultimately responsible to negate drought situation, with very limited options.

To identify options of negating droughts and the expected financial implications of such options a valid method is required. Research rest on two components, the method for assessment and the way data is collected and verified. Because of the multifaceted nature of the farm system and the need to compare various drought negating strategies simulation modelling in the form of whole farm budgeting is an attractive tool that is also well known to producers. Producers was included in the research in the design and model use phases in a participatory research design manner.

The following chapters will introduce, evaluate and discuss strategies farmers can incorporate on their farming entities to mitigate the negative financial effects of a drought.

Chapter 3 – Research Methodology and Data Acquisition

3.1 Introduction

The main aim of this research project is to identify and evaluate drought mitigation strategies for livestock farms in the Beaufort West area of the Central Karoo region. The area is farmed mostly under extensive sheep systems and periodic droughts are common. In the previous chapter the research method was explained as whole-farm budgeting based on information generated through a participatory process. This chapter will introduce the farming strategies available to farmers to mitigate the negative effects of a drought.

Understanding and perspective of the research methods as applied in this research are covered. These include a description of incremental budget modelling including its applicable benefits and setbacks in modelling the financial data used in the project. A description of financial budget modelling as well as the construction and explanation of the financial models applicable to complete the project.

This section will start by stating and describing the four strategies identified for mitigating the negative financial effects of a drought. Following the above, the section will elaborate on the methodology in designing and constructing the base budget model. A supporting narrative will accompany each individual section to explain how the four strategies are accounted for and modelled in the research. Lastly the data collection activity and interviews with professional personnel within the Beaufort West agricultural community are presented.

For this research project, elements of incremental budgeting were incorporated into a financial budget model as to best describe, calculate and illustrate the effects various farming strategies have at mitigating the negative implications of a drought.

3.2 Definition of the term budget

A budget is a forecast of all income and expenses, and helps a business identify future financial needs and plan based on expected profit, expenses and cash flow. Budgets generally cover a certain period of time and can be periodically updated based on current information. It is recommended that budgets cover a minimum of at least three years, and preferably a period of five years for their effects to become evident. In research budgets are used as a form of simulation modelling and is especially powerful in terms of the amount of variables it can accommodate. The real benefit is that various alternatives can be evaluated in terms of expected financial performance of the whole system. In this case the alternatives are the options of negating a drought that are available to extensive livestock producers. The budget models used in this research project cover a period of ten years.

3.3 Incremental Budget Modelling

An incremental budget model in the traditional sense is a financial model in which budget proposals and allocations are based upon the funding levels of the previous year. Only new revenue is allocated to the expenses of the budget model.

The benefits of incremental budget modelling are that it is easy to implement, provides budgetary stability and allows units and institutions to plan multiple years into the future due to the predictability of the model.

The drawback of incremental budget modelling is that it is limited in its vision, as it is difficult to determine where costs have been incurred and how these costs contribute to revenue and value creation without explanation. (Hanover Research, 2016)

3.4 Financial forecast modelling

A financial forecast model, narrowly defined as a budget model, is a system of mathematical equations, logic and data that describes the relationships among financial and operating variables. A financial model can be viewed as a subset of broadly defined planning models or a stand-alone functional system that attempts to answer a certain financial planning problem (Accounting Financial and Tax, 2009). The sophistication of financial models, especially as developed in a spreadsheet program, lies in the amount of variables that can be integrated through a sequence of equations.

Financial modelling is the task of building an abstract representation of a real-world financial situation. This is a mathematical model designed to represent the performance of a financial strategy. Financial modelling is a technique for risk analysis and "what if" experiments. The model is also needed for day-to-day operational and tactical decisions for immediate planning problems (Accounting Financial and Tax, 2009). A financial model provides a summary of a business's performance, based on certain variables, that helps a business forecast future financial performance (Corporate Finance Institute, 2017).

3.5 The Four Financial Strategies

A strategy is defined as a plan of action designed to achieve a long-term aim. Four financial strategies were identified that can be implemented to mitigate the negative effects of a drought. The four strategies are unique in their approach.

The four financial strategies are as follows:

- Strategy 1 Feed through the drought at cost.
- Strategy 2 Shrink breeding stock during drought and rebuild after (protect genetic

material)

- Strategy 3 Relocate the entire enterprise to area not experiencing drought.
- Strategy 4 Sell off the entire enterprise, invest in the capital market and buy back at the end of the drought

The central focus of this research project is to evaluate these strategies in terms of expected financial implications. For this purpose a whole farm incremental budget model is constructed to model the consequences of each strategy over time. It is important to note that in the construction of the five financial models (Baseline or *status quo* plus four modelled strategies), each strategy was isolated in its own financial model to best compare the results and financial feasibility of implementing the said farming strategy.

3.5.1 Strategy 1 - Feed through the Drought at Cost

The first financial strategy is a highly reactionary strategy. Farmers have historically overcome the loss of grazing pastures through the acquisition and provision of fodder feed to animals. Although the strategy may seem to be the most feasible solution to mitigate the negative effects of a drought, feeding through a drought results in a farm enterprise incurring high additional input costs. The cost to maintain livestock increases proportionally to the increase in variable input costs.

In addition to the injection of capital to implement the strategy, a considerable effort is required from management. A drought will cause an increase in the demand of fodder feed, which in turn will result in an increase in price in a perfectly competitive market. Farm management will need to source and compare various supply options for fodder feed. For simplicity, a single factor can be used in the comparison, namely price. Other relevant factors that fall into the decision-making process would be feed quality, feed availability, producer location and subsequent logistic costs.

The impact that providing additional feed could have on the enterprise is that other farming activities will experience a decline in allocable resources. Apart from the high financial commitment, labour capacity and allocation, which forms a vital part in the operational functionality of a farming enterprise, is likely to be negatively impacted. Livestock and labour logistics will need to be intricately revised to provide the most efficient solutions for daily fodder feed distribution. This will in turn determine the necessity on additional storage facilities. These options will not be explored in detail for the purpose of this thesis.

A positive result of implementing the strategy is that grazing pastures, which are under exceptionally strenuous conditions, will gain an opportunity to recoup. Livestock may however develop a selected affinity toward fodder feed over extended periods which could prove difficult to reverse at the end of a drought period.

The first adaption of the baseline financial model will consider this strategy. As monthly rainfall levels decline, representing the effects of a drought, the amount of feed required to sustain the enterprise increases. The algorithm for calculating this amount of feed is stated and explained in the design methodology of the base model under section 3.6.3, annual rainfall.

3.5.2 Strategy 2 - Shrink Breeding Stock

The second strategy is a proactive approach to dealing with a drought. The position of this strategy is that the livestock numbers will be reduced during drought periods. Three main elements are factored in whilst implementing the strategy. Firstly, less animals will require less overall grazing, and as such reduced strain will be placed on the land to produce food for the livestock population. A somewhat negative impact that needs to be considered is that natural veld pastures never fully gain an opportunity to recoup. Secondly, variable input cost will reduce in similar proportions to that of livestock, thus reducing the overall expenditure incurred by the farming enterprise during a financial year. Lastly, genetic material is protected through shrinking breeding stock. The opposing approach to this element would be a robust sale of livestock and replenishing numbers at the end of the drought period, thus eliminating preferable genetic material. The strategy rather aims to gradually reduce the number of animals the enterprise operates with, thereby increasing the grazing capacity per small stock unit (SSU).

In contrast to the previous strategy, the farming enterprise will require a reduced financial commitment as a reduction of variable input costs transpires. Although positive in the short run, reducing livestock will also result in lower gross income in the coming financial periods. Farm management will have to carefully plan and forecast for future periods to ensure the financial requirements of the enterprise can be met.

Furthermore, fewer labour hours are required to manage and work the reduced livestock numbers. A positive repercussion is that labour hours can be allocated to farming activities that require more immediate attention.

The reduction of stock is achieved by adjusting the enterprises' replacement strategy. The replacement strategy is adjusted by increasing/decreasing the livestock sale percentage. Increasing the sale percentage of livestock results in the farm enterprise shrinking its breeding stock, which ultimately results in less animals being hosted by the enterprise for the following financial year. The replacement strategy is explained in the design of the method of the base model discussed under Section 3.6.5 of the livestock inventory.

In short, implementing this second strategy will require a far more informed and specialized managerial approach to ensure the continuation of the farming enterprise.

In the interview with farmer Christie Mocke on 01/06/2016, it was strongly advised that reducing breeding stock was the most preferable strategy to implement. The advantage of the strategy is that genetic material is protected, and thus the reputation of the farming entity remains intact over and post the drought period.

3.5.3 Strategy 3 – Relocation

The third strategy is relatively expensive and unpredictable. The strategy involves moving the entire livestock population of the farm to a new farm in an area not experiencing drought. Relocating livestock to a new region will take an exceptional effort and will require a large initial capital contribution.

Livestock will be susceptible to new climatic conditions, new diseases and a new management environment all together (Parker, 2016). Although grazing pastures may be sufficient, the loss of livestock due to adaptation in a new environment, and in turn additional diseases is unpredictable. The major setback of implementing this strategy is that increased variable costs need to be incurred on the farming enterprise to inoculate animals against this susceptibility to new diseases. An increased effort will be required from management to monitor the livestock's ability to successfully acclimatize to the new environment, thus detracting efforts from other daily farming operations.

Operational facilities on the new farm may not be suited toward a sheep farming enterprise. As such, more labour and capital will need to be allocated in order to fully equip the facilities to operate efficiently. It should be noted that these permanent upgrades are a sunk cost and are not able to be claimed back at the end of the lease period.

Overhead costs will most likely be incurred during the relocation of livestock. In a telephonic interview with a consultant at Flying Animals, a company specializing in livestock transportation, it was estimated that transportation costs can amount to R100.00 per small stock unit (SSU). This figure is discussed in further detail in the design of the base model under Section 3.6.7, Overhead costs.

Apart from the large initial resource requirement and risk element, the strategy does have merits. Livestock numbers should remain fairly constant, thus providing stability to the farming enterprises' operations. The farming enterprise will encompass a large overhead expenditure, which can be absolved in future planning and budgeting. The condition of the natural veld will also be protected as no further grazing pressure is put on the veld.

The final consideration that needs to be accounted for is the cost of renting land instead of operating from owned land. Whilst the owned farmland experiences severe conditions of drought, it will not be accounted as a producing resource. This opportunity cost in conjunction with the new overhead cost of renting farmland proves costly toward a farming enterprise.

3.5.4 Strategy 4 – Capital Market Investment

The fourth financial strategy takes the position of avoiding the drought altogether. This is strictly speaking not a farming strategy, but rather a method of maintaining capital value of assets through the drought period. The strategy involves selling off the enterprises' entire variable inventory and investing the proceeds in the capital market. The strategy also assumes complete isolation. As a result, the farming entity does not earn a supplementary income. For this reason, the investment product will need to be a movement product, allowing the farmer to withdraw on a regular basis to sustain a living.

The strategy aims to buy back variable inventory (livestock and implements) at the end of the drought period to continue the farming operation. The substantial disadvantage to the strategy is that genetic material is completely lost in the process, which will have serious implications to the intrinsic value of the farming entity's reputation. Furthermore, the rising consumer price index (CPI) will result in the value of livestock and implements to have risen far beyond the original price at which they were initially sold. This strategy aims to protect the money market value of the enterprise, with the objective of resuming business once the drought period has passed.

All of these strategies depend on the ability to predict the duration of the drought period accurately. A relatively short drought would mean that a producer would try to limit the changes as much as possible, while this may simply not be an option during continuing droughts.

3.6 Model Design: Base Budget Model

A baseline budget model was constructed to simulate the financial effects and implications of a normal drought free period on a farming enterprise. This will serve as basis for comparison of the alternative strategies.

The base model calculates and illustrates the financial effects of a typical farming enterprise, over a fixed period, in the Beaufort West area. It is important to note that the baseline model represents a "perfect world" scenario, where harsh climatic conditions are not a considering factor. The hypothetical time frame of ten years, 2016 to 2025, was budgeted and modelled in this research project.

The following sub-sections are included in the baseline budget model. These sub sections will state and elaborate on the various criteria used in calculating the relevant financial outcomes for this project.
The baseline budget model is referred to as "the model" for the rest of Chapter 3. The basic structure of the budget models are illustrated by Figure 3.1.

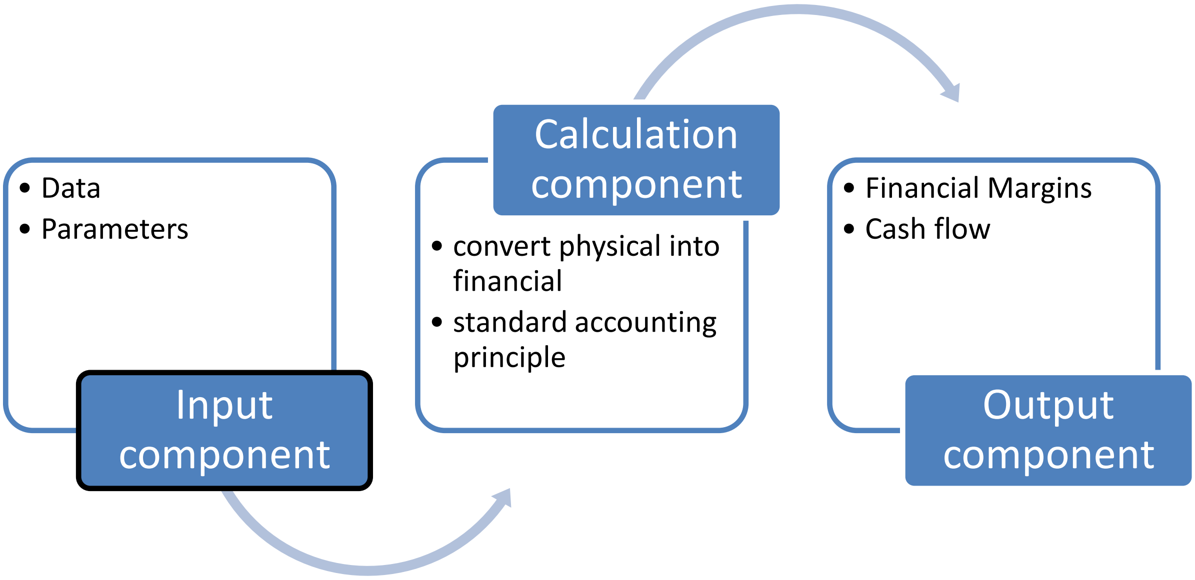

Figure 3.1 A graphical representation of the layout of the whole farm budget model

3.6.1 The input component

The first section in the model, illustrated by Table 3.1., provides the option to update data and calculate results that are both current and accurate. These are the most crucial parameters that drives profitability of a typical extensive sheep farm.

Table 3.1. – Data Inputs

Financial Inputs		
Inflation Rate		6,40%
Loan Summary		
Annual Interest Rate		7,50%
Loan Period in Years		12
Number of Payments per Year		10
Bank Account Summary		
Interest on Bank Account		
Negative Bank Balance		0,63%
Positive Bank Balance		0,17%
General Data		
Selected Starting Year		2016
Replacement Strategy		
Ewe Sale Percentage		20,00%
Lamb Sale Percentage		70,00%

The first input is the inflation rate. Inflation is the rate at which the general level of prices for goods and services are increasing year on year and, consequently, the purchasing power of currency is falling (Investopedia, 2016). The model assumes a fixed inflation rate over the ten-year period. At the time of the study, the South African consumer price index (CPI) was 6.4% (StatsSA, 2017).

The loan summary of the data inputs sheet accommodates the acquisition of a loan. The loan summary includes options for an annual interest rate, a loan period and a number of instalments per year. When requesting a loan these figures are negotiated between the farmer and commercial or Land bank. The rates applicable are subject to vary between different farmers and banks. The physical dimension calculates the size of the loan. This section includes a separate algorithm used to tailor the farmer's required rented capacity to the model.

The bank account summary of data inputs allows for an updated bank balance with current interest rates. This data relates to the cash flow, which calculates the bank balance of the enterprise once all respective incomes and expenditures for the period are accounted. In the data inputs, the only differentiation stated is that a negative and positive bank balance will have varying interest rates applicable to calculate the balance.

The final section of the data inputs allows altering of the replacement strategy for the enterprise. The replacement strategy denotes the percentage of the livestock sold on an annual basis. This figure varies between the four models. The livestock inventory section accommodates this variation in further detail.

3.6.2 The physical dimension of the base farm for extensive sheep farming in Beaufort West

The physical dimension, illustrated by Table 3.2, lets the farmer account a land distribution value and land usage pattern.

Table 3.2. – Physical Dimension

Land Distribution

Grazing Pastures	Ha	*Value	
		R/ha	Total
Karoo Veld	10900	R 2 500,00	R 27 250 000,00
Operating Land	Ha	*Value	
		R/ha	Total
Farm House	5	R 3 500 000,00	R 3 500 000,00
Total	10905		R 30 750 000,00
		Percentage Rented	
Total Rented Land	0	0,00%	R 0,00

*Untilled land value

Land Usage Pattern

	Camp No.	Total Land Usage (ha)	% of Total
Total		10900	99,95%
Land per Large Stock Unit		62,727	0,58%
Land Usage Total			99,95%

The land distribution value divides into two sub sections, namely grazing pastures and operating land. The grazing pastures account for the total land value. The data inputs required for this calculation are number of hectares and the value per hectare. During the producer interviews with the size of the farm that can be described as typical for the area was determined to be 10,900 ha (Mocke, 2016). The value per hectare was determined from the current property market in conjunction with the average value stated by the farmer. Three farms advertised on Property24 were valued per hectare and used in this calculation (Property24, 2017). This value amounted to R2500.00 per hectare. The operating land's value, which includes the farmhouse, was estimated at R3,500,000.00. The interview with James Parker stated that assets such as a farmhouse, operating facility (kraal), water supply and electricity supply greatly increase the value of operating land.

The land usage pattern calculates the total land usage per large stock unit. This figure is calculated by dividing the current year's total inventory by the available grazing pastures. This calculation is important to determine whether the farmer qualifies for drought disaster relief from the Department of Agriculture (Pienaar, 2016).

3.6.3 Annual Rainfall

Beaufort West has dry periods throughout the calendar year. On average, March is the wettest month, whereas July is the driest month. The total annual average rainfall for the region is 220mm per year (BKS Pty Ltd, 2004).

The annual rainfall uses data to monitor whether feed is required for the current month. The rainfall data separates into parameters that determines the amount of feed required for a given month. The feed cost calculates using a scale factor. Table 3.3 displays the scale factor that applied to a corresponding monthly rainfall interval.

Table 3.3. – Monthly rainfall scale factor

Monthly Rainfall Interval	Fodder Feed Scale Factor
0-20mm	2
20-30mm	1
30+mm	0

For example, if monthly rainfall falls between the interval of 0-20mm per month, a scale factor of two is applied to the fodder feed equation. During the interview with farmers a rough estimate on the feed allocated to each enterprise was determined (Mocke, 2016 and Pienaar, 2016). The data acquired from the interview show a calculated amount of R10.88 per small stock unit per month. The following equation calculates the total rand value for cost of feed applicable to a given month:

$$Value\ Fodder\ feeding = 10.88\ x\ \ Livestock\ inventory_{(Year\ start)}\ x\ Rainfall\ Scale\ Factor$$

Strategy 1 – Feed through at cost

The equation above allows for fodder feed cost to the enterprise to adjust accordingly as the amount of livestock fluctuates on the enterprise. This equation is only applicable to the Strategy 1, feed through a drought at cost.

Strategy 2 – Stock Reduction, Strategy 3 - Relocation

When modelling the stock reduction and relocation strategies, the fodder feeding value is manually adjusted to zero for each year. This is done in order to isolate the financial effects of the various strategies from one another.

3.6.4 Inventory and Fixed Implements

The calculation of the carrying value of inventory and implements contributes toward determining the farm profitability. Inventory and implements divides into two sections, namely fixed (permanent) inventory and variable (temporary) inventory. The reason for this being that annual depreciation is not deducted from the carrying value of permanent inventory items, for example, the farm shed (Liapis and Kantianis, 2015). The carrying value of permanent inventory items is determined by the current market value of the item.

Before the carrying value of variable farming implements can be calculated, annual depreciation needs to be determined on these items. An estimate of annual depreciation is calculated by determining the economic life for an implement and a salvage value at the end of the implement's economic life.

The economic life of a machine is the number of years over which costs are estimated. A good rule of thumb is to use an economic life of 10 to 12 years for most farm implements and a 15-year life for tractors (Edwards, 2015). For the more permanent farming implements, namely the kraal and spray race pump, an economic life of 25 years was allocated.

Salvage value is an estimate of the sale value of the machine at the end of its economic life. The salvage value is the amount you could expect to receive as a trade-in allowance (Edwards, 2015). The salvage value is calculated on a fixed percentage of the current market value of the inventory item. Table 3.4 summarizes the estimated percentages for calculating salvage value:

Table 3.4. – Estimated percentages for calculating salvage value

Inventory Item	Salvage Percentage
Vehicle/Tractor	10%
Farming Machinery	15%
Miscellaneous Farming Implements	5%

The following equations illustrate the process for calculating the carrying value of farming implements:

$$Salvage\ value = Current\ Market\ Value\ x\ Estimated\ Salvage\ Percentage$$

$$Total\ Depreciation = \frac{Current\ Market\ Value - Salvage\ Value}{Expected\ Economic\ Life} x\ Current\ Age$$

$$Carrying\ Value = Current\ Market\ Value - Total\ Depreciation$$

The problem with using the aforementioned formula sequence is that it is inaccurate for totalling carrying value of farming implements whose current age exceeds their expected economic life. For example, using the formula sequence for calculating the carrying value of a 50-year old tractor with a market value of R 400,000.00 would yield a carrying negative value of –R 800,000.00 if applied without logic.

Solving this problem, the equation sequence can be reversed, by using mathematical substitution to calculate a suitable market value. The aim for the equation was to return an accurate market value using the current carrying value on implements provided by the farmer. The problem with this approach was that it failed to include inflation on the market values of implements into the calculation.

The following equations illustrate the process for reversing the carrying value equation sequence:

MV – Market Value
SV – Salvage Value
CV – Carrying Value
EX – Expected economic life
Age – Current implement age

Dep – Depreciation
TDep – Total Depreciation

$$CV = MV - TDep$$

$$\therefore MV = CV + TDep$$

$$MV = CV + (Dep\ x\ Age)$$

$$MV = CV + \left(\frac{MV - 0.1MV}{EX}\ x\ Age\right)$$

$$MV = CV + \left(\frac{0.9MV}{EX}\ x\ Age\right)$$

$$\therefore \frac{MV}{Age} = \frac{CV}{Age} + \left(\frac{0.9MV}{EX}\right)$$

$$\therefore \frac{EX\ x\ MV}{Age} = \frac{EX\ x\ CV}{Age} + 0.9MV$$

$$\frac{EX\ x\ MV}{Age} - 0.9MV = \frac{EX\ x\ CV}{Age}$$

$$\frac{EX\ x\ CV}{Age} = MV\left[\frac{EX}{Age} - 0.9\right]$$

$$\therefore MV = \frac{\frac{EX\ x\ CV}{Age}}{\frac{EX}{Age} - 0.9}$$

Although mathematically correct, using the final equation for an estimated market value on implements older than their expected economic life continued to produce inaccurate results. The carrying value of the 50-year tractor would exceed the market value, suggesting the implement appreciated over its 50-year lifetime. The final solution for the equation is able to reverse the carrying value of implements whose current age did not exceed their current economic life.

The solution to the problem was achieved by including an “IF” function in the carrying value total column of the base model. This function stated that the model calculates a carrying value using the original three step formula sequence illustrated above. Should the salvage value, however, exceed the calculated carrying value, the salvage value would be used as a substitute carrying value for that item.

3.6.5 Livestock Inventory

The typical farm that was modelled trades in livestock, and therefore the primary source of income for the farm is through sales of livestock. Table 3.5 illustrates the opening livestock inventory for the given year. In addition, the different categories of sheep, their large stock unit equivalent as well as estimated market value are also provided. The livestock numbers displayed in Table 3.5 are the opening inventory numbers that were provided during farmer interviews and used as baseline for all the livestock calculations.

Table 3.5. – Opening Livestock Inventory

Item	Quantity	LSU-Equivalent	Value	Total
Lamb (Unweaned up to 4 months)	97	7,76	R 900,00	R 87 300,00
Weaner lambs (4 months and older)	0	0	R 750,00	R 0,00
Ewe (2-tooth and older)	1073	160,95	R 1 250,00	R 1 341 250,00
Wether (2-tooth and older)	0	0	R 900,00	R 0,00
Castrate (2-tooth and older)	0	0	R 800,00	R 0,00
Ram (2-tooth and older)	22	5,06	R 2 500,00	R 55 000,00

The large stock unit equivalent is an important indicator used to determine whether the enterprise qualifies for a drought relief rebate from the regional Department of Agriculture. Table 3.2 displayed the total land usage per large stock unit to be 62.7 hectares for the Beaufort West area. This means that each large stock unit need on average 63 hectares of grazing pastures available. If a farmer chooses to operate an enterprise and exceed their grazing capacity during a drought, they will forfeit their claim to drought relief from the regional Department of Agriculture (Pienaar, 2016). Table 3.6 illustrates the relevant conversion factors for small stock units (SSU) to large stock units (LSU) for the different categories of sheep. The typical farm operates only with dorper sheep, which is a mutton breed. Therefore, only the middle column conversion factors are relevant for this research. Using an example from Table 3.6, 97 lambs (SSU) multiplied by 0.08 equals 7.76 large stock units.

Table 3.6. – LSU-Equivalent

Small Stock Unit	Wool Sheep	Mutton Sheep	Dual Purpose
Lamb (Unweaned up to 4 months)	0.05	0.08	0.08
Weaner lambs (4 months and older)	0.10	0.11	0.12
Ewe (2-tooth and older)	0.14	0.15	0.17
Wether (2-tooth and older)	0.15	0.16	0.17
Castrate (2-tooth and older)	-	-	-
Ram (2-tooth and older)	0.19	0.23	0.25

Table 3.7. - Closing livestock inventory for a given year.

Item	Quantity	LSU-Equivalent	Value	Total
Lamb (Unweaned up to 4 months)	1342	107,36	R 900,00	R 1 207 800,00
Weaner lambs (4 months and older)	0	0	R 750,00	R 0,00
Ewe (2-tooth and older)	887	133,05	R 1 250,00	R 1 108 750,00
Wether (2-tooth and older)	0	0	R 900,00	R 0,00
Castrate (2-tooth and older)	0	0	R 800,00	R 0,00
Ram (2-tooth and older)	21	4,83	R 2 500,00	R 52 500,00

The livestock inventory differentiates into six categories namely: Lambs, weaner lambs, ewes, wethers, castrates and rams (Roux, 2016). The term "weaner" refers to an animal that has been removed from its mother, and thus solely dependent on grazing pastures for nutrition. A castrated ram is called a wether. Wethers are less aggressive than rams therefore are far easier to manage (Sheep101, 2016).

When comparing the numbers within a given year the opening inventory and closing inventory will differ. The following activities influence this difference: Livestock purchases, livestock sales, new-born animals and animal growth. When modelling these changes in livestock inventory, the replacement strategy and the livestock breeding percentage need to be stipulated (Parker, 2016). In the baseline model it is assumed that a constant breeding percentage of 125% is obtained. This was a rough estimate made by the participation farmers (Mocke, 2016). Additionally, the model has a function on the data inputs sheet to adjust the replacement strategy. The replacement strategy is divided into two key components, the ewe sale percentage and the lamb sale percentage.

Baseline Model assumptions

The base model assumes a 20% ewe sale percentage and a 70% lamb sale percentage, as illustrated by Table 3.8. This replacement strategy is used for all of the farming strategies, barring stock reduction strategy.

Table 3.8. – Baseline model Replacement Strategy

Replacement Strategy	
Ewe Sale Percentage	20,00%
Lamb Sale Percentage	70,00%

Strategy 2 – Stock Reduction

The stock reduction strategy adjusts the ewe sale percentage to 22% and the lamb sale percentage 73%. Over the ten-year period, a vast reduction in livestock inventory numbers will result. This reduction in livestock has a knock-on effect for not only the enterprises' gross turnover, but also the cost structure. These results are discussed in Chapter 4.

The model uses the following assumptions for livestock inventory:

1. New-born lambs in the current year are all categorised as lambs (Unweaned up to four months) in the current years closing inventory.
2. Lambing occurs once per year.
3. New-born lambs (Unweaned up to four months) are 50% male, 50% female and are recorded as such in the following years opening inventory. Female lambs are categorised as "Lambs (Unweaned up to four months) and male lambs are categorised as castrate (two-tooth and older).
4. All male new-born lambs to mature into castrates (two-tooth and older) at the beginning of the following year and is produced to sell.
5. Female new-born lambs mature into ewes within a one year period.
6. All ewes on the farm lamb.
7. The farm enterprise retains no male new-born animals to mature into rams.
8. Ram purchases and sales are adjusted manually on the model at the farmer's discretion.

The following equations illustrate how sales for a given year is calculated.

$$Lamb\ (Unweaned) = \ Lamb\ (Unweaned)_{Opening}\ x\ Lamb\ Sale\ Percentage$$

$$Ewe\ (2\ tooth\ \&\ older) = \ Ewe\ (2\ tooth\ \&\ older)_{Opening}\ x\ Ewe\ Sale\ Percentage$$

$$Castrate\ (2\ tooth\ \&\ older) = Castrate\ (2\ tooth\ \&\ older)_{Opening}$$

Once the sales for a given year have been calculated, the model can calculate the closing inventory. The following equations illustrate how the closing inventory for a given year is calculated.

$$New\ born\ lambs = 1.25\ x\ Ewe\ (2\ tooth\ \&\ Older)_{Opening\ Inventory}$$

**This figure is calculated using the assumed 125% breeding percentage for all ewes on the enterprise.*

$$Lamb\ (Unweaned\ up\ to\ 4\ months) = New\ born\ lambs + Purchases$$

**It should be noted that purchases of new-born lambs is almost always zero.*

$$Ewe\ (2\ tooth\ \&\ older) = Ewe_{Opening} + (Lamb_{Opening} - Lamb_{Sale}) - Ewe_{Sale} + Purchases$$

Using the above-mentioned assumptions, the model adjusts the previous year's closing inventory to the current year's opening inventory using the following equations.

$$Lamb\ (Unweaned\ up\ to\ 4\ months) = 0.5\ x\ Lamb\ (Unweaned\ up\ to\ 4\ months)_{Previous\ closing}$$

**This is the calculation for the female portion of the previous year's new-born animals which is based on the second assumption in the list above.*

$$Ewe\ (2\ tooth\ \&\ older) = Ewe\ (2\ tooth\ \&\ older)_{Previous\ closing}$$

$$Castrate\ (2\ tooth\ \&\ older) = 0.5\ xLamb\ (Unweaned\ up\ to\ 4\ months)_{Previous\ closing}$$

**This is the calculation for the male portion of the previous year's new-born animals which is based on the second assumption in the list above.*

Once the model calculated the inventory for a given period, total livestock value can be calculated for the farm over that given period. This is achieved by multiplying the inventory quantity by the value of the inventory item in the given time period. Inventory item values are adjusted annually using the constant annual inflation that is specified in the data inputs.

At the end of every financial year the model calculates the change in inventory. This value is used in the calculation of the enterprise's gross value of production calculation.

3.6.6 Production Cost

The production activity cost calculates the day-to-day operating costs for the enterprise and the farm. These running costs include, but are not limited to wages, fuel and animal medicines. Table 3.9 illustrates which inputs are included in the base model and the unit amount in which they are purchased. The medication prices, their unit amounts and application rates were supplied from agribusinesses (BKB, Port Elizabeth Branch, 2016).

Table 3.9. – Production Inputs for 2016

Input Price List		
Input Needed	Unit Amount	Price
General Activity Inputs		
Wire	100m roll	R 850,00
Dropper	Dropper	R 8,00
Pole	Pole	R 30,00
Gate	Gate	R 1 500,00
Diesel	Litre	R 10,18
Labour	Labourers	R 2 670,00
Sheep Activity Inputs		
Deadline	20 litre	R 3 059,50
Cydectin	0.5 litre	R 1 330,00
Coglavax	0.5 litre	R 1 098,39
Enzovax	0.1 litre	R 265,73
Paracide	5 litre	R 2 405,71

In the whole farm multi-period budget, the prices in Table 3.9 are adjusted annually using the constant annual inflation that is specified in the data inputs.

The model uses the following assumptions for production activity costing:

1. General farm maintenance is at the farmer's discretion and is therefore not modelled for this research. Quantity values for all fencing activities are thus zero throughout the model.
2. A constant amount of diesel is used per month calculated from the farmer's most recent annual diesel usage.
3. The monthly price of fuel is assumed constant at R10.18 for the base year.
4. Farm labourers are assumed to be in the low skill bracket and receive a constant monthly wage. The monthly wage rate is assumed to fall between the minimum wage bracket of R 2000.00 – R 3000.00 per month.
5. The model assumes a constant amount of dipping per animal for the 10-year period.
6. The model assumes a constant dosage per animal for the 10-year period.
7. When a given medicine requires one dosage per annum, the dosage is applied in December of the given year.
8. When a given medicine requires two dosages per annum, one dosage is dealt in June and the other in December of the given year.

Table 3.10 illustrates the annual production activity expenditures supplied by the farmer.

Table 3.10. – Annual Production Activity Expenses supplied by farmer

Production Activity	Expense
Fuel	R 61 241.00
Labour	R 160 205.00
Animal Feed	R 12 971.00

These totals are supplied by the farmers are not modelled in a month to month cash flow. Therefore, in order to model the data correctly, the model required that these totals be transformed into practical figures.

The model first required for a monthly fuel usage in litres to be calculated.

$$Monthly\ fuel = \frac{Annual\ Usage}{12} = \frac{61241.00}{12} = 5103.42$$

$$Monthly\ usage\ in\ litres = \frac{Monthly\ fuel}{Assumed\ price/litre} = \frac{5103.42}{10.18} = 501.32\ell$$

The second equation is reversed in the model every month, but the total litre usage is important for calculating a monthly cash flow for the farm enterprise.

Secondly, the model required calculating the number of workers on the enterprise as well as their monthly wage rate. The following equations illustrate this calculation using the above mentioned assumptions.

$$Monthly\ wage\ expense = \frac{Annual\ wage\ expense}{12} = \frac{160205.00}{12} = 13350.42$$

$$No.of\ workers = \frac{Monthly\ wage\ expense}{Assumed\ wage\ rate} = \frac{13350.42}{2500} = 5.34 \approx 5$$

$$Wage\ rate\ per\ worker = \frac{Monthly\ wage\ expense}{No.of\ workers} = \frac{13350.42}{5} = 2670.08$$

Farmers supplied a list of medication used on the farm enterprise, however never supplied the medication application schedule. The amount of Deadline (dip) which is used on average per annum was disclosed. To resolve the problem, an animal medication application schedule was designed in an interview with more farmers (Parker, 2016).

The following equations illustrate how a medication schedule for each medicine was designed and modelled.

Deadline:

Deadline is a dip for sheep that is applied on a monthly basis.

$$Annual\ Deadline = \frac{Given\ annual\ usage_{litre}}{Litre\ per\ bottle} = \frac{\pm 7\ell}{20\ell} = 0.35\ units/annum$$

$$Monthly\ Deadline = \frac{0.35}{12} = 0.0292\ units/month$$

$$Monthly\ Deadline\ Expense = 0.0292\ x\ Price/Bottle$$

Cydectin:

Cydectin is an anti-parasitic remedy for cattle and sheep with residual activity against certain important roundworms of cattle and sheep as well as blue ticks in cattle (Zoetis, 2013). Cydectin is applied once per year and each animal requires 1 millilitre per dose. Cydectin application is therefore only modelled in December.

$$Cydectin\ per\ dosing = \frac{Usage_{litre}\ per\ dose}{Litre\ per\ bottle} x\ Opening\ Livestock\ Inventory$$
$$= \frac{0.001\ell}{0.5\ell}\ x\ Opening\ Livestock\ Inventory$$

$$Cydectin\ Expense\ per\ dosing = 0.002\ units\ x\ Opening\ Livestock\ Inventory\ x\ Price/Bottle$$

Coglavax:

Coglavax is a polyvalent-inactivated vaccine for the prevention of clostridial infections in sheep and cattle (Ceva, 2016). Coglavax is applied twice per year and each animal requires 1 millilitre per dose. Coglavax application is therefore modelled in June and December.

$$Coglavax\ per\ dosing = \frac{Usage_{litre} per\ dose}{Litre\ per\ bottle}\ x\ Opening\ Livestock\ Inventory$$
$$= \frac{0.001\ell}{0.5\ell}\ x\ Opening\ Livestock\ Inventory$$

$$Coglavax\ Expense\ per\ dosing = 0.002\ units\ x\ Opening\ Livestock\ Inventory\ x\ Price/Bottle$$

Enzovax:

Enzovax is used for the active immunisation of susceptible breeding female sheep as an aid in the prevention of abortion and stillbirth caused by the *Chlamydia abortus* infection (MSD Animal Health, 2009). Enzovax is applied once per year to each ewe. Each ewe requires 2 millilitres per dose.

$$Enzovax\ per\ dosing = \frac{Usage_{litre} per\ dose}{Litre\ per\ bottle}\ x\ Opening\ Ewe\ Inventory$$
$$= \frac{0.002\ell}{0.1\ell}\ x\ Opening\ Ewe\ Inventory$$

$$Enzovax\ Expense\ per\ dosing = 0.02\ units\ x\ Opening\ Ewe\ Inventory\ x\ Price/Bottle$$

Paracide

Paracide is a pyrethroid dip that controls and kills external parasites on cattle, sheep and goats (Zoetis, 2013). Paracide is applied on a monthly basis.

$$Annual\ Paracide = \frac{Given\ annual\ usage_{litre}}{Litre\ per\ bottle} = \frac{\pm 10\ell}{5\ell} = 2\ units/annum$$

$$Monthly\ Paracide = \frac{2}{12} = 0.17\ units/month$$

$$Monthly\ Paracide\ Expense = 0.17\ x\ Price/Bottle$$

3.6.7 Overhead Cost

Overhead costs are the indirect costs or fixed expenses of operating a business. That is, the costs not directly related to the manufacture of a product or delivery of a service. Overhead costs range from rent to administrative costs to marketing costs (Entrepreneur, 2017). Table 1.13 illustrates the overhead expense items incurred by the modelled farming enterprise.

Table 3.11. – Overhead Expenditure

Overhead Expense Item
Bank Charges
Accounting Fee
Cartage
Water & Electricity
Insurance
Repairs and Maintenance
Muncipal Tax
Licences
Telephone
Security
Tools
Veterinary
Predator Control
Sundries
Farmer Salary

If a loan is required for the purchase of land or equipment, the loan repayments would form part of the factor cost. Table 3.11 does not include a payment on a loan. The modelled typical farm also assumed that land is inherited; therefore, the farmer does not incur a mortgage repayment on the land itself. The baseline model does include an option for a loan repayment should a loan be taken out in the future.

Strategy 3 – Relocation incorporates two additional entries in the overhead costs. The first is the initial transport cost incurred in relocating livestock between farming enterprises. This figure was estimated to be R100 per small stock unit in a telephonic interview with transport specialists (Britz, 2017). The second is farmland rental cost incurred for the new grazing pastures hired. This figure reflects as a standard monthly amount that updates on an annual basis in line with inflation.

Overhead expenditure figures was supplied directly from the participating farmers from their respective bank statements. The total cost items given were annual figures for each cost item. In order to model these totals to a monthly cash flow, the total values were simply divided by twelve, and were assumed to be equal monthly expenditures. Some fixed costs may show slight deviations between months, e.g. permanent labour cost may be higher in a month where bonuses are paid out, but for planning purposes an equal allocation is standard practice. To project these expenditures into the future over the selected 10-year period, the values are adjusted annually using the constant annual inflation specified in the data inputs.

The profit margins as calculated in the model are the net present value (NPV) of the typical farm and subsequently the internal rate of return (IRR). The strategies producing a higher net present value after the 10-year period, relative to the initial investment, would subsequently have a positive influence on the internal rate of return (Hoffmann, 2010).

The core focus of this research project is to determine the financial implications of various drought mitigation strategies available to extensive mutton sheep producers in the Beaufort West area. For this purpose, it is important to integrate all factors that could influence the total farm in financial terms. To assure the validity of the model producers was included in the design of the model structure as well as the composition of the typical farm and the drought mitigation strategies. This model is designed according to standard accounting principles. These principles are briefly described in the following sections.

3.6.8 Gross Value of Production

The gross value of production for a livestock enterprise is the total value of production of livestock products plus trading income plus the livestock inventory change. The total gross value of production is the sum of all the farm enterprises plus the sundry farm income.

Gross income of an enterprise is calculated in the same way as gross value of production, except that internal transfers (intermediate inputs) of products from one enterprise to another are not taken into account (Department of Agriculture, Forestry and Fisheries, 2005). This model assumes all the farm enterprises as one, therefore does not include internal transfers to and from other enterprises in the gross value of production calculation (as the value will be zero). As a result, gross value of production and gross income are synonymous in this research.

The gross value of production is calculated using data from preceding sheets within the model. Table 3.12 illustrates the gross value of production calculation.

Table 3.12. – Gross Value of Production Calculation

Product Income
Sales of livestock products
+ Insurance on product loss
+ Personal consumption
-Opening stock
+ Closing stock
Trading Income
Sales of livestock
+ Insurance on livestock loss
+ Slaughtered stock for household use
-Purchases of livestock
Inventory Change
Closing value of livestock
-Opening value of livestock

3.6.9 Net Farm Income

Net farm income is defined as the return to land (own and hired), capital (own and borrowed) and management (own and hired) (Department of Agriculture, Forestry and Fisheries, 2005). When calculating the net farm income of a livestock enterprise, certain terms first need to be specified.

Gross margin of an enterprise is the enterprise gross production value less directly allocable variable costs (defined as Production Activity Costs in the model). The specific variable cost items included depend on the purpose of the calculation and the practical feasibility of the allocation. Cost items therefore must be specified (Department of Agriculture, Forestry and Fisheries, 2005).

Total gross margin is the sum of the gross margins from all individual enterprises. Total farm gross margin is the total gross margin plus sundry farm income. (Department of Agriculture, Forestry and Fisheries, 2005). Since the farming enterprise being modelled has only a livestock enterprise and no sundry incomes, gross margin, total gross margin and total farm gross margin are equal in this research.

The net farm income is calculated extracting data from other sheets of the model. Table 3.13 illustrates the net farm income calculation.

Table 3.13 – Schematic presentation of the calculation of Net Farm Income

Net Farm Income
Gross Value of Production
-Production Activity Costs
= Gross Margin
=Total Farm Gross Margin
-Farm Overhead Costs
NET FARM INCOME

Additionally, the net farm income sheet includes a farm profitability calculation. This is an income investment ratio used to determine the operators earning performance. The following equation illustrates how farm profitability is calculated:

$$Farm\ profitability = \frac{Net\ Farm\ Income}{Total\ Capital}\ x\ 100$$

The total capital employed in the enterprise was calculated in the inventory and fixed implements sheet. Total capital omits the value of land in the calculation. The total capital is updated year on year for inflation is referenced in the model accordingly.

3.6.10 Cash Flow

The cash-flow statement records the amount of cash and cash equivalents entering and leaving the farming enterprise (Investopedia, 2016). The cash-flow statement allows the farmer to understand the running of operations, the origin of cash and its allocation. The income and balance sheet are not included in this financial model.

The cash-flow budget is similar in structure as the cash-flow statement but work on future expected in and out flows of money. The cash flow budget for this model records cash flows on a monthly basis for the 10-year period. The cash flow budget reflects three sets of important data: cash inflows, cash outflows and the farming enterprise bank balance.

<u>Cash Inflows:</u>

The farm earns no sundry incomes and therefore relies solely on livestock sales as the primary source of cash inflow. Although annual livestock sales are calculated in the livestock inventory, the assumption holds that sales are only in December. As a result, the cash inflow from livestock sales reflects only at the end of the year in the cash flow statement. Each model was randomly allocated an opening balance of R 1, 000, 000.00 operating capital. No information is available on the past cash flow which would determine the cash balance at the start of the current period. A random figure for all models was suggested which provides the basis for comparison in terms of the drought negating strategy. Since incomes generated is only reflected at year-end, the operating capital allocation is incorporated to avoid negative bank balances and ultimately high interest expenses not reflective of the situation.

The model accommodates manual data inputs to be included for practical application. This data can capture on the gross value of production sheet. It should be noted that the data does not automatically calculate from the livestock opening inventory as livestock sales do. Table 3.14 illustrates the data criteria included for total cash inflows for the typical farm.

Table 3.14. – Schematic presentation of Total Cash Inflows

Livestock Production Inflow
Sales of Livestock
+ Insurance Received on Livestock
+ Sales of Livestock Products
+ Insurance Received on Livestock Product
Total Cash Inflows

<u>Cash Outflows:</u>

A farm typically incurs a large variety of cash outflow items. Expenditures are calculated and modelled month by month, therefore allowing to accurately include cash outflows on a monthly basis. Table 3.15 illustrates the expenditure used to calculate total cash outflows for the enterprise.

Strategy 4 differ in this regard as the capital market investment includes an additional cash outflow in the overhead expenditure. It is assumed that the farm owner makes a monthly withdrawal of R35,000.00 as owners' remuneration.

Table 3.15 – Total Cash Outflows

Livestock Production Outflow
+Production Activity Expenses
+Purchases of Livestock
Sundry Cash Outflows
+General Farm Activity
+Overhead Expenses
+Inventory Purchases
Total Cash Outflows

Although the production activity expense and general farm activity expense are both calculated on the production activity cost sheet, they are categorised differently on the cash flow. Production activity expenditure refer to the costs directly allocable toward livestock production (ie: dips and doses). The general farm activity expenditure refer to costs incurred undergoing general farm operations (diesel and labour).

Furthermore, it should be noted that although inventory purchases are included in the cash outflows, depreciation is not. Therefore, depreciation of capital employed is not reflected on the cash flow statement.

Bank Balance:

Total monthly cash-flow is reflected in the bank account calculation in the cash flow budget. Interest income/expense is calculated from the monthly net cash flow with the interest rates given in the data inputs sheet. Table 3.16 illustrates the calculation of the bank balance.

Table 3.16 – Schematic presentation of the Farming Enterprise Bank Balance

Balance Beginning
+Total Cash Inflows
-Total Cash Outflows
=Net Inflow/Outflow
Interest Income/Expense
Balance End

The actual current bank balance of the farmers was not made available. The data was deemed too confidential, but for assessment of the strategies not essential. It was also agreed that the farm entities make use of no rented capital (ie: loans) therefore, the model assumes a starting bank balance of R 1,000,000.00. It should be noted that due to the cash inflows only at year-end, the monthly interest calculations are not an accurate reflection of the real world scenario. The interest calculation is consistent through all four farming strategies, therefore will not deter the results of the research.

3.6.11 The construction of the Capital Budget

Capital budgeting is the process followed to determine and evaluate potential expenses or investments that are large in nature and over the longer term. A prospective project's lifetime cash inflows and outflows are assessed in terms of the initial capital requirement in order to determine whether the potential returns generated meet a sufficient target benchmark, also known as investment appraisal (Investopedia, 2010). The capital budget constructed for this project calculate two measurements of profitability namely the net present value (NPV) and internal rate of return (IRR). The capital budget requires three criteria to be defined, the time periods, the initial capital outlay and the total cash flows for the time period. The capital budget is over a 10-year period and determine NPV and IRR. The initial capital outlay, in theory, takes the sum of all the capital employed into a farming enterprise and is recorded in time period zero. Table 3.17 illustrates the initial capital outlay for the typical farm. In the case of this typical farm the initial capital outlay consists of the cost of land and the current carrying value of inventory. The capital outlay is expressed as a negative value as it a capital outflow as this represents the investment requirement of the capital budget.

Table 3.17. – Initial Capital Outlay for the Farming Enterprise

Physical Dimension	-R 30 750 000,00
Inventory and Fixed Implements	-R 2 307 799,56
Total Initial Outlay	(R 33 057 799,56)

The total cash flows for the respective time period is required. The total annual cash flows were calculated on the previous cash flow sheet.

The following formula illustrates how to calculate the present value of cash flows:

$$PV = (\frac{Cash\ Flow}{1 + Interest})^{Time\ Period}$$

The formula discounts the cash flow received at a specific time period by the interest rate, to return the current value of money should it be banked. The net present value for the farming enterprise is determined by totalling the present values of all future cash flows.

The internal rate of return (IRR) is a measurement used in capital budgeting that calculate the profitability of potential investments. The internal rate of return is a discount rate that makes the net present value (NPV) of all cash flows from a particular project equal to zero. In its simplest sense the IRR should be higher than inflation but can also be used to assess alternative investment opportunities.

3.7 Data Collection

The data used in this study was acquired from a variety of sources from the Stellenbosch University and Beaufort West agricultural communities. The following section highlight the process and content of a series of meetings that was important for this research project.

3.7.1 Phyllis Pienaar, Department of Agriculture – 13/04/2016

This component helped to gain an understanding of drought relief strategies currently in place. Understanding was established as to what is done by the Department of Agriculture to assist farmers in the area when experiencing a severe drought. The findings of the meeting are discussed Chapter 2 of this study.

3.7.2 Dean Gous, Agri Central Karoo – 13/04/2016

This interview was a supplementary to the meeting with P. Pienaar. Pienaar was present for the interview to identify and a farm dimension that would be representative for the broader area. This served eventually as the typical farm that forms the basis on which the strategies could be modelled around.

3.7.3 Juan-Marie Straus, Elsenburg – 19/04/2016

This was a supplementary interview to the one with P. Pienaar. During this interview, hard copies of the sources were acquired. These sources were used for the elaborating on the government's current function in drought relief.

3.7.4 Christie Mocke – 01/06/2016

The interviews with Christie Mocke was organised in advance. The strategies and data required for the research were stipulated. The required data was sent through a serious of emails. Additional to the data, the discussions were around the feasibility and practicalities around the various strategies and the probability of them being implemented on farming enterprises regardless of research findings. Between Mocke and Pienaar access was also gained to other producers.

3.7.5 James Parker – 20/06/2016

These interviews provided insight into the various findings of the research. The following list of categories were discussed in the meeting:

- Average small stock unit (SSU) value
- Medical application schedules for sheep
- Suitable replacement strategies for a sheep enterprise
- Average lambing rates for different areas of South Africa

3.7.6 Justus Britz – Flying Animals – 01/07/2017

The telephonic interview with the consultant at Flying Animals. The purpose was to gauge the average cost of transporting livestock between farms over relatively large distances. Flying Animals is a livestock transportation company based in Gauteng, South Africa.

3.8 Conclusions

The area of Beaufort West is part of the Central Karoo and highly susceptible to droughts. The aim of this study is to determine the financial implications of drought mitigation strategies available to extensive mutton producers in this area. The strategies were identified by local producers and officers of the Department of Agriculture, Western Cape. A farm with no draught and this no mitigation serves as the baseline. The strategies that were assessed for financial implications are: full feed through the drought, decreasing herd size according to veld condition, sell whole livestock unit and buy in after drought and relocate the whole herd to unaffected area at additional costs.

To assess the financial implications of each option of drought mitigation a whole farm budget model was constructed. This whole farm budget model is essentially a simulation model that is based on accounting principle. These underlying principles were discussed briefly to provide the underlying assumptions for the integration into a whole farm budget and eventually into an incremental budget which allow only for expenditure that are affordable on the cash flow. The process of identifying and modelling the typical farm was done in a participatory manner and the participants were interviewed followed up by a series of email or telephonic conversations. The following chapter presents the results and interpret the outcome of the modelling exercise.

4 Chapter 4 – Results and Discussion

4.1 Introduction

The previous chapter described the mechanism by which the various financial models were designed to assess the strategies to mitigate a drought in the Beaufort West area. The method described explain the working of each model and how the results are produced.

The identification and construction of a typical farm model for the area provided a basis for comparison of the strategies identified to mitigate a drought. This chapter illustrate and compare the results that the financial models produced. Each section illustrates unique features of each strategy that impact on the overall expected financial outcomes. Where possible trends on the results are shown. The strategies are measured against each other to best determine the most feasible farming strategy to mitigate the financial effects of a drought.

It is important to note that only Strategy 1 – Feed through at cost, Strategy 2 – Stock reduction and Strategy 3 – Relocation are farming strategies, are included as farming strategies. The results for the first categories are only applicable to these three strategies.

Strategy 4- Capital market investment, is introduced in the year-end bank balance and capital budget sections. This is used to identify whether it would be feasible to sell off the enterprise, withhold from a farming income for the 10-year period and buy back at the end. This option is strictly theoretical and is not presented or evaluated as a farming strategy.

4.2 Livestock Inventory

The first set of results look at how the number of livestock fluctuates over the 10-year period for the given strategies. The base model is included in this section to illustrate that livestock numbers remain identical when implementing either, no strategy (in a no drought scenario), Strategy1 – Feed through at cost or Strategy 3 – Relocation. For this reason, the livestock numbers for Strategy 3 - Relocation are not tabulated or illustrated, as they would be identical to that of the base model and Strategy 1.

4.2.1 Livestock Numbers

The section focuses on the opening livestock numbers in relation to closing livestock numbers. The opening livestock figures are included to illustrate the division between lambs and castrates. The livestock sales section will illustrate that this factor is important, as all castrates are sold in the given year and the retained percentage of lambs (those not sold) develop into ewes.

Table 4.1: Total Livestock at Year Beginning for the Base Model

Base Model							
Year	**Total Livestock at Year Beginning**	**Lamb (Unweaned up to 4 months)**	**Weaner lambs (4 months and older)**	**Ewe (2-tooth and older)**	**Wether (2-tooth and older)**	**Castrate (2-tooth and older)**	**Ram (2-tooth and older)**
2016	1192	97		1073		0	22
2017	2250	671		887		671	21
2018	2041	555		910		555	21
2019	2053	569		894		569	21
2020	2024	559		885		559	21
2021	2004	554		875		554	21
2022	1981	547		866		547	21
2023	1961	542		856		542	21
2024	1937	535		846		535	21
2025	1915	529		836		529	21

Table 4.2: Total Livestock at Year Beginning for Strategy 1 – Feed through at Cost

Strategy 1 - Feed through at Cost							
Year	**Total Livestock at Year Beginning**	**Lamb (Unweaned up to 4 months)**	**Weaner lambs (4 months and older)**	**Ewe (2-tooth and older)**	**Wether (2-tooth and older)**	**Castrate (2-tooth and older)**	**Ram (2-tooth and older)**
2016	1192	97		1073		0	22
2017	2250	671		887		671	21
2018	2041	555		910		555	21
2019	2053	569		894		569	21
2020	2024	559		885		559	21
2021	2004	554		875		554	21
2022	1981	547		866		547	21
2023	1961	542		856		542	21
2024	1937	535		846		535	21
2025	1915	529		836		529	21

Table 4.3: Total Livestock at Year Beginning for Strategy 2 – Stock Reduction

Strategy 2 - Stock Reduction							
Year	**Total Livestock at Year Beginning**	**Lamb (Unweaned up to 4 months)**	**Weaner lambs (4 months and older)**	**Ewe (2-tooth and older)**	**Wether (2-tooth and older)**	**Castrate (2-tooth and older)**	**Ram (2-tooth and older)**
2016	1192	97		1073		0	22
2017	2225	671		862		671	21
2018	1952	539		853		539	21
2019	1899	534		810		534	21
2020	1810	507		775		507	21
2021	1731	485		740		485	21
2022	1654	463		707		463	21
2023	1581	442		676		442	21
2024	1513	423		646		423	21
2025	1446	404		617		404	21

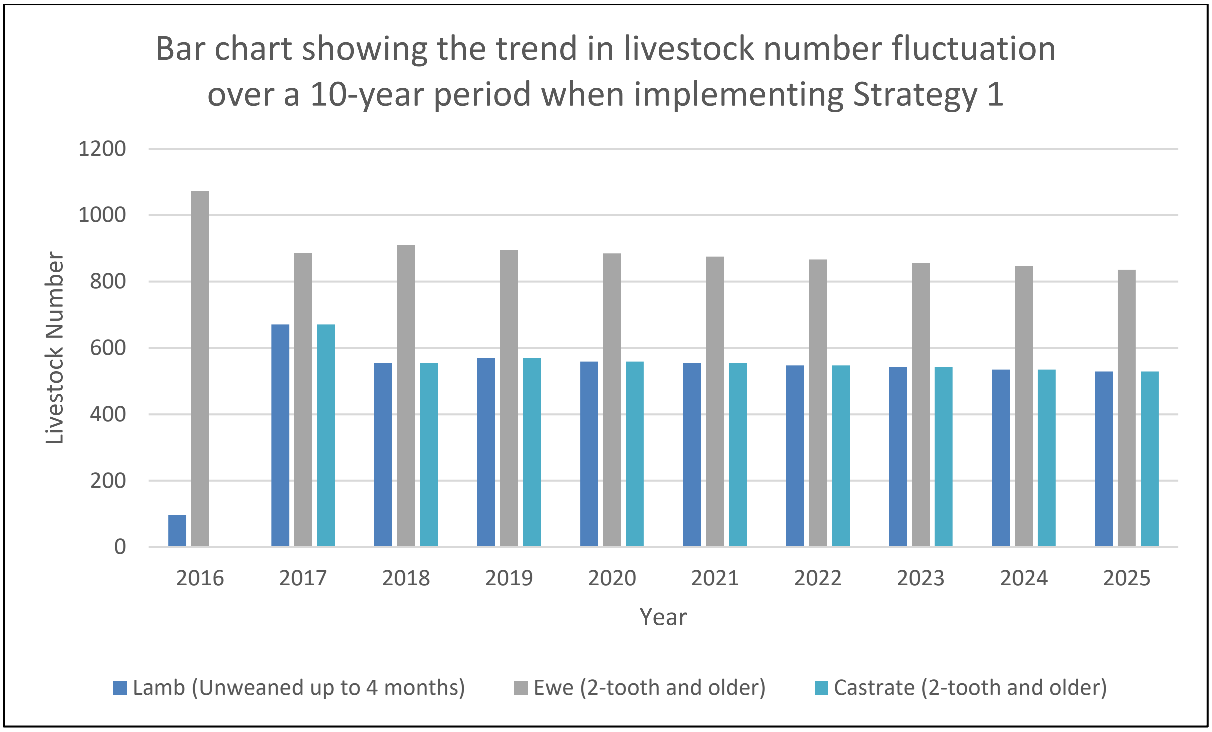

Figure 4.1: Livestock number fluctuation over 10-year period when implementing Strategy 1 – Feed through at Cost

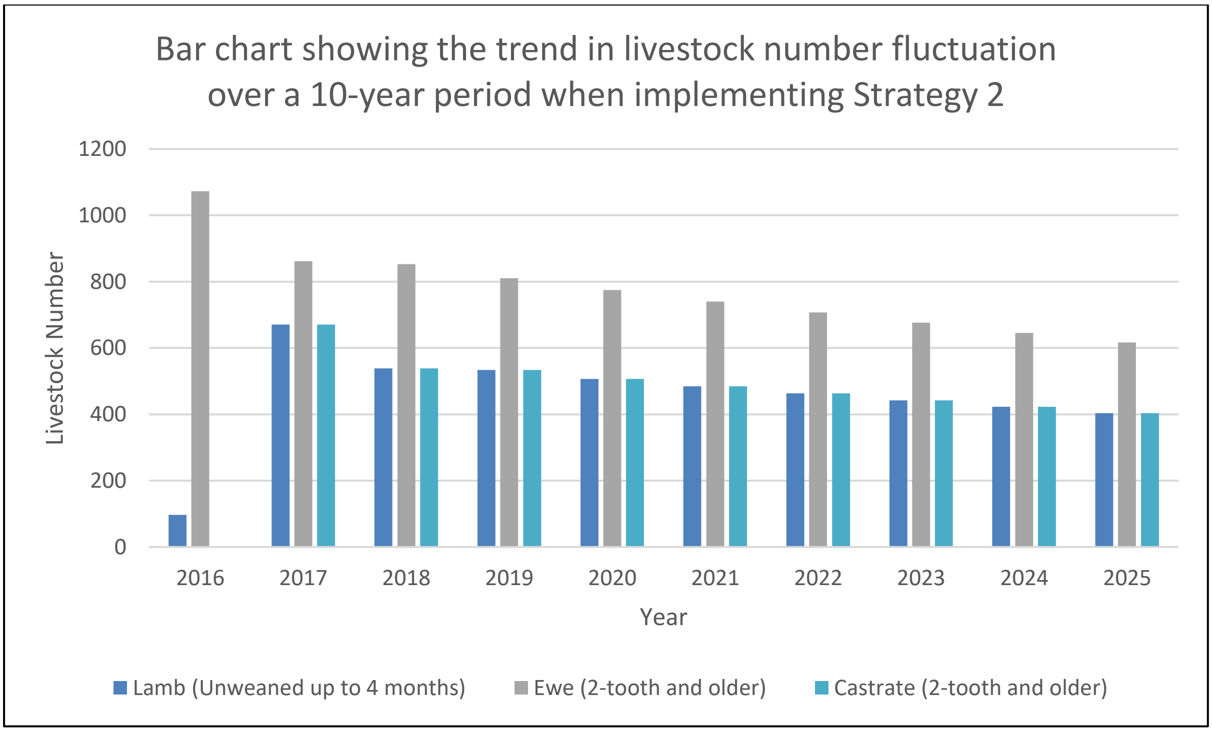

Figure 4.2: Livestock number fluctuation over 10-year period when implementing Strategy 2 – Stock Reduction

Table 4.1 and 4.2 are replicas of one another. This illustrates that the ewe and lamb replacement strategy is similar across the base model, Strategy 1 and Strategy 3.

From the graphs, it is evident that the opening figures are the same across all strategies. This is because the opening inventory was directly captured from the livestock numbers provided by the farmers. The livestock numbers do not differ greatly in the first financial year. This is due to the replacement strategy showing a slight lag. The number of lambs for the start of the first year is very low. This is because the breeding strategy of 125% have not yet been implemented and the stock on hand supplied by the farmers was very low. The breeding strategy is implemented during the 2016 financial year, which can be seen by the massive increase in total livestock inventory levels for all strategies from 2016 to 2017.

It is noticeable that the number of lambs and castrates are equal in both Figures 4.1 and 4.2 from year 2017 onward. This is attributed to the 50/50 split in male and female of new-born animals that was explained in Chapter 3.

Comparing Figure 4.1, which illustrates Strategy 1, to Figure 4.2, which illustrates Strategy 2, the difference in livestock number fluctuation becomes apparent. The livestock numbers for Strategy 1 – Feed through at cost, fluctuate around the same level as the years progress, with only a marginal decrease. The livestock numbers for Strategy 2 – Stock Reduction, decrease at a far higher rate than that of the former. Figure 4.2 illustrates this decrease in livestock numbers over the 10-year period. This is a direct result of the increased ewe and lamb sale percentage, compared to that of Strategy 1 and 3, which was stated and explained in Chapter 3.

Table 4.4: Total Livestock at Year End for the Base Model

Base Model	
Year	**Total Livestock at Year End**
Opening	1192
2016	2250
2017	2040
2018	2053
2019	2024
2020	2003
2021	1981
2022	1960
2023	1937
2024	1915
2025	1892

Table 4.5: Total Livestock at Year End for Strategy 1 – Feed through at Cost

Strategy 1 - Feed through at Cost	
Year	**Total Livestock at Year End**
Opening	1192
2016	2250
2017	2040
2018	2053
2019	2024
2020	2003
2021	1981
2022	1960
2023	1937
2024	1915
2025	1892

Table 4.6: Total Livestock at Year End for Strategy 2 – Stock Reduction

Strategy 2 - Stock Reduction	
Year	**Livestock Number at Year-End**
Opening	1192
2016	2225
2017	1952
2018	1898
2019	1809
2020	1730
2021	1653
2022	1581
2023	1512
2024	1446
2025	1383

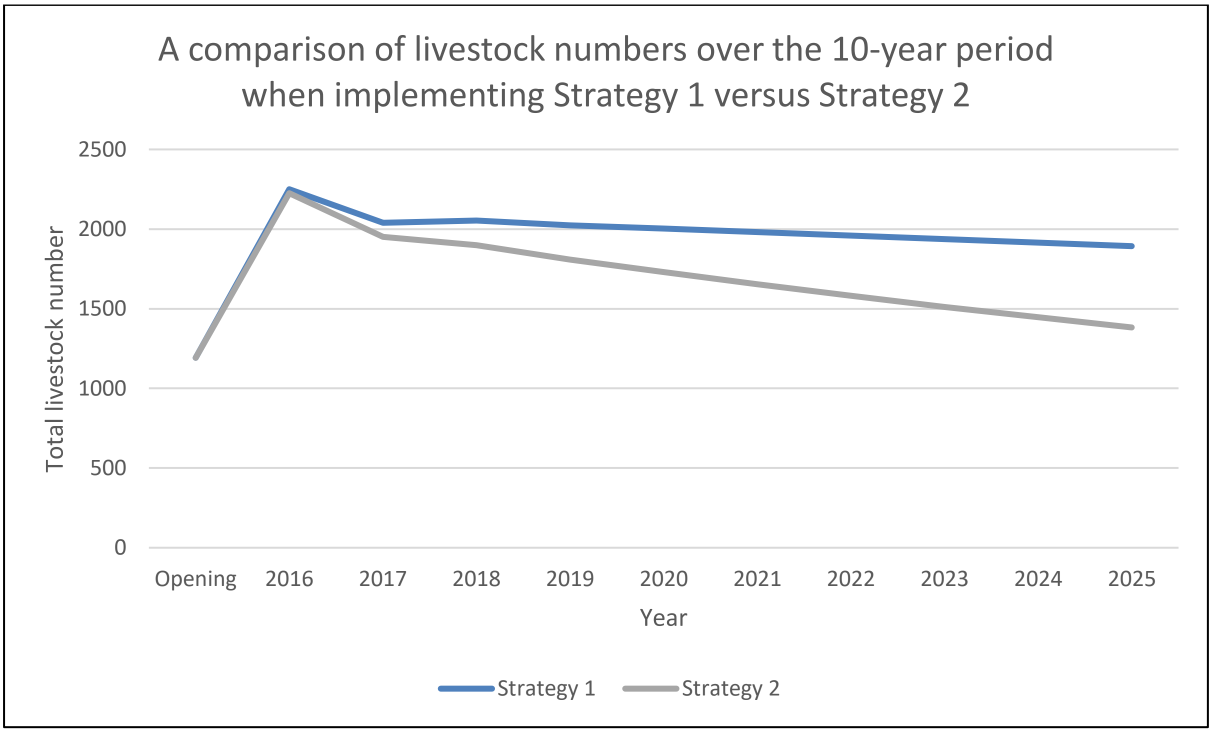

Figure 4.3: Comparing livestock number fluctuation for a typical farm in the Beaufort West area over 10-year between Strategy 1 and Strategy 2

Tables 4.4, 4.5 and 4.6 show the expected closing livestock inventory for the financial years over the 10-year period. These closing inventory figures are given as totals as oppose to showing individual category of animal.

Comparing Table 4.1 to Table 4.4, one notices the closing inventory for a given year is equal to the opening inventory for the following year. Although the livestock totals of the different categories (rams lamb, ewe and castrates) differ, the total number remains constant. This trend is remains valid when comparing Table 4.2 to Table 4.5 and Table 4.3 to Table 4.6.

Based on the above trend, Figure 4.3 can relatively accurately compare the trend in livestock numbers over the 10-year period when implementing Strategy 2 versus any of the other strategies. In Figure 4.3, it is evident that livestock numbers plateau around the 2000 number mark when implementing Strategy 1, whereas livestock numbers show a constant decline when implementing the stock reduction strategy.

4.2.2 Livestock Values

This section focuses on the monetary value of livestock on the enterprise. It would be expected that the trend of livestock value follows the same pattern as the trend in livestock numbers. This is however not the case. Due to the rapid rate of inflation at 6.4%, which is the same across all five models, the value of livestock displays an alternate trend to that of the livestock numbers. The values that was used for the base model development was provided by producers and through suppliers of intermediaries.

Table 4.7: Total livestock values for a typical farm in the Beaufort West area over the 10-year period for Strategy 1 – Feed through at cost

Strategy 1 - Feed through at Cost		
Year	**Livestock Value Year Beg**	**Livestock Value Year End**
2016	R 1 483 550.00	R 2 369 050.00
2017	R 2 449 274.80	R 2 328 138.40
2018	R 2 415 326.82	R 2 484 045.04
2019	R 2 574 485.02	R 2 607 790.83
2020	R 2 703 045.70	R 2 745 980.68
2021	R 2 847 403.63	R 2 890 427.30
2022	R 2 996 048.17	R 3 042 913.57
2023	R 3 155 375.43	R 3 200 300.05
2024	R 3 317 239.91	R 3 366 846.56
2025	R 3 489 869.76	R 3 540 029.65

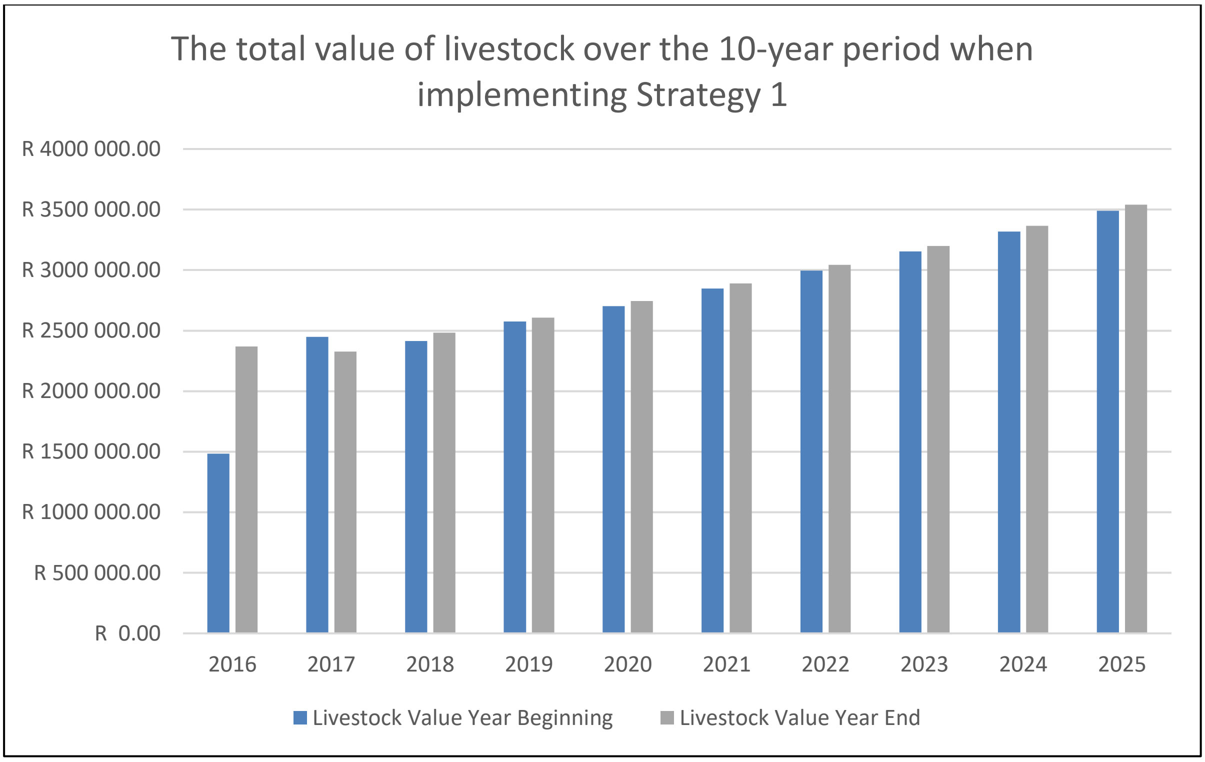

Figure 4.4: The total value of livestock for a typical farm in the Beaufort West area over the 10-year period when implementing Strategy 1 – Feed through at cost

Table 4.8: Total livestock values for a typical farm in the Beaufort West area over the 10-year period for Strategy 2 – Stock Reduction

Strategy 2 - Stock Reduction		
Year	**Livestock Value Year Beg**	**Live Stock Value Year End**
2016	R 1 483 550.00	R 2 337 800.00
2017	R 2 416 024.80	R 2 222 642.80
2018	R 2 303 871.96	R 2 292 834.03
2019	R 2 376 336.52	R 2 328 335.20
2020	R 2 413 522.91	R 2 370 523.85
2021	R 2 457 326.85	R 2 411 984.94
2022	R 2 500 479.26	R 2 456 588.29
2023	R 2 545 573.92	R 2 501 729.97
2024	R 2 593 836.86	R 2 547 597.54
2025	R 2 640 035.44	R 2 595 031.36

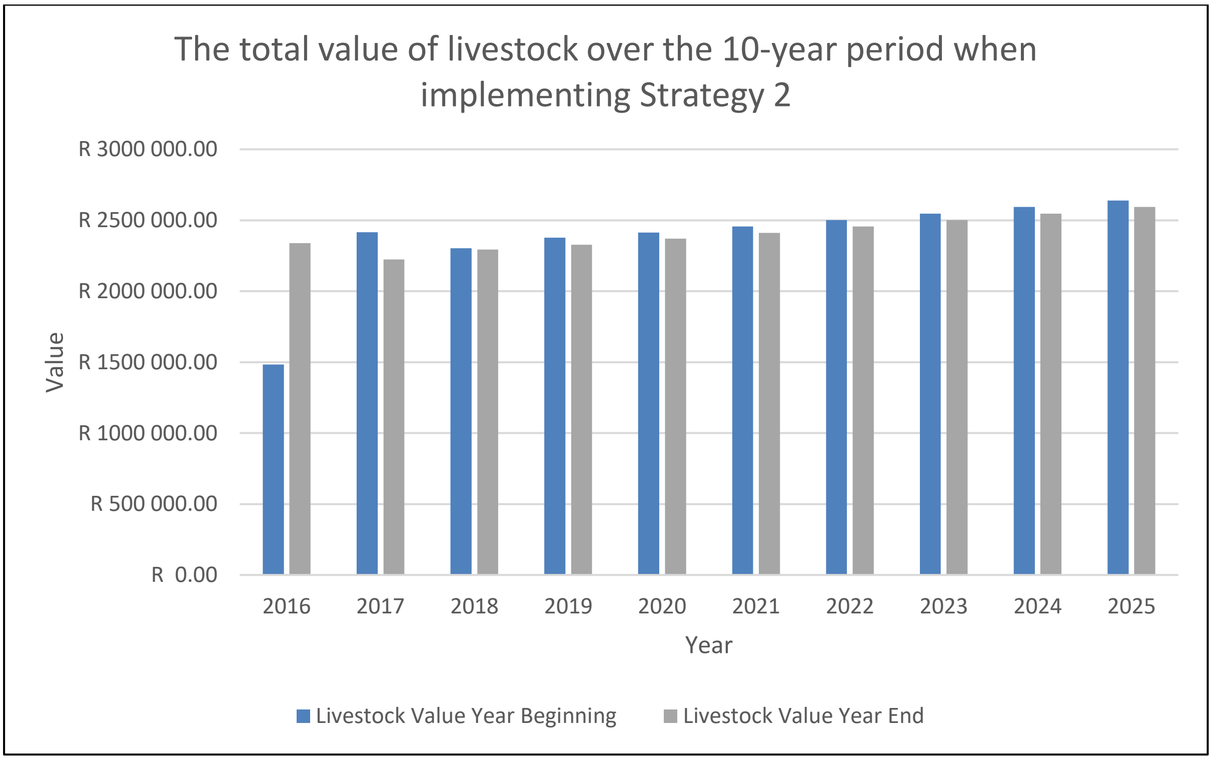

Figure 4.5: The total value of livestock for a typical farm in the Beaufort West area over the 10-year period when implementing Strategy 2 – Stock Reduction

Table 4.7 and Figure 4.4 illustrate the trend in livestock value on the farming enterprise when implementing Strategy 1 – Feed through at cost. The increasing trend is a direct result of the increasing value of livestock, due to inflation, and the maintenance of a relatively constant number of animals on the enterprise.

Table 4.8 and Figure 4.5 illustrate the trend in livestock value on the farming enterprise when implementing Strategy 2 – Stock Reduction. What becomes evident is that the value of livestock remains relatively constant over the 10-year period regardless of the decline in livestock numbers. When examining Figure 4.5 in isolation, the only indication that a stock reduction strategy is in place is the minor decline in livestock value at the start of the year versus livestock value at year-end.

In both Figure 4.4 and Figure 4.5, a large discrepancy between livestock value in the start of the year and livestock value at the end of the year is evident. As stated in the previous section, this is a direct result of the breeding strategy being implemented for the first time during the 2016 financial year.

The livestock values for 2017 for both strategies deviate from the trend that prevails from years 2018 to 2025. The trend in Strategy 1 shows the livestock valuation at year-end edge slightly higher than livestock valuation in the beginning of the year, barring 2017. The trend in Strategy 2 shows the livestock valuation at year-end only slightly lower than the valuation in the beginning of the year. With reference to Figure 4.1 and Figure 4.2, the number of castrates and lambs in relation to ewes is significantly closer in 2017 compared to the following years. Once again, the replacement strategy and breeding strategy, although implemented have not yet stabilized for the model outcomes. Table 3.7 shows that the value of ewes is substantially higher than that of lambs and castrates. These two factors offer an explanation to the deviation from the trend seen in 2017.

4.2.3 Livestock Sales

As previously mentioned, the modelled farm produces livestock, and therefore the primary source of income for the enterprise is through sales of livestock and livestock products. It is important to reiterate that since the livestock inventory levels for Strategy 1 – Feed through at cost, are the same with the livestock inventory levels of the base model and Strategy 3 – Relocation, their livestock sales will also be identical. Therefore, for the following section, only a comparison between Strategy 1 and Strategy 2 is conducted.

Table 4.9: A comparison of livestock sales for a typical farm in the Beaufort West area over the 10-year period when implementing Strategy 1 versus Strategy 2

Comparison of Livestock Sales		
Year	**Strategy 1**	**Strategy 2**
2016	R 332 450.00	R 362 650.00
2017	R 1 257 967.20	R 1 293 079.20
2018	R 1 156 549.27	R 1 155 643.60
2019	R 1 250 383.28	R 1 206 899.02
2020	R 1 308 876.23	R 1 221 724.62
2021	R 1 378 871.28	R 1 242 641.01
2022	R 1 450 650.86	R 1 261 738.34
2023	R 1 529 289.54	R 1 282 204.15
2024	R 1 606 467.26	R 1 306 281.27
2025	R 1 690 230.89	R 1 326 003.70

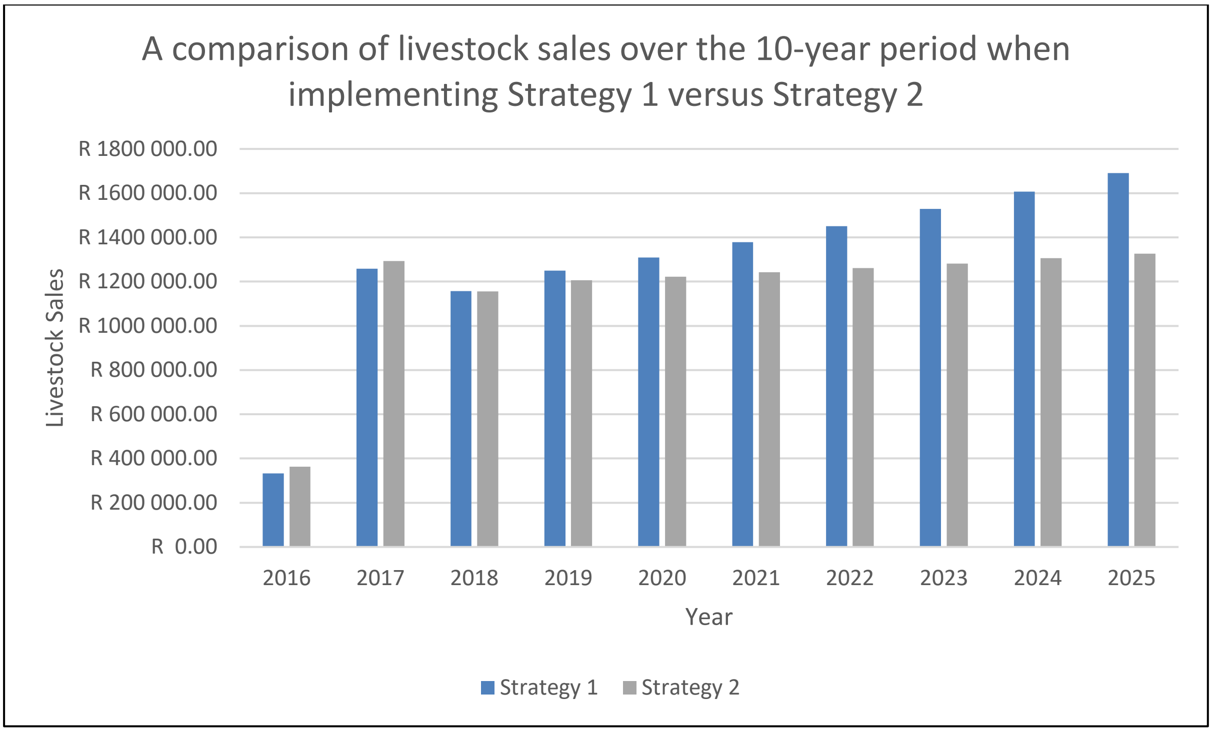

Figure 4.6: A comparison of livestock sales for a typical farm in the Beaufort West area over the 10-year period when implementing Strategy 1 versus Strategy 2

Table 4.9 and Figure 4.6 illustrate the comparison in livestock sales.

Table 3.8 in Chapter 3 identified the various livestock sales strategies. Strategy 1 – Feed through at cost and Strategy 3 – Relocation, employ a 20% ewe sale percentage and a 70% lamb sale percentage. As seen in Figure 4.3, this results in a minor decrease in livestock inventory levels over the 10-year period. Strategy 2 – Stock Reduction employs a 22% ewe sale percentage and a 73% lamb sale percentage. As seen in Figure 4.3, this results in a greater decrease in livestock inventory levels over the 10-year period.

It is noticeable that for the first two financial years, 2016 and 2017, livestock sales are higher than that of the other strategies while implementing Strategy 2 – Stock Reduction, This is due to inventory levels still being comparable in these years, in addition to Strategy 2 having a higher lamb and ewe sale percentage.

From 2019 to 2025 the inventory levels maintained through implementing Strategy 2 are not high enough to sustain the inventory sale levels of the other strategies. The expected gross income while implementing Strategies 1 and 3 exceed that of Strategy 2.

Although the number of animals being sold is decreasing, since sale percentages are constant and livestock inventory levels are decreasing, the value of sales remains relatively constant while implementing Strategy 2. Once again, this can be attributed in part to the inflation rate.

4.3 Gross Value of Production

The gross value of production for a livestock enterprise is the total value of production of livestock products plus trading income plus the livestock inventory change. The total gross value of production is the sum of all the farm enterprises plus the sundry farm income. Table 3.12 in Chapter 3 illustrates the calculation of the gross value of production.

The following section compares the gross value of production when implementing Strategy 1, Strategy 2 and Strategy 3.

Table 4.10: A comparison of gross value of production for a typical farm in the Beaufort West area over the 10-year period when implementing Strategy 1, Strategy 2 and Strategy 3

Comparison of Gross Value of Production			
Year	**Strategy 1**	**Strategy 2**	**Strategy 3**
2016	R 1 217 950.00	R 1 216 900.00	R 1 217 950.00
2017	R 1 136 830.80	R 1 099 697.20	R 1 136 830.80
2018	R 1 225 267.50	R 1 144 605.66	R 1 225 267.50
2019	R 1 283 689.09	R 1 158 897.69	R 1 283 689.09
2020	R 1 351 811.22	R 1 178 725.55	R 1 351 811.22
2021	R 1 421 894.96	R 1 197 299.10	R 1 421 894.96
2022	R 1 497 516.26	R 1 217 847.37	R 1 497 516.26
2023	R 1 574 214.16	R 1 238 360.19	R 1 574 214.16
2024	R 1 656 073.92	R 1 260 041.96	R 1 656 073.92
2025	R 1 740 390.78	R 1 280 999.62	R 1 740 390.78

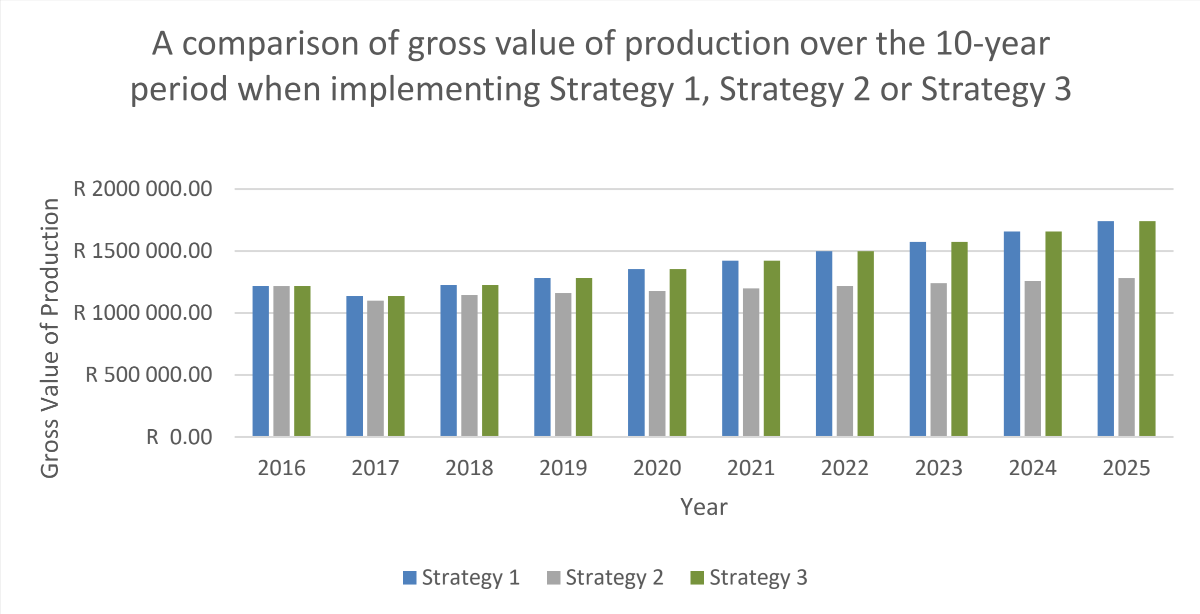

Figure 4.7: The expected gross value of production for a typical farm in Beaufort West over the 10-year period when implementing Strategy 1, Strategy 2 or Strategy 3

Figure 4.7 shows the gross value of production (GVP) following the same trend as that of livestock sales. The GVP for all three strategies start at the same level for the first financial year. From years 2017 to 2025 the expected GVP for Strategy 1 – Feed through at cost and Strategy 3 – Relocation gradually, increase, which is mainly due to the increase livestock sales.

The difference between the livestock sales trend and the GVP trend is that in 2017, GVP for Strategy 2-Stock Reduction is immediately lower than that of the Strategy 1 – Feed through at cost and Strategy 3 – Relocation. This difference can be attributed to the change in livestock inventory, which is also accounted for in the GVP calculation.

4.4 Production Activity Costs

The production activity cost consists of the operating input costs for the farming enterprise. These running costs are stated in Table 3.9 in Chapter 3. What is important to note is that fodder feed is included in the production activity costs. For this reason, we expect to notice a discrepancy between Strategy 1 – Feed through at cost and the other strategies.

The following section compare the production costs of running the farming enterprise. This is the first section where differences in all three strategies become more evident.

Table 4.11: Production costs for the typical farm in the Beaufort West area over the 10-year period when implementing Strategy 1, Strategy 2 or Strategy 3

Production Activity Cost				
Year	**Base Model**	**Strategy 1 - Feed through at Cost**	**Strategy 2 - Stock Reduction**	**Strategy 3 - Relocation**
2016	R 240 847.16	R 487 257.40	R 240 847.16	R 240847.16
2017	R 258 842.01	R 723 962.01	R 258 513.02	R 252842.01
2018	R 274 803.65	R 696 719.17	R 273 877.78	R 274 803.65
2019	R 292 271.67	R 716 667.83	R 290 722.86	R 292 271.67
2020	R 310 743.99	R 729 145.27	R 308 530.23	R 310 743.99
2021	R 330 414.85	R 701 074.69	R 327 474.24	R 330 414.85
2022	R 351 328.25	R 760 840.57	R 347 615.24	R 351 328.25
2023	R 373 567.87	R 778 945.79	R 369 042.03	R 373 567.87
2024	R 397 191.95	R 797 608.59	R 391 831.1	R 397 191.95
2025	R 422 322.11	R 818 190.91	R 416 047.19	R 422 322.11

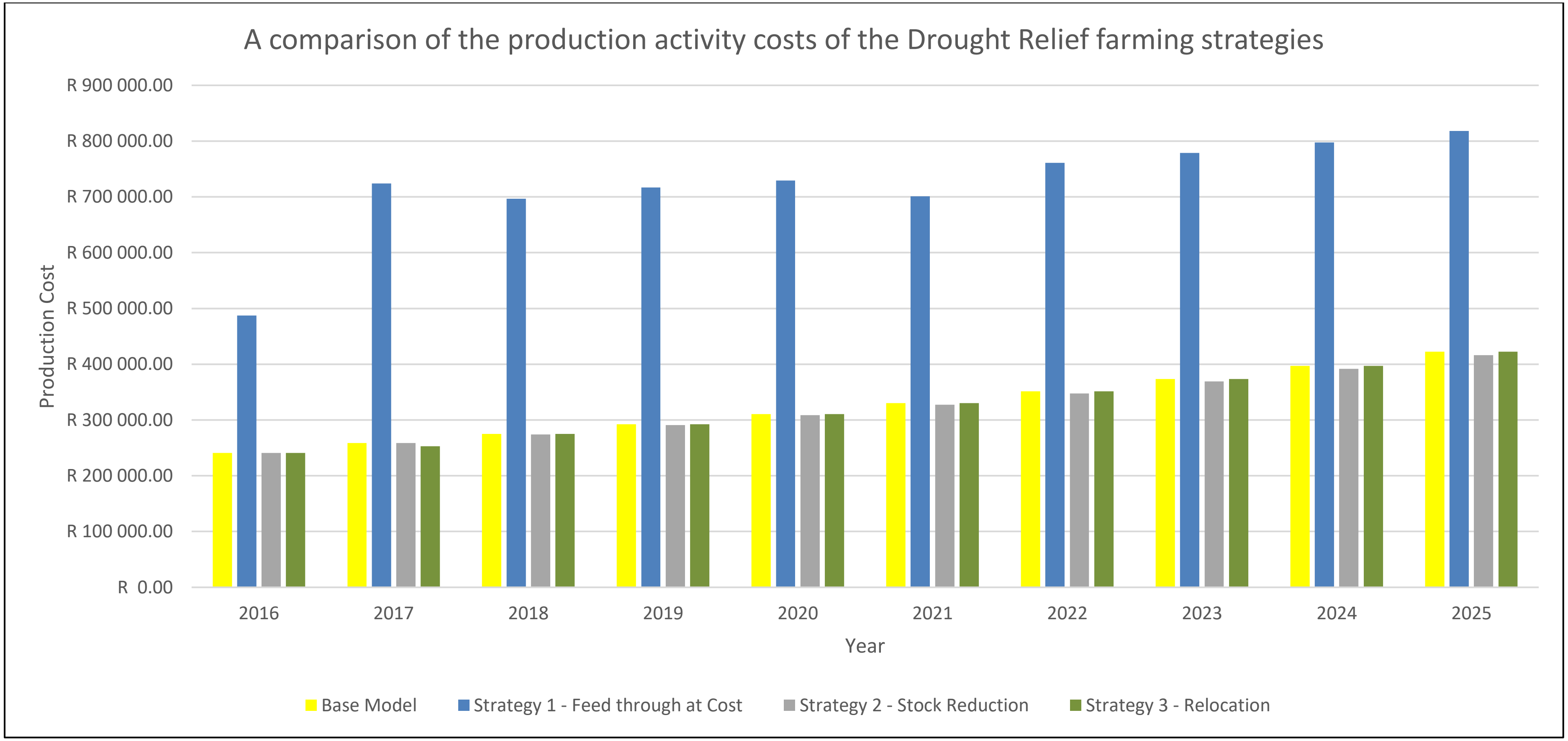

Figure 4.8: Graphical presentation of production costs for the typical farm in the Beaufort West area over the 10-year period when implementing drought relief farming Strategy 1, 2 or 3

Figure 4.8 confirms the expectation that the production costs would differ. The production costs of implementing Strategy 1 – Feed through at cost, far exceed that of the other two strategies as expected. The consequence of sustaining such a high level of livestock inventory during a drought is that production activity costs are more than double that of the other two strategies. While isolating the individual strategies, none barring Strategy 1 consume any feed in the production costs. The full extent of this downside to Strategy 1 is discussed in the following sections.

The production activity costs follow the same upward trend as the livestock valuation, livestock sales and gross value of production. This is due to the inflation rate causing input prices to increase.

A fact that is not clear from Figure 4.8 is that production activity costs for Strategy 2 – Stock Reduction is slightly less than that of the base model and that of Strategy 3 – Relocation. This can be confirmed by comparing the figures in Table 4.11. The reduced inventory levels reduce the total amount of medicines and doses required by the livestock on the enterprise.

4.5 Gross Margin

Gross margin of an enterprise is the enterprise gross production value less directly allocable variable costs (defined as Production Costs). The specific variable cost items included depend on the purpose of the calculation and the practical feasibility of the allocation.

The format for calculating the gross margin is given is Chapter 3, Section 3.6.9.

Table 4.12: Expected gross margins for a typical farm in the Beaufort West area over the 10-year period when implementing Strategy 1, Strategy 2 or Strategy 3

Gross Margin				
Year	**Base Model**	**Strategy 1 - Feed through at Cost**	**Strategy 2 - Stock Reduction**	**Strategy 3 - Relocation**
2016	R 977 102.84	R 730 692.60	R 976052.84	R 977102.84
2017	R 877 988.79	R 412 868.79	R 841184.18	R 877988.79
2018	R 950 463.85	R 528 548.33	R 870727.88	R 950 463.85
2019	R 991 417.42	R 567 021.26	R 868174.84	R 991 417.42
2020	R 1 041 067.23	R 622 665.95	R 870195.32	R 1 041 067.23
2021	R 1 091 480.11	R 720 820.27	R 869824.86	R 1 091 480.11
2022	R 1 146 188.01	R 736 675.69	R 870232.13	R 1 146 188.01
2023	R 1 200 646.29	R 795 268.37	R 869318.17	R 1 200 646.29
2024	R 1 258 881.96	R 858 465.32	R 868210.86	R 1 258 881.96
2025	R 1 318 068.67	R 922 199.87	R 864952.43	R 1 318 068.67

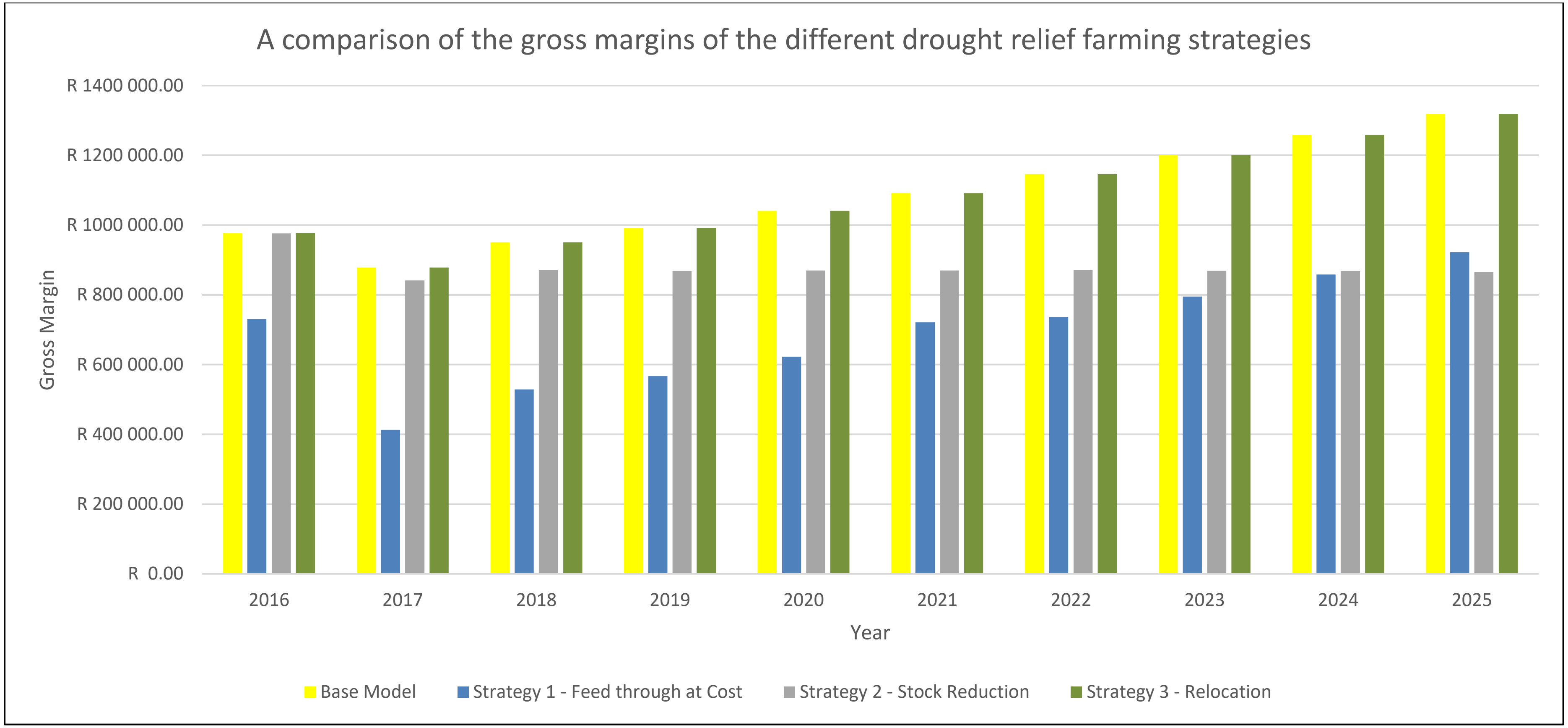

Figure 4.9: The gross margins for a typical sheep farm in Beaufort West over the 10-year period when implementing Strategy 1, Strategy 2 or Strategy 3

Figure 4.9 illustrates that the baseline model and Strategy 3 – Relocation, produces the highest expected gross margins. It should be noted that the baseline model incorporates no consequence of a drought scenario. Up until this point in the recorded data, Strategy 3 – Relocation has not encountered a setback due to the drought scenario. Only the exceptionally high production activity costs impacted the feasibility of Strategy 1 – Feed through at cost. For the same reason the feasibility of Strategy 3 – Relocation be impacted when incorporating overhead costs is under suspicion.

The gross margin for Strategy 1 – Feed through at Cost still display an upward trend. Therefore, the margin (difference) between the gross value of production achieved and the costs of achieving this gross value of production is still increasing. This proves that the strategy is in fact viable to mitigate the effects of a drought and ensure the continuation of the farming enterprise. The reason for the expected increase in the gross margin is in real terms, the inflation of livestock prices relative to the inflation of the feed required to sustain the livestock level is higher.

The gross margin for Strategy 2 – Stock Reduction steadily fluctuates around the same figure through the 10-year period. What is evident from all the produced results so far is that performance for Strategy 2 – Stock Reduction is most consistent at the gross margin level.

4.6 Farm Overhead Costs

Overhead costs are the indirect costs and fixed expenses of operating a business. That is, the costs not directly related to the manufacture of a product or delivery of a service. The items included in farm overhead costs is discussed in Section 3.6.7.

As stated in the previous section, Strategy 3 – Relocation has not yet encountered a setback. The transportation costs and farm rental costs incurred when implementing Strategy 3 – Relocation are included in the farm overhead costs. For this reason, a discrepancy is expected between Strategy 3 – Relocation and the other strategies on fixed costs basis.

Table 4.13: A comparison of the overhead costs for a typical farm in the Beaufort West area over the 10-year period when implementing Strategy 1, Strategy 2 or Strategy 3

Farm Overhead Costs				
Year	**Base Model**	**Strategy 1 - Feed through at Cost**	**Strategy 2 - Stock Reduction**	**Strategy 3 - Relocation**
2016	R 425 372.88	R 425 372.88	R 425372.88	R 665372.88
2017	R 452 596.74	R 452 596.74	R 452596.74	R 580276.74
2018	R 481 562.94	R 481 562.94	R 481562.94	R 617 414.46
2019	R 512 382.96	R 512 382.96	R 512382.96	R 656 928.98
2020	R 545 175.47	R 545 175.47	R 545175.47	R 698 972.44
2021	R 580 066.70	R 580 066.70	R 580066.7	R 743 706.67
2022	R 617 190.97	R 617 190.97	R 617190.97	R 791 303.90
2023	R 656 691.20	R 656 691.20	R 656691.2	R 841 947.35
2024	R 698 719.43	R 698 719.43	R 698719.43	R 895 831.98
2025	R 743 437.48	R 743 437.48	R 743437.48	R 953 165.23

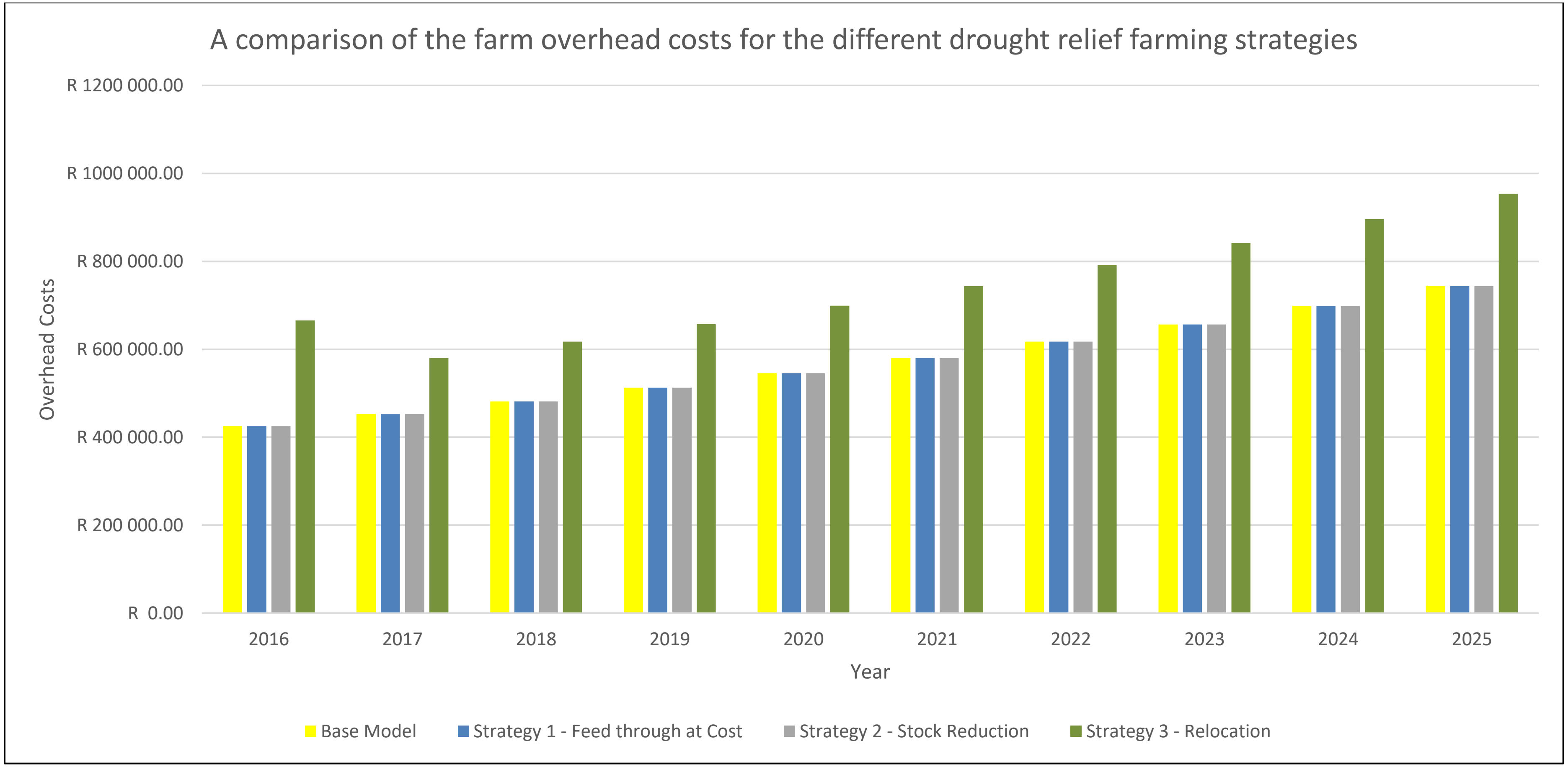

Figure 4.10: A comparison of farm overhead costs for a typical farm in the Beaufort West area over the 10-year period when implementing Strategy 1, Strategy 2 or Strategy 3

Figure 4.10 confirms the expectation that the overhead costs of implementing Strategy 3 – Relocation far exceed that of the other strategies. As previously stated, the difference is attributed to the addition of farm rental costs when implementing Strategy 3 – Relocation.

A spike in overhead costs is observed in the farm overhead costs for first financial year when implementing Strategy 3 – Relocation. This is a result of including the initial once off cost of transporting the total livestock to a new farm.

All the other overhead expenditures remain constant across the enterprise; therefore, the overhead costs for the base model, Strategy 1 – Feed through at cost and Strategy 2 – Stock Reduction are equal Refer to Table 4.13. The overhead costs follow the same trend as the cost structure of the previous sections, which is due to the inflation rate. Inflation causes commodity and service expenditure to increase over the years.

The overhead costs have a direct impact on the net farm income and total enterprise cash flow as will become evident in the following sections.

4.7 Net Farm Income (NFI)

Net farm income is defined as the return related to land (own and hired), capital (own and borrowed) and management (own and hired) (Department of Agriculture, Forestry and Fisheries, 2005).

Table 3.13 illustrates the format of calculating the net farm income.

This section gives a detailed description on the various alternate strategies available to farmers in the Beaufort West are in terms of negating a drought.

Table 4.14: A comparison of net farm income for a typical farm in the Beaufort West area over the 10-year period when implementing either Strategy 1, Strategy 2 or Strategy 3

Net Farm Income				
Year	**Base Model**	**Strategy 1 - Feed through at Cost**	**Strategy 2 - Stock Reduction**	**Strategy 3 - Relocation**
2016	R 551 729.96	R 305 319.72	R 550 679.96	R 240 847.16
2017	R 425 392.04	-R 39 727.96	R 388 587.43	R 252 842.01
2018	R 468 900.91	R 46 985.39	R 389 164.95	R 274 803.65
2019	R 479 034.46	R 54 638.30	R 355 791.87	R 292 271.67
2020	R 495 891.76	R 77 490.48	R 325 019.85	R 310 743.99
2021	R 511 413.40	R 140 753.56	R 289 758.15	R 330 414.85
2022	R 528 997.03	R 119 484.71	R 253 041.16	R 351 328.25
2023	R 543 955.10	R 138 577.18	R 212 626.97	R 373 567.87
2024	R 560 162.53	R 159 745.89	R 169 491.43	R 397 191.95
2025	R 574 631.20	R 178 762.40	R 121 514.95	R 422 322.11

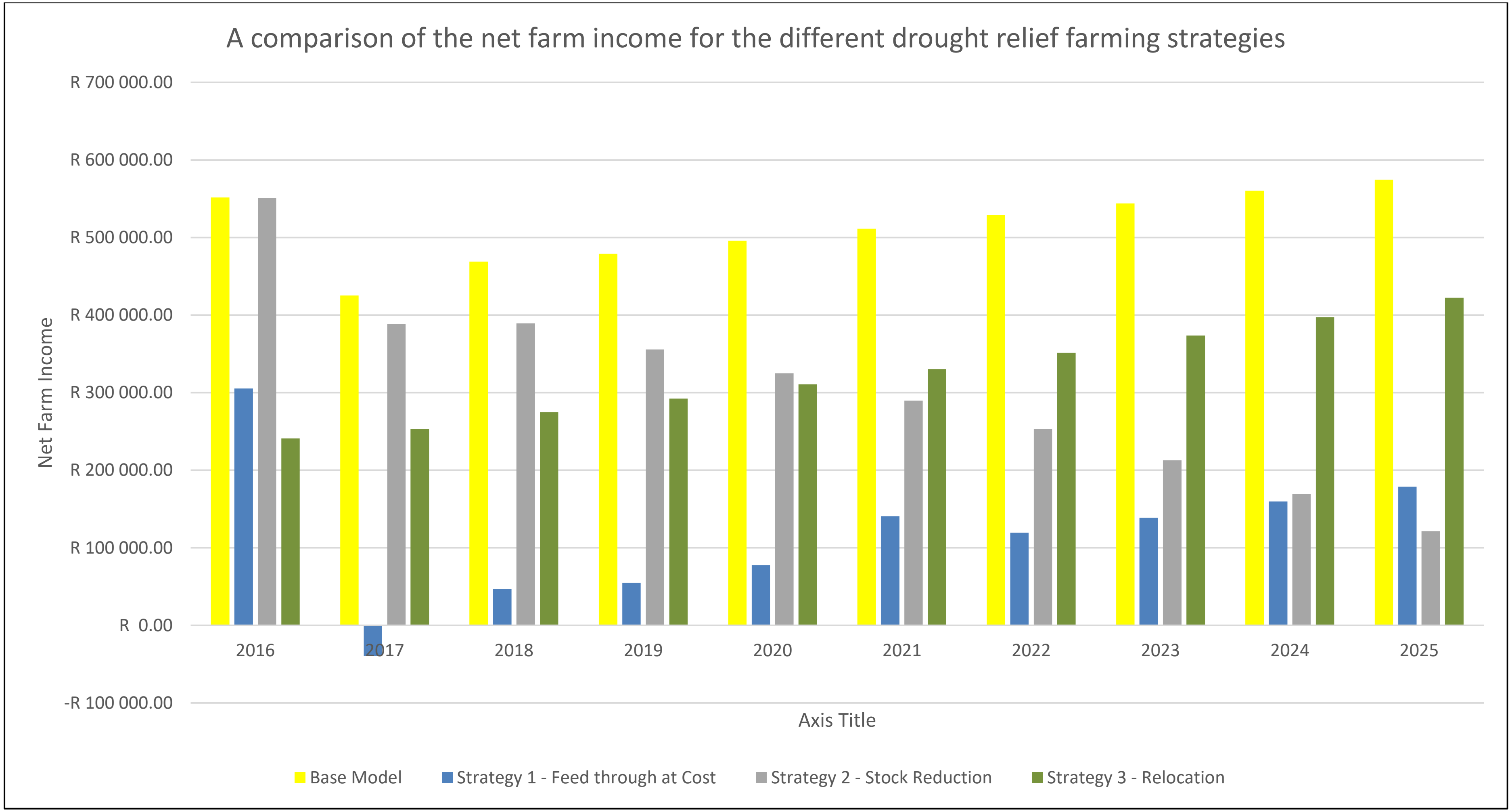

Figure 4.11: The expected net farm income for a typical farm in the Beaufort West area over the 10-year period when implementing Strategy 1, Strategy 2 or Strategy 3

Figure 4.11 illustrates the comparison of net farm income over the 10-year period when implementing Strategy 1 – Feed through at cost, Strategy 2 – Stock Reduction or Strategy 3 - Relocation. The net farm income calculation includes all incomes and expenditures applicable to a farming business. The calculation of the net farm income allows the farm profitability to be calculated for a given financial year.

The Baseline Model

The baseline model produces the best expected net farm income. As previously stated, this is because the baseline model simulates the expected financial performance of the farm over the 10 year period without a drought scenario. The steadily increasing net farm income illustrated by the base model is a direct consequence of an increasing livestock population, proportionate production activity costs and constant overhead expenditure. In layman's terms, more livestock results in a higher income. The possibility of livestock loss due poor grazing pastures is unpredictable, hence not included in the base model. For all the other models a drought is simulated, the drought lasts over the whole 10-year period. This means that the whole sequence of years below average rainfall is assumed.

Strategy 1 – Feed through at cost

Implementing Strategy 1 produces a comparable net farm income in the first financial year. This is illustrated by Figure 4.11. In the second financial year the net farm income slumps to a negative figure.

It must be reiterated that the breeding strategy is implemented at year-end of the first financial year. Additionally, production activity expenditure is calculated on opening livestock inventory for the financial year.

The results presented so far, show that the overhead costs remain constant. The gross margin produced in 2017, illustrated by Table 4.12, is below that of the gross margin produced in 2016. Table 4.2 show the increase in livestock inventory from 2016 to 2017. This is a result of the breeding strategy being implemented at the end of 2016. The increase in livestock value causes a spike in production activity costs in 2017. Table 4.11 show that production costs are calculated based on the livestock opening values. Table 4.10 illustrates a decline in gross value of production in comparison to the previous year. This is attributed to the negative change in inventory value from year beginning and year-end, illustrated by Table 4.7 and Figure 4.4. As a result, Strategy 1 – Feed through at cost, produces a negative net farm income for the second financial year, 2017. The negative farm profitability results from a negative net farm income, illustrated in figure 4.12.

Following the negative figure in 2017, net farm income steadily trends upward for the rest of the period whilst implementing Strategy 1 – Feed through at cost.

Strategy 2 – Stock Reduction

Implementing Strategy 2 – Stock Reduction, produces a high net farm income in the opening years of the 10-year period, refer to Figure 1.12. This figure trends downward over the 10-year period. The downward trend can be attributed to the decreasing gross margins, illustrated by Figure 4.9, and the gradually increasing overhead costs, illustrated by Figure 4.10, over the 10-year period. The downward trend gives a true reflection of the conservative nature of the strategy.

Strategy 3 – Relocation

Implementing Strategy 3 – Relocation produces a low net farm income in the first financial year, illustrated by Figure 4.11. This low net farm income in 2016 is directly related to the high overhead costs occurred by the enterprise in the opening financial year, illustrated by Figure 4.10. The net farm income whilst implementing Strategy 3 – Relocation, follows the same trend as the baseline model, although this amount is substantially lower due to the farm rental payable every month.

It should be noted that Figure 4.11 does not explain the full extent of the situation. The research did not account for the additional inoculation animals will have to incur over the period to survive the new and foreign environment. This is only a theoretical exercise and the area of relocation will determine what kind of additional veterinarian treatments are required, for some areas it might be none. Furthermore, loss of livestock due to the relocation is omitted from the research, as this is an unpredictable figure.

4.8 Farm Profitability

Farm profitability is an income to investment ratio used to determine the business’s earning performance. In lay terms, farm profitability is an indication of the amount of income generated by the enterprise in relation to the capital employed. The format for calculating farm profitability is described in Section 3.6.9.

It is important to reiterate that capital employed omits the value of land in the profitability calculation. Since the fixed inventory and machinery is synonymous across all three strategies, the expectation is that farm profitability will follow the same trend as net farm income.

Table 4.15: The expected farm profitability of the typical farm for the Beaufort West area over the 10-year period when implementing drought mitigating Strategy 1, Strategy 2 or Strategy 3

Farm Profitability				
Year	**Base Model**	**Strategy 1 - Feed through at Cost**	**Strategy 2 - Stock Reduction**	**Strategy 3 - Relocation**
2016	23.91%	13.23%	23.86%	13.51%
2017	19.33%	-1.80%	17.65%	13.53%
2018	22.39%	2.24%	18.58%	15.90%
2019	23.85%	2.72%	17.71%	16.65%
2020	25.78%	4.03%	16.90%	17.79%
2021	27.74%	7.63%	15.72%	18.86%
2022	29.61%	6.69%	14.16%	19.86%
2023	31.45%	8.01%	12.29%	20.74%
2024	33.49%	9.55%	10.13%	21.71%
2025	35.39%	11.01%	7.48%	22.47%

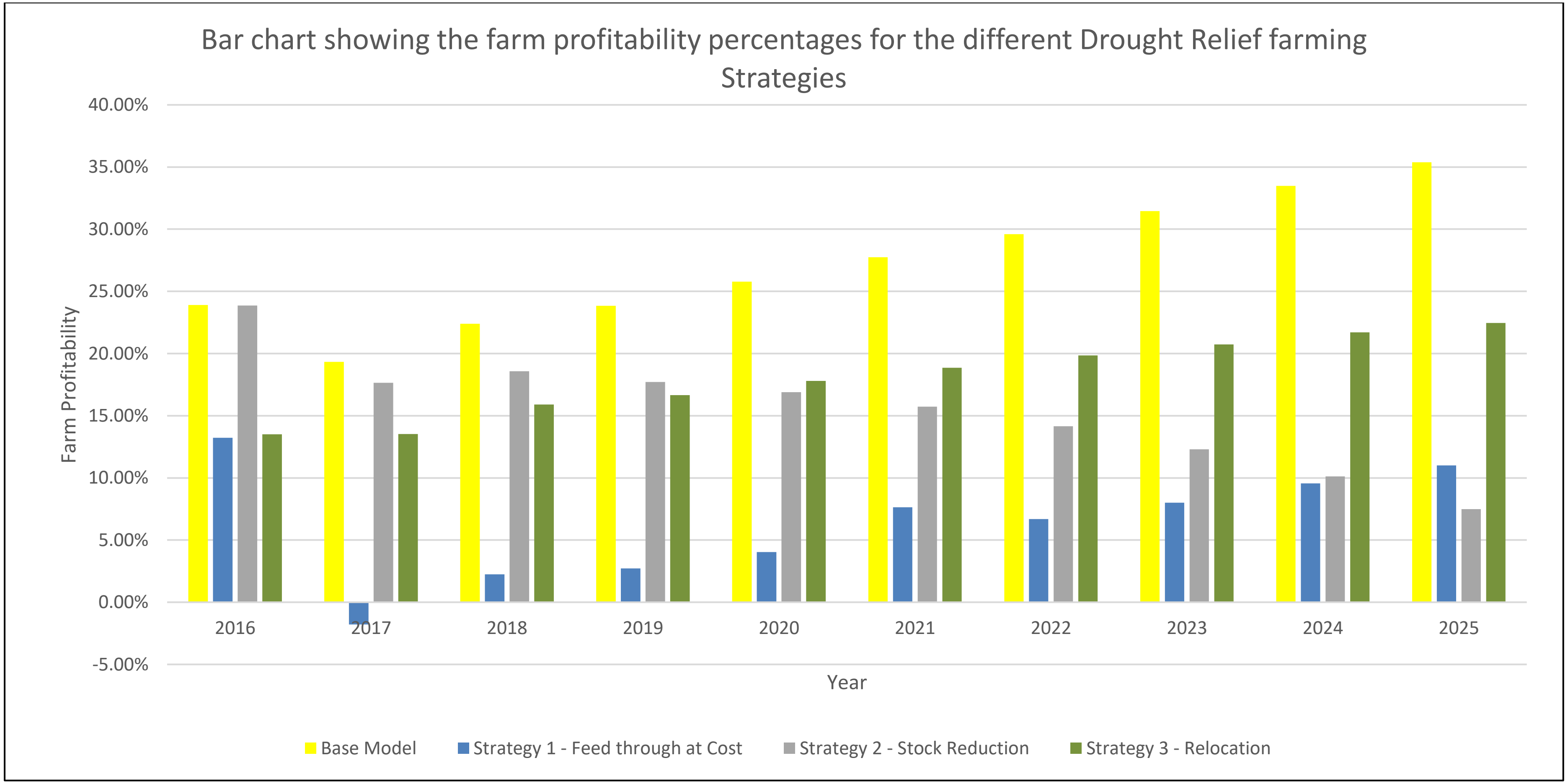

Figure 4.12: Figure 4.12: Schematic presentation of farm profitability for the typical farm in the Beaufort West area over the 10-year period when implementing drought mitigating Strategy 1, Strategy 2 or Strategy 3

Figure 4.12 confirms the expectation stated in the section introduction.

Profitability is assessed relative to costs and expenses, and it is analysed in comparison to assets to see how effective an entity is in deploying assets to generate income and eventually profits. Farm profitability is synonymous with the return on assets financial ratio. The term return in the profitability ratio customarily refers to net profit, the amount of earnings from sales after all expenses. The more assets an entity has amassed, the more income and potentially more profits the entity could generate. As economies of scale help lower costs and improve margins, return may grow at a faster rate than assets; ultimately increasing profitability. The higher the percentage, the better the entity is at utilizing its assets to generate income. Farming entities typically achieve a farm profitability percentage within the range of 4-10% (Hoffmann, 2014).

Table 4.15 illustrates the percentages achieved by the farming strategies over the 10-year period. Although Strategy 1 – Feed through at cost, is the only strategy to fall negative, the margins recover and ultimately achieve a commendable return over the 10-year period. Figure 4.11 and Figure 4.12 reiterates the declining profitability that Strategy 2 – Stock Reduction, produces over the 10-year period. This should not discourage utilization sentiment for farmers. This statement will become evident in the final section of the chapter.

The profitability percentage for Strategy 3 – Relocation, follows the same trend as the net farm income for the strategy. Although Relocation is the closest match to the perfect world scenario given by the base model, it is still not evident that this is the most feasible strategy to follow to mitigate the negative financial effects of a drought. This is for one thing based on the assumption of availability of pastures in an area unaffected by drought. This is a practical assumption that might not work seeing that droughts are often over large areas.

All three of the farming strategies ultimately produce positive profitability margins, hence are feasible strategies to follow during a drought period.

4.9 Cash Flow

The cash flow budget shows the amount of cash entering and leaving the farming enterprise. This allows insight into how operations are running, sources of cash, and how it is being spent. The cash flow statement does not take into account future inflowing and outflowing money that has been recorded on credit.

This section of the results evaluates the net financial effect of all four farming strategies. This section weighs all the advantages and setbacks of the previous sections to determine which strategy is the most feasible.

Table 4.16: A comparison of the expected year-end bank balances for the typical farm in the Beaufort West area over the 10-year period when implementing Strategy 1, Strategy 2 or Strategy 3

Year End Bank Balance					
Year	**Base Model**	**Strategy 1 - Feed through at Cost**	**Strategy 2 - Stock Reduction**	**Strategy 3 - Relocation**	**Strategy 4 - Capital Market**
Starting Balance	**R 1 000 000.00**	**R 1 000 000.00**	**R 1 000 000.00**	**R 1 000 000.00**	**R 1 000 000.00**
2016	R 680 080.91	R 431 098.18	R 710 332.25	R 438 542.61	R 3 486 296.52
2017	R 1 234 962.39	R 500 288.11	R 1 301 338.50	R 855 212.66	R 3 232 838.27
2018	R 1 654 256.59	R 469 454.38	R 1 722 021.60	R 1 129 325.04	R 2 966 433.85
2019	R 2 127 360.34	R 478 798.71	R 2 154 517.25	R 1 445 466.24	R 2 686 421.98
2020	R 2 616 970.51	R 500 532.67	R 2 559 609.07	R 1 765 527.92	R 2 392 107.62
2021	R 3 131 615.25	R 586 535.17	R 2 939 562.64	R 2 097 180.39	R 2 082 760.22
2022	R 3 670 083.77	R 648 653.50	R 3 288 570.04	R 2 438 299.09	R 1 757 611.93
2023	R 4 235 994.46	R 733 204.17	R 3 603 662.50	R 2 791 529.03	R 1 415 855.67
2024	R 4 824 493.21	R 836 509.95	R 3 883 825.61	R 3 150 979.33	R 1 056 643.12
2025	R 5 438 400.23	R 961 121.93	R 4 119 815.33	R 3 518 365.90	R 679 082.66

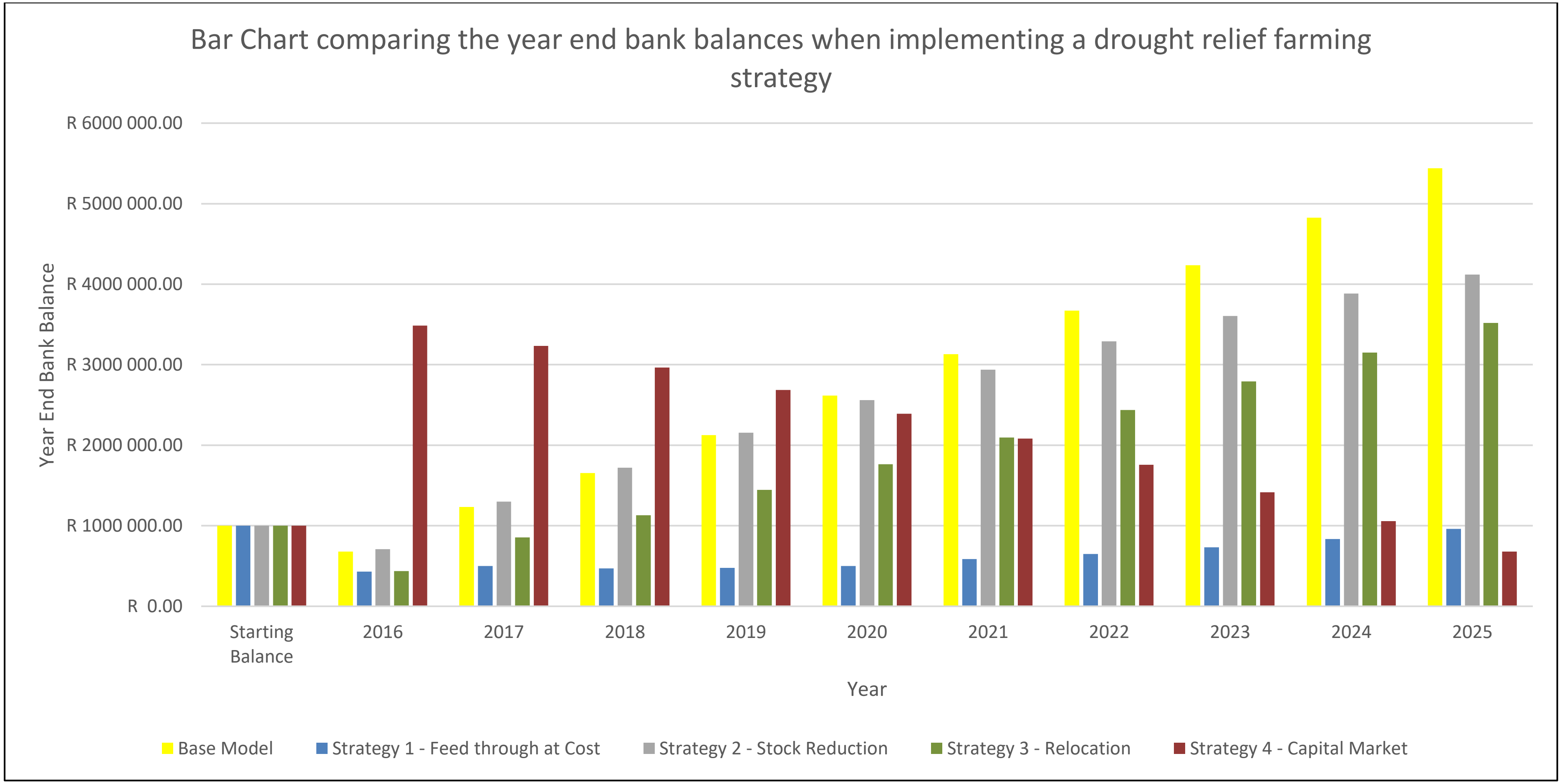

Figure 4.13: The year –end bank balance for the typical farm in the Beaufort West area over the 10-year period when implementing drought negating Strategy 1, Strategy 2 or Strategy 3

Table 4.16 and Figure 4.13 illustrate the expected year-end bank balances of the farming enterprise whilst incorporating each of the drought negating strategies.

The base model and all four strategies are allocated a starting operating capital of R1,000,000.00. In Section 3.6.10 it was discussed that this allocation was to avoid a negative bank balance, and in turn interest expenses not reflective of the situation.

Strategy 1 – Feed through at cost

Whilst implementing Strategy 1 – Feed through at cost, the bank balance decrease during the first financial year. This is due to a high production expenditure incurred by the farming enterprise, illustrated by Figure 4.8. The drop in the bank balance is supported by the results from the previous section. A significant decrease in the farm profitability is directly reflected in the decline of the year-end bank balance in the first financial year. Figure 4.12 show the farms cash flow recovers over the 10-year period whilst implementing Strategy 1 – Feed through at cost. The recovery of the year-end bank balances to match the opening balance at the beginning of the drought period. The evidence of the bank balance recovery supports the fact that implementing Strategy 1 – Feed through at cost is a feasible solution to mitigating the negative financial effects of a drought.

Strategy 2 – Stock Reduction

Whilst implementing Strategy 2 – Stock Reduction, the farm enterprises' bank balance also takes a significant drop in the first financial year. The recovery is more apparent when implementing Stock Reduction. The year-end bank balance displays a stable increase over the 10-year period, only experiencing a slight tapering off toward the end. This tapering effect is attributed to the strategy settling to less productive scaling of its input resources. Strategy 2- Stock Reduction is the more feasible strategy to employ in mitigating the negative financial effects of a drought.

Strategy 3 – Relocation

Although the farm profitability whilst implementing Relocation displayed the most promising results, the feasibility of the strategy falls short to Stock Reduction in the year-end bank balance. As previously stated, the true reflection of the feasibility of implementing the strategy is not known, due to the unpredictability of livestock loss that was not incorporated in the financial model for Strategy 3 – Relocation. There is also the question of availability of alternative grazing land for renting.

Strategy 4 – Capital Market Investment

Strategy 4 – Capital Market employs a highly conservative approach to overcoming a drought. The variable inventory (livestock and implements) is sold off at the beginning of the period and invested in the capital market. As a result, the year-end bank balance skyrockets in the first financial year. In conjunction with the entity earning no supplementary income, and monthly withdrawals to sustain a livelihood, the year-end bank balance show a sharp decline over the

10-year period. The only income earned by the farm enterprise is interest income. The income earned by the capital market investment is slightly higher than that of a current access account; however, due to the nature of the needs, it will not be as high as the interest returns of a non-movement account.

Whilst implementing Strategy 4 operating capital shrinks to less than a quarter of its opening balance in the first financial year. The strategy leaves no option for variable inventory to be purchased back at the end of the drought period. Therefore, Strategy 4 – Capital Market Investment is the only strategy of the four that is not feasible whatsoever in mitigating the negative financial effects of a drought.

4.10 Capital Budget, Net Present Value and Internal Rate of Return

Capital budgeting is the process in which a business determines and evaluates potential expenses or investments that are large in nature. A prospective project's lifetime cash inflows and outflows are assessed in order to determine whether the potential returns generated meet a sufficient target benchmark. The method for constructing a capital budget is explained in Section 3.6.11.

The following section illustrates the net cash flows for the 10-year period for the four strategies, which will determine the year-end bank balance. The purpose for the following section is to determine the net present value and internal rate of return achieved by these strategies over the 10-year period.

It is expected that the results achieved when assessing the strategies in terms of yield on investment it will be synonymous with the conclusion stated in the previous section.

Table 4.17: The expected total cash flows for the typical farm for the Beaufort West area over the 10-year period for the Baseline model (no drought)

Total Cash Flow - Base Model			
Year	**Cash Inflow**	**Cash Outflow**	**Net Cash Flow**
2016	R 330 363.94	R 666 220.04	-R 335 856.10
2017	R 1 258 896.30	R 711 438.76	R 547 457.54
2018	R 1 157 229.58	R 756 366.59	R 400 862.99
2019	R 1 251 141.02	R 804 654.63	R 446 486.39
2020	R 1 309 646.26	R 855 919.46	R 453 726.80
2021	R 1 379 667.54	R 910 481.55	R 469 185.99
2022	R 1 451 470.48	R 968 519.22	R 482 951.26
2023	R 1 530 137.90	R 1 030 259.07	R 499 878.83
2024	R 1 607 335.20	R 1 095 911.38	R 511 423.82
2025	R 34 748 922.05	R 1 165 759.58	R 33 583 162.47

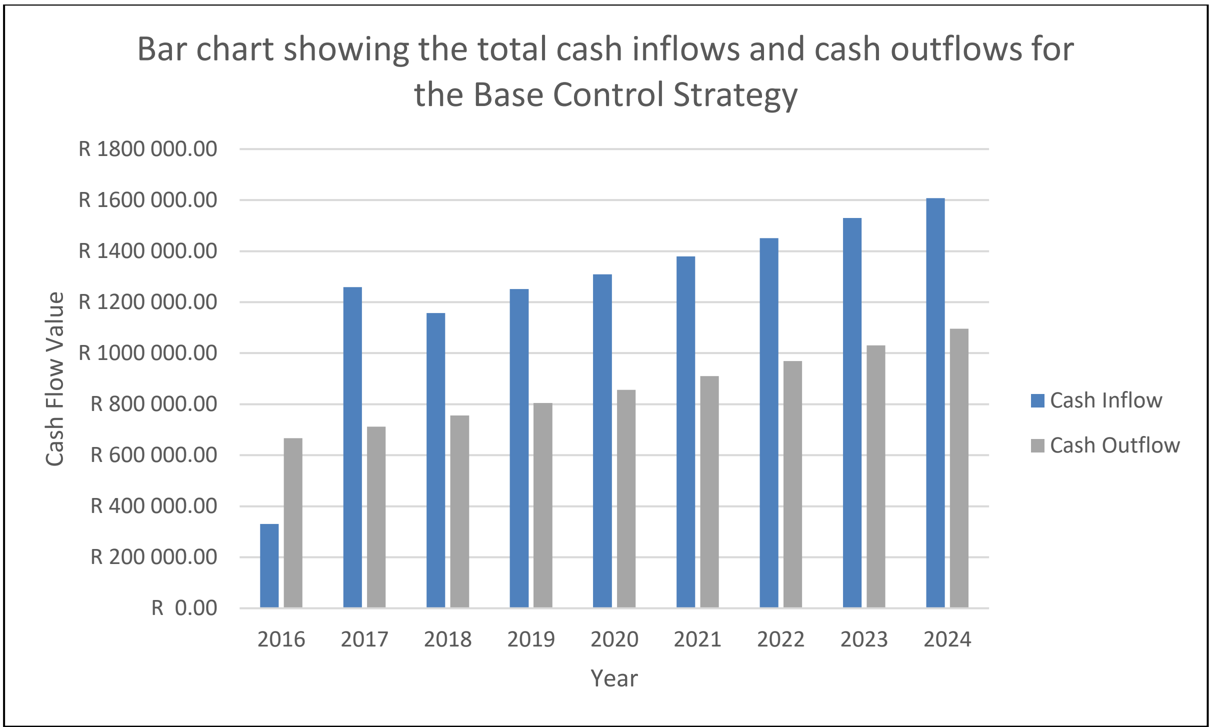

Figure 4.14: Graphical presentation of the cash inflows and outflows for the typical farm for the Beaufort West area over the 10-year period for the Baseline model

Table 4.18: The total cash flows for a typical farm in the Beaufort West area over the 10-year period when implementing Strategy 1 – Feed through at cost

Total Cash Flow - Strategy 1 - Feed through at Cost			
Year	**Cash Inflow**	**Cash Outflow**	**Net Cash Flow**
2016	R 343 728.46	R 912 630.28	-R 568 901.82
2017	R 1 245 748.69	R 1 176 558.76	R 69 189.93
2018	R 1 147 448.38	R 1 178 282.11	-R 30 833.73
2019	R 1 238 395.11	R 1 229 050.79	R 9 344.32
2020	R 1 296 054.70	R 1 274 320.74	R 21 733.96
2021	R 1 367 143.89	R 1 281 141.39	R 86 002.50
2022	R 1 440 149.88	R 1 378 031.54	R 62 118.34
2023	R 1 520 187.66	R 1 435 636.99	R 84 550.67
2024	R 1 599 633.80	R 1 496 328.02	R 103 305.78
2025	R 34 744 039.92	R 1 561 628.38	R 33 182 411.54

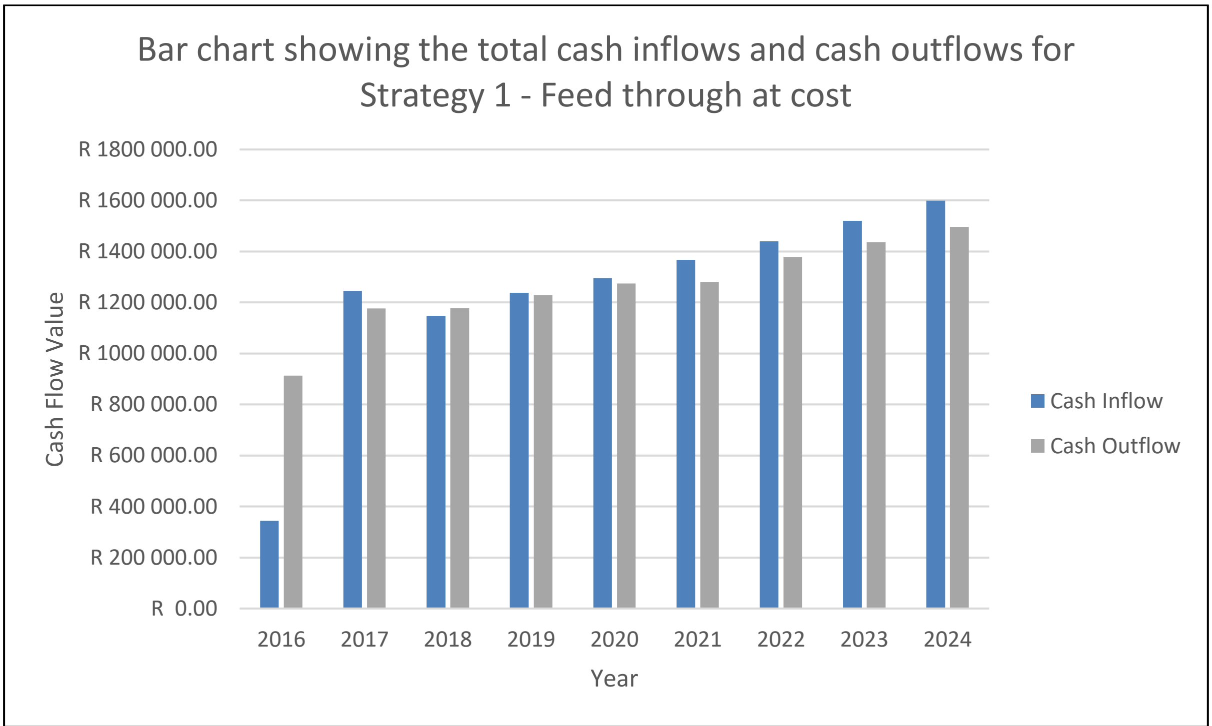

Figure 4.15: The total cash flows for a typical farm in the Beaufort West area over the 10-year period when implementing Strategy 1 – Feed through at cost

Table 4.19: The total cash flows for a typical farm in the Beaufort West area over the 10-year period when implementing Strategy 2 – Stock Reduction

Total Cash Flow - Strategy 2 - Stock Reduction			
Year	**Cash Inflow**	**Cash Outflow**	**Net Cash Flow**
2016	R 376 552.30	R 666 220.04	-R 289 667.74
2017	R 1 302 116.02	R 711 109.77	R 591 006.25
2018	R 1 176 123.81	R 755 440.71	R 420 683.10
2019	R 1 235 601.46	R 803 105.82	R 432 495.64
2020	R 1 258 797.52	R 853 705.70	R 405 091.82
2021	R 1 287 494.52	R 907 540.95	R 379 953.57
2022	R 1 313 813.61	R 964 806.21	R 349 007.40
2023	R 1 340 825.68	R 1 025 733.22	R 315 092.46
2024	R 1 370 713.64	R 1 090 550.53	R 280 163.11
2025	R 34 453 273.94	R 1 159 484.67	R 33 293 789.27

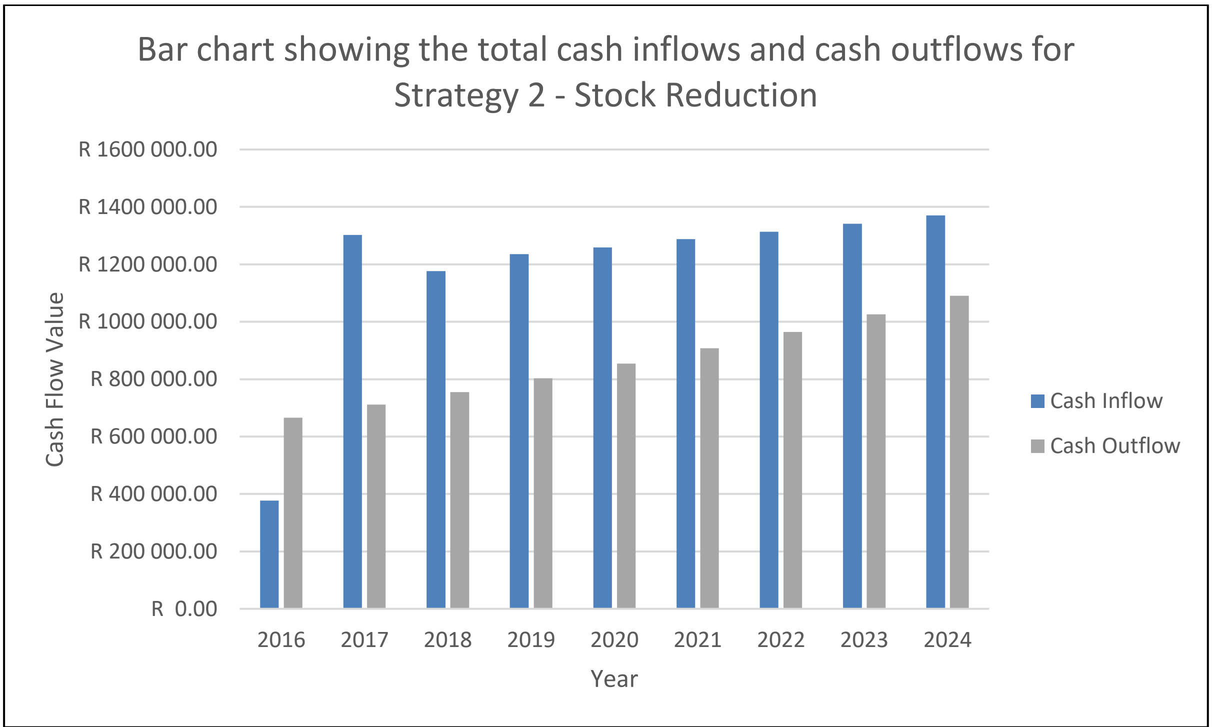

Figure 4.16: The total cash flows for a typical farm in the Beaufort West area over the 10-year period when implementing Strategy 2 – Stock Reduction

Table 4.20: The total cash flows for a typical farm in the Beaufort West area over the 10-year period when implementing Strategy 3 – Relocation

Total Cash Flow - Strategy 3 - Relocation			
Year	**Cash Inflow**	**Cash Outflow**	**Net Cash Flow**
2016	R 344 762.66	R 906 220.04	-R 561 457.38
2017	R 1 255 788.81	R 839 118.76	R 416 670.05
2018	R 1 166 330.49	R 892 218.11	R 274 112.38
2019	R 1 265 341.84	R 949 200.65	R 316 141.19
2020	R 1 329 778.10	R 1 009 716.42	R 320 061.68
2021	R 1 405 773.99	R 1 074 121.52	R 331 652.47
2022	R 1 483 750.85	R 1 142 632.15	R 341 118.70
2023	R 1 568 745.16	R 1 215 515.22	R 353 229.94
2024	R 1 652 474.23	R 1 293 023.93	R 359 450.30
2025	R 34 800 673.45	R 1 375 487.33	R 33 425 186.12

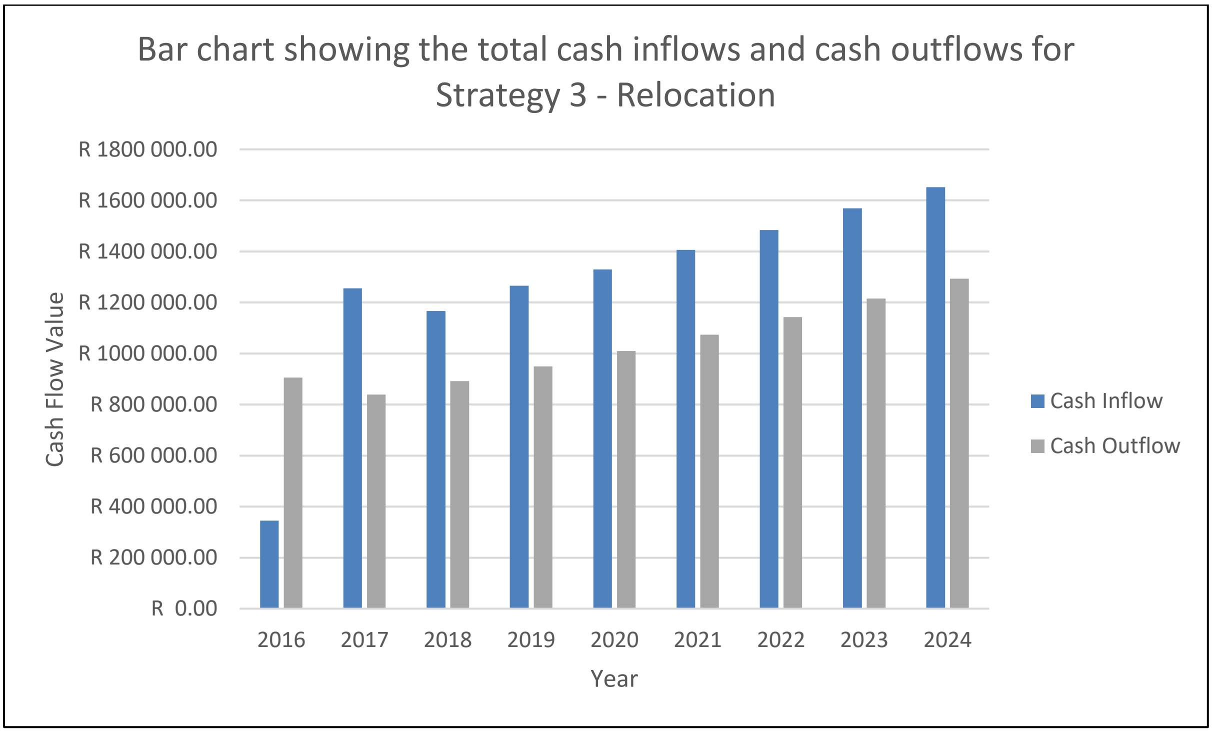

Figure 4.17: The total cash flows for a typical farm in the Beaufort West area over the 10-year period when implementing Strategy 3 – Relocation

Table 4.21: The total cash flows for a typical farm in the Beaufort West area over the 10-year period when investing in the capital market

Total Cash Flow - Strategy 4 - Capital Market			
Year	**Cash Inflow**	**Cash Outflow**	**Net Cash Flow**
2016	R 2 726 296.52	R 240 000.00	R 2 486 296.52
2017	R 166 541.76	R 420 000.00	-R 253 458.24
2018	R 153 595.58	R 420 000.00	-R 266 404.42
2019	R 139 988.13	R 420 000.00	-R 280 011.87
2020	R 125 685.64	R 420 000.00	-R 294 314.36
2021	R 110 652.60	R 420 000.00	-R 309 347.40
2022	R 94 851.71	R 420 000.00	-R 325 148.29
2023	R 78 243.73	R 420 000.00	-R 341 756.27
2024	R 60 787.45	R 420 000.00	-R 359 212.55
2025	R 42 439.54	R 420 000.00	-R 377 560.46

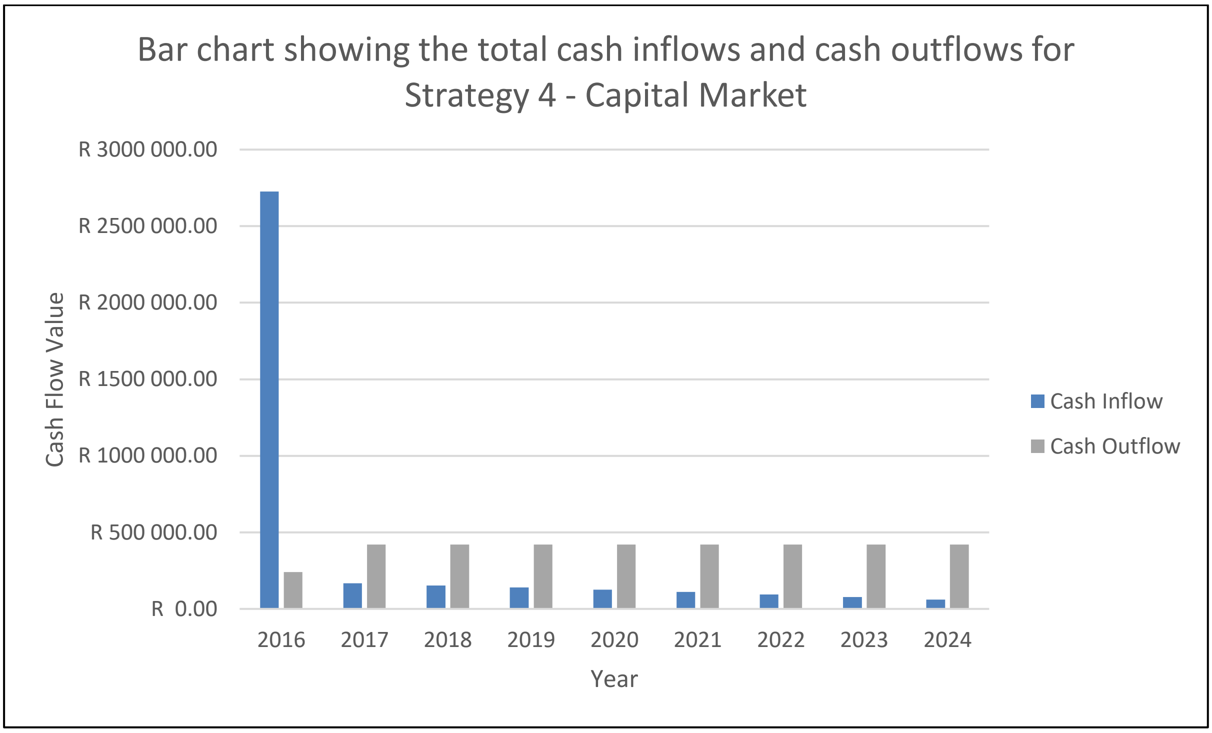

Figure 4.18: The total cash flows for a typical farm in the Beaufort West area over the 10-year period when investing in the capital market

Table 4.22 – Table 4.22 – The expected Net Present Value and Internal Rate of Return for the typical farm in the Beaufort West area when implementing drought mitigation Strategy 1, Strategy 2, Strategy 3 or Strategy 4.

Net Present Value and IRR		
Strategy	**Net Present Value**	**IRR**
Strategy 1	-R 17 235 458.79	-0.01%
Strategy 2	-R 14 937 877.35	0.94%
Strategy 3	-R 15 515 462.72	0.75%
Strategy 4	-R 3,551,482.94	-11.45412%

The internal rate of return (IRR) is a criteria used in capital budgeting measuring the profitability of potential investments. Internal rate of return is a discount rate that makes the net present value (NPV) of all cash flows from a particular project equal to zero. The discount rate that was used for calculating the NPV was 7.5%, therefor all instances where the IRR is lower the NPV will be negative. The relatively even internal rates of return for the first three strategies was achieved by allocating the capital outlay, namely land and fixed implements, as a cash inflow in the final period. Strategy 4 does not include a capital inflow of land and fixed implements in the final period. Strategy 4 uses the inflow from selling fixed implements as the initial capital outlay.

Should an enterprise be able to find an alternative investment that offers a higher interest rate than the IRR, they are more beneficial investing in the alternative investment, as they would earn more.

Strategy 1 – Feed through at cost

Strategy 1 – Feed through at cost produces a slightly negative internal rate of return. This can be expected due to the high input costs that incurred whilst implementing this strategy. It should be noted that these strategies take into account a severe lack of rainfall, therefore being able to maintain the capacity to operate during a drought attributes toward the feasibility of the strategy.

Strategy 2 – Stock Reduction

Strategy 2 – Stock Reduction produces the highest internal rate of return. As was stated in the section introduction, this result was expected. Strategy 2 – Stock Reduction is the most feasible strategy to employ whilst mitigating the negative financial effects of a drought.

Strategy 3 – Relocation

Strategy 3 – Relocation produces the second highest internal rate of return. Furthermore, the opportunity cost of leaving an entire farm dormant over a 10-year period is not calculated in this research. Incorporating a combination of two strategies can contribute towards the feasibility of operating with a heavily reduced stock count over the drought period on the farmers land in conjunction with operating a portion of the stock on rented land.

Strategy 4 – Capital Market Investment

Strategy 4 – Capital Market Investment produces a poor internal rate of return. Although the net present value looks promising, the periodic withdrawals from the enterprises' capital grossly reduces the strategies earning potential. As stated in the previous section, Strategy 4 – Capital Market Investment is not feasible for mitigating the negative financial effects of a drought.

4.11Conclusion

Droughts have a negative influence on the productivity and profitability of a typical farming system. The aim of the chapter was to evaluate the modelled strategies and determine which strategy would be best to employ on a typical farming system to mitigate the negative financial effects of a drought.

The first major discrepancy on a typical farm whilst implementing the different strategies was in the production costs (variable input cost). Feeding through a drought at cost causes the annual input cost of a farm to increase more than two-fold in comparison to the other strategies. The basis of the first strategy is centred around incurring this additional expenditure. Subsequently, the gross margin achieved by a farm when feeding through a drought at cost is considerably lower compared to when implementing the other strategies.

The next major discrepancy is observed when comparing the overhead expenditure of a typical farm. Relocating a farming enterprise requires a large initial capital outlay to transport livestock and farming inventory. Furthermore, the cost of rented land causes overhead expenditure to increase, whilst the farm suffering the drought remains dormant. The effect on net farming income whilst implementing a strategy of relocating was not as severe as that of feeding through the drought at cost.

Whilst implementing a strategy of reducing breeding stock on a farm, a gradual downscaling of the farm output is observed. No extreme movement in livestock numbers, production costs or overhead expenditure is apparent.

When comparing the net present value and internal rate of return on a typical farm whilst implementing the proposed strategies, shrinking the breeding stock proves to be the most financially feasible. The fourth non farming strategy of avoiding a drought altogether disregards the capital cost of the farm in the calculation. The internal rate of return achieved by the strategy is relative to the net present value compared to the capital outlay.

It can be concluded that the most financially feasible solution to mitigating a drought on a typical farm would be to shrink the breeding stock, thus protecting genetic material and ensuring positive financial potential in the future.

Chapter 5 – Conclusions, summary and recommendations

5.1 Conclusions

South Africa, particularly the Beaufort West region, is recognized as an area subject to recurring periods of drought. The farming community in the Beaufort West region, which specialize predominantly in sheep farming, possess a high understanding of the most suitable farming practices in dealing with drought situations.

Mutton is categorized as a preferable food source in the South African consumer market. The Central Karoo forms a vial sector in supplying mutton to the South African market.

Currently the only form of drought relief available to South African beef farmers is through government subsidization set out by the National Drought Action Plan. This is a reactive response mechanism which requires substantial effort and time. The need for a proactive approach for mitigating the negative financial effects of a drought is eminent.

The central research question asked is “which strategies are available to a Central Karoo farmer to mitigate a drought and what are the expected financial implications of these strategies?”

A farming system is inherently complex and multi-faceted, therefore changing one part of the farming operation might have an unexpected implication on another part. Whole farm modelling is a method of research that can accommodate the complexity of a farming system and show the implications of alterations to the system. The benefit of whole farm budget modelling is that it is adaptable to incorporate such changes to the farming system and accurately represent the results and implications of these changes.

The research identified and evaluated four whole farming strategies that a farmer in the Beaufort West region can pursue to mitigate the negative financial impact of a drought on a sheep farming enterprise.

The strategies are stated below.

1. Feed through the drought at cost.
2. Shrink breeding stock during drought and rebuild after (protect genetic material)
3. Relocate the entire enterprise to area not experiencing drought.
4. Sell off the entire enterprise, invest in the capital market and buy back at the end of the drought

The strategy to shrink breeding stock during a drought proved to be the most financially feasible. The methodology and results stated and explained the advantages and shortcomings of employing the different farming strategies to a farming enterprise. Although the figures were based on a highly specific scenario, the consistency of isolating each individual farming strategy aided the research to produce the most accurate results.

The strategy to shrink breeding stock focused on reducing input costs as a result of decreasing the amount of livestock the farming enterprise operates with. This was achieved by adjusting the farming enterprises' replacement strategy, namely sale percentage. The advantage of implementing this strategy is that genetic material of the farming livestock is protected through the period of the drought. Furthermore, the long run effect of the strategy is easily rectified post drought merely by adjusting figures in the replacement strategy.

Attempting to accurately recreate a real-world scenario in the budgeted simulations proved challenging. It should be noted that produced figures are highly dependent on the underlying assumptions dictating the budget models and could not factor in all possible variations. Further challenges included the attempt to align the produced figures and results with that of theory.

Livestock numbers whilst implementing the strategy decreased at a far higher rate than that of the other strategies. This was a direct result of increasing the ewe and lamb sale percentage in the given financial years. Throughout the budgeted period, the livestock inventory levels maintained whilst implementing the strategy are not high enough to equal sale levels of the other strategies. As such we notice that the enterprise gross income declines over the period, and in turn the gross value of production is lower.

A reduced figure is observed when comparing production input costs. The reduced inventory levels reduce the total amount of medicines required by the livestock on the enterprise. Furthermore, no additional feed is required whilst implementing the strategy. Overhead expenditure only adjusts for inflation for the budgeted period as no additional costing activities are included on the enterprise.

The farm profitability experiences a reduction from 17.65% to 7.48% over the 10-year budgeted period. Farm profitability gives an indication of the amount of income generated by the enterprise in relation to the capital employed. Since fixed capital commitment are not being reduced whilst implementing the strategy, the decreasing figure is to be expected.

The bank statement reflects a large drop in the first financial year when implementing the strategy. The stabilization of the balance is far quicker in comparison to implementing one of the other strategies. At the end of the 10-year budgeted period, shrink breeding stock results in the highest closing balance in comparison to the other approaches. This further results in a positive internal rate of return 0.94% being achieved over the 10-year drought period.

We conclude that the strategy to shrink breeding stock over the 10-year period to be the best as it produces the best internal rate of return and highest closing bank balance.

To conclude, the research presented provides an introduction into the topic of mitigating the negative impact of a drought on the South Africa Agricultural sector. The research focussed on the sheep industry of the Beaufort West community. Broadening the scope of the research and introducing the research into other commodities of agricultural sector is a solution toward grasping a perfected understanding of how to mitigate the financial impact a drought can have.

5.2 Summary

In Chapter 1, the topic of the importance of droughts and the frequency of their occurrence is highlighted. South Africa is recognized as a country subjected to recurring droughts, with parts of the country historically having been declared a disaster drought area. Currently, the only form of drought relief available to South African farming entities is through government subsidization.

Farmers can employ their own strategies on a farm level to mitigate the negative financial impacts of a drought. There is however a lack of knowledge regarding the financial implications of the strategies available to producers to manage or negate a drought.

The research focused on identifying and evaluating whole farming strategies that a farmer in the Beaufort West region can pursue to mitigate the financial impacts of a drought on a typical sheep farming enterprise. Addressing the aforementioned issue requires identifying and assessing the alternative strategies of mitigating drought on the whole farm level, acquiring data through participatory research and constructing various budget models to convey the acquired data so as to determine the most feasible strategy to employ on a farm level.

The first section of Chapter 2 provides a literature review on the background of droughts in South Africa and the economic, environmental and social impacts caused by a drought. Most of the agricultural land area of South Africa is not conducive to crop production. The Karoo gets as little as 400 mm of rain annually. A deficit of 25% of normal annual rainfall is considered a severe drought.

In these areas that are known for low rainfall extensive livestock farming is the only financially viable option in terms of agriculture. Within the livestock industry mutton is an important component. The notable characteristics of the South African mutton industry are addressed to provide context to the subject matter.

The second section of Chapter 2 identifies and discusses the role of government in mitigating the financial losses caused by a drought. The primary responsibility of dealing with a climate disaster lies with the government. Government role players have proven to be insufficient to negate the effects of a drought crisis. South African producers are left to their own to deal with the drought. This creates the need for proactive measures to mitigating the effects of a drought at farm level, giving rise to the need for budget modelling.

The final section of Chapter 2 discusses whole farm modelling as a research method.

The first section of Chapter 3 focuses on providing an understanding of the different terminology used in financial budgeting. A budget is a forecast of all income and expenses, and helps a business identify future financial needs and plan based on expected profit, expenses and cash flow. Budgets cover a certain period and can be updated based on current information.

The second section of Chapter 3 discusses the four strategies to mitigate the negative financial effects of a drought. The first strategy discussed is to feed through a drought period at cost. Feeding through a drought results in a farm enterprise incurring high additional input costs. The impact that providing additional feed could have on the enterprise is that other farming activities will experience a decline in allocable resources. A positive result of implementing the strategy is that grazing pastures, which are under exceptionally strenuous conditions, will gain an opportunity to recoup. The second strategy is shrinking breeding stock during the period of a drought and rebuild after, thus protecting the genetic material. The three main elements are factored in the strategy. Less animals will require less overall grazing; variable input cost will reduce in similar proportions to that of livestock and genetic material is protected through a drought period. The third strategy involves moving the entire livestock population of the farm to a new farm in an area not experiencing drought. Although grazing pastures may be enough, the major setback of implementing this strategy is that increased variable costs need to be incurred on the farming enterprise to inoculate animals against this susceptibility to new diseases. The fourth strategy aims to avoid the drought altogether. The strategy of selling off the farms' variable inventory and investing the proceeds in the capital market is not a farming strategy, but rather a method of maintaining capital value of assets through the drought period. The substantial disadvantage to the strategy is that genetic material is completely lost in the process, which will have serious implications to the intrinsic value of the farming entity's reputation. The final section of Chapter 3 leads onto discussing the methodology for acquiring and modelling the financial data used in the research. A baseline budget model was constructed to simulate the financial effects and implications of a normal drought free period an adapted to model the four financial strategies.

Chapter 4 tabulates, illustrates and discusses the results produced by the modelled financial strategies. The results produced whilst implementing the different strategies indicated various spikes and dips in the performance metrics of a typical farm. Feeding through a drought at costs proves to be a costly strategy, however livestock number are able to be retained. Relocating a farming enterprise to an area not experiencing drought results in a typical farm having to incur high additional overhead expenditure, which in turn has a dampening effect on net farm income. Shrinking the breeding stock on a typical farm results in a gradual downscaling, however the typical farm business is still able to survive and operate. Thus, the most financially feasible solution to mitigate a drought on a typical farm would be to shrink breeding stock.

5.3 Recommendations

Numerous recommendations are proposed to further the research. The budget models assume that the drought continues throughout the modelled 10-year period. This allows a farmer the option to assess their financial situation and opt out if need be at any point in the period should the drought come to an end. Including a post drought recovery scenario in future studies will be useful in giving insight into the expected time frame for a farming business to recover and return to a business as usual state. The length of the recovery period might influence the feasibility of the proposed financial strategies.

It is further recommended that the strategies be employed on farms operating with different breeds of sheep. The research has been modelled on a single breed of sheep, as the Beaufort West farming community farms primarily with dorper sheep. Different breeds of sheep are farmed across areas with varying climatic regions. These results can be used in conjunction with the original study to determine whether the expected outcomes are similar across all breeds of sheep.

The final recommendation is to explore in further detail other non-farming diversification options. This will grant a more holistic view on the effectiveness of non-farming methods at mitigating the financial impacts of a drought.

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