Financial implications of converting from livestock to game farming in the Karoo region, South Africa

By

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DECLARATION

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ABSTRACT

South Africa's game farming industry is becoming more common and more popular in the country's agricultural sector. It is one of the geographically growing agriculture subsectors, with an approximate growth rate of between 2 and 2.5% per year on average. Currently, game farming is widely adapted within traditionally extensive cattle and sheep producing areas, where current sheep producers are moving towards game farming practises. This type of farming, is regarded as a lifestyle investment and, because of this; it is largely investors with a large capital who can afford this. Due to the complexity of this type of farming, influenced by the huge initial capital required, interrelationships of biological, physical and economic aspects, and exposure to high risk and uncertainties, game farming is not easy to tap into without a considerable degree of capital. There is a general lack of finance, knowledge and access to markets by South African farmers, hence switching from sheep to game farming can become even more costly. To mitigate this deficiency, use of efficient and effective decision making processes is useful in order to make informed decisions. The researcher employed whole farm budget modelling as a technique, which is useful for the decision making process, by adapting the use of a multi-period budget model. The proficiency of the systems thinking approach was used in order to deal with complexity in the whole farm system where physical and financial components of the farm were incorporated together as a single item. The main aim of this study is to analyse the financial and managerial implications of converting from sheep farming to game farming in Beaufort West, a town in the Karoo in the Western Cape of South Africa, with the objective of finding out if it is financially profitable for a current sheep farmer to move to a game farming system. To achieve this, a collaborative research method is used following a review of literature and then empirical investigation is used to analyse the results. The intention is to generate comprehensive and feasible insight for farmers to tap into, thus assisting them in making informed choices with improved knowledge in their daily operations. The findings of this work reveals that current sheep farming system over a period of 20 years is profitable, but converting to game farming is more profitable. This was revealed by an IRR of 4.02% in a sheep farming system compared to IRR of 5.85% in a game farming system. The IRR was described and analysed to show how it is used to measure profitability in a whole farm system situation.

It was noted that there are external factors that also influence whole farm profitability. Scenarios were simulated to analyse the impact of specified factors on whole farm profitability. The factors were high game prices, drought and decrease in carrying capacity.

The results are significant in all scenarios. The scenario with high game prices show increase in IRR from 5.85% to 7.45% and the scenario with a decrease in carrying capacity show decrease in IRR from 5.85% to 2.41%. Lastly, the scenario with drought shows decrease in IRR from 5.85% to 5.53%. This explains that the occurrence of drought and decrease in carrying capacity decreases whole farm profitability, whilst high game price increases whole farm profitability.

OPSOMMING

In Suid-Afrika is wildboerdery besig om meer algemeen en populêr te word binne die landbousektor as geheel. Hierdie subsektor is geografies besig om uit te brei en groei teen ‘n gemiddelde koers van tussen twee- en 2.5% per jaar. Wildboerdery ontwikkel veral in areas wat voorheen vir ekstensiewe bees- en skaapboerdery gebruik is en waar landbouers hul fokus toenemend na die wildsektor verskuif. Hierdie tipe boerdery word egter dikwels as ‘n leefstylboerdery beskou wat beteken dat dit grotendeels beleggers van buite die landbousektor, met genoeg kapitaalbronne, is wat in die bedryf investeer.

Wildboerdery is ‘n komplekse bedryf wat aanvanklik ‘n groot kapitaalbelegging verg om te implementeer. Dit, tesame met die wisselwerking tussen biologiese, fisiese en ekonomiese faktore, maak dit ‘n onsekere en hoë risiko bedryf, wat moeilik is om te betree sonder noemenswaardige kapitaalbesteding.

Suid-Afrikaanse landbouers het dikwels nie genoeg kennis van die wildbedryf of toegang tot die nodige kapitaal of markte om die skuif van skape en beeste na ‘n wildboerdery suksesvol uit te voer nie. Om hierdie probleme aan te spreek is die gebruik van doeltreffende en effektiewe besluitnemingsprosesse noodsaaklik om ingeligte besluite te neem. In hierdie studie is ’n geheel-plaas begrotingsmodel gebruik. Die bedrewenheid van hierdie werkswyse is aangewend om die kompleksiteit van die geheel-plaas begrotingsmodel aan te spreek en die fisiese- en finansiële komponente van die boerdery as ‘n enkele meetbare item te inkorporeer.

Die fokus van hierdie studie is om die finansiële en bestuursimplikasies van die skuif van skaapboerdery na wildboerdery in die Beaufort-Wes area van die Karoo, Wes-Kaap, te analiseer, met die doel om vas te stel of dit finansiëel winsgewend is vir ‘n huidige skaapboer om na wildboerdery oor te skakel. Dit is gedoen deur ‘n literatuurstudie, gevolg deur deelnemende navorsing. ‘n Empiriese ondersoek is gedoen om die navorsingsresultate te genereer. Die voorneme is om omvattende en uitvoerbare insig en kennis daar te stel wat boere kan gebruik om hulle te help om ingeligte besluite binne hul daaglikse werksaamhede te neem.

Die studie het bevind dat ‘n huidige skaapboerdery oor ‘n periode van 20 jaar winsgewend is, maar deur oor te skakel na ‘n wildboerdery die winsgewendheid toeneem. Dié resultate

is onthul deur ’n interne opbrengskoers van kapitaal investering IOK van 4.02% met betrekking tot die skaapboerdery sisteem teenoor ‘n interne opbrengskoers van 5.85% vir ‘n wildboerdery sisteem. Die interne opbrengskoers word beskryf en geanaliseer om aan te toon hoe dit gebruik is om winsgewendheid binne ‘n geheel-plaassisteem te bepaal.

Eksterne faktore is ook geïdentifiseer wat geheel-plaas winsgewendheid beïnvloed. Verskillende scenarios is gesimuleer en ontleed om die impak van spesifieke faktore op geheel-plaas winsgewendheid te bepaal. Hierdie faktore sluit hoër wildspryse, droogtes en ‘n afname in drakapasiteit van die plaas in. Noemenswaardige resultate is vir al die scenarios verkry. Hoër wildspryse het ‘n toename in die interne opbrengskoers van 5.85% tot 7.45% tot gevolg gehad. ‘n Afname in drakapasiteit het die interne opbrengskoers verlaag van 5.85% tot 2.41%, terwyl ‘n droogte die interne opbrengskoers verlaag het van 5.85% na 5.53%.

DEDICATION

I dedicate this thesis to my mother, Angela Chiyangwa, and my father, Clever Chiyangwa, for making me the person that I am and making me realize that nothing can stop me from achieving my goals.

BIBLIOGRAPHICAL SKETCH

Tafadzwa Chiyangwa was born in Chirumhanzu district, Midlands Province, Zimbabwe on 06 November 1986. He completed his High school in Geography, Management of Business and Principles of Accounts at Holy Cross High school in Midlands Province, Zimbabwe. He pursed a Bachelor of Agricultural Economics and Management degree in 2015 from Stellenbosch University and also obtained the BAgric-Admin Hons-degree in the same year. In 2016, he completed the Honnours-degree and was accepted as a Masters student under the supervision of Dr Willem Hendrick Hoffmann in the Department of Agricultural Economics and Management, Stellenbosch University.

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PREFACE

This thesis is presented as a compilation of 5 chapters.

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CHAPTER 1: INTRODUCTION

1.1 Background to the study

Agriculture forms the basis for economic development in many countries (Goldblatt, 2010). It is therefore important for such economies to maintain a vigorous and fruitful agricultural system to ensure food security, employment and general socio-economic growth. South Africa's game farming industry is an important agricultural subsector to the economy. There are different views concerning the historical overview of wildlife in South Africa. According to Bothma & Du Toit (2016), wildlife dates back to the 1960s but it was not common because it did not have the same monetary value as it does currently.

South Africa's wildlife industry is comprised of state-owned game reserves and national parks as well as privately owned wildlife or game farms. The initial recognition of South African game farming by its government as an agricultural activity that has the capability of contributing significantly to economic growth was in 1987 (Gouws, 2014). However, it is debatable that even before that, it has always been paramount. Its development was constrained by livestock supporters arguing that wild animals transmit diseases to livestock and compete with them for grazing pastures.

Game farming has numerous contributions to the economy of South Africa, ranging from conservation of precious flora and fauna to socio-economic wellness. It contributes to creation of employment, food supply, generation of local and foreign currency and functions as a conservation farming practice (Bachmann et al., 2016; Van der Waal & Dekker, 2000). Game farming is a broad industry that includes various economic activities. Most of the income that flows into the industry come from hunting activities, photographic work, environmental education, meat production and live game sales (Cloete, Taljaard & Grove, 2007; Van der Merwe & Saayman, 2007; ABSA, 2003 & Luxmoore, 1985). Hunting is regarded one of the most significant contributing factors from an economic perspective. The economic contribution from hunting activities are attributed to its large share of income, generated mainly from international clients who prefer to hunt for trophies as well as local clients who hunt for biltong. In addition to that, economic activities associated with game farming also support other industries up and down stream. Hunting provides the structure and framework for ecotourism activities (Saayman, Van der Merwe & Rossouw, 2011). Income can be generated through catering, accommodation, game drives, meat processing and taxidermic services. It is important to be acknowledge that several economic activities within the game farming industry increases complexity.

Complexity in agricultural systems has always been a major challenge and has increased in the present day. One of the reasons is diversification in systems. South Africa’s agriculture is diversified into crop production, bee-keeping, wine making, crop husbandry, horticulture, animal production and aquaculture (GCIS, 2010; AGRI-SETA, 2010). Diversification is a useful strategy of risk mitigation on the one hand; on the other hand, it simultaneously increases complexity.

In the past 15 years, South Africa’s game farming industry experienced significant growth with an estimated average of 20.3% per year in revenue terms. In 2008, the worldwide economic recession reduced potential growth, along with local drought occurrence, fluctuation of the Rand and electricity shortages (Steyn, 2012). Statistics have informed variations between percentage growth in revenue and geographical expansion in game farming. The reasons for variations can be attributed to improvements in management efficiency, the intensification of systems as well as the development of better breeding systems. The bottom line is that game farming is increasing popularity in present day agriculture and is occupying more agricultural land.

South Africa has a growing game farming industry in geographical and economic aspects. Growth within the industry emerged from being a small industry at the beginning of the 1960s when it evolved to become a current real economic role player (Van der Waal & Dekker, 2000). Moreover, the area exempted to its practices has increased at an average of 5.6% per annum (Ellof, 2002). Growth in the industry has mostly been a result of policies that create conducive conditions for private wildlife ownership. An important policy that legislatively underpins the game sector is the restrictive private game ownership through the Game Act 105 of 1991, amended by Act 18 of 1996 and Act 62 of 2000 ((Bothma & Du Toit, 2016). This policy paved the way for individual commercial resource farmers to expand game farming. Before its signing, wildlife utilisation received higher priority for public use that raised problems of public ownership, such as free riding. The aforementioned policy also aims to promote the existence of well-defined property rights that result in price mechanisation of allocating wildlife resources efficiently, which in return increases profitability.

Switching from livestock production to game farming has become a common practice in South Africa. Popular belief is that it is often capitally strong and lifestyle investors that invest in game farming. Van der Waal & Dekker (2000) mentioned that significant transformations has been experienced in the Northern Cape Province; cattle numbers have declined significantly due to farmers giving priority to game farming. A conversion rate of between 2% to 2.5% has been experienced countrywide (Patterson & Khosa, 2005). In addition, there have been significant conversions from commercial livestock production to game farming in the Eastern Cape, according to Pasmans & Hebinck (2017) 12% of the land has been converted since 1996. This shows that South African extensive livestock farmers are moving to game farming systems.

It is important to note that these conversions are taking place mostly in private operations. In other words, more game farmers or private game farmers have joined or are joining the game farming industry, not the state owned wildlife uses. Over the past ten years, private wildlife industry or game farming expanded at a rate of between 2% and 2.5% per annum geographically, while their real farm income decreased by 5.3% per year (Dry, 2009; Child et al., 2012; Bothma & Du Toit, 2016). In response to declining profits, extensive livestock farmers have supplemented livestock with game, while others completely moved to game farming (Child et al., 2012). However, it is uncertain whether decreasing the domestic livestock component guarantees generating a higher income with game farming. Substantial initial capital is required to purchase game stock, investing in capital assets, developing fencing and water holes and training of staff.

Switching farming systems also means numerous new challenges. Switching from domestic livestock systems to game farming without proper planning could worsen profitability (Bothma & Du Toit, 2016). This is especially true in the current economic climate, characterized by volatility of the Rand, exposure to high risks and uncertainties and changes in game prices. These challenges arise in the short term and long run and in worst case scenarios, farmers could go out of business (Friedrick & Kienzle, 2007). In the real world, the adoption of new systems requires a change in mindset to accommodate novel ideas (Abrol, Gupta & Malik, 2005).

In game farming systems profitability varies depending on rainfall, land prices, capital invested and management efficiency (Friedrick & Kienzle, 2007). A typical profitable commercial game farming system could generate R220 per hectare per month, compared to that of livestock generating R80 per hectare per month on average (Steyn, 2012). The profitability of game farming depends on animal species, cost of inputs, drought occurrences, diseases, poaching activities, fluctuation of currency and political climate. The bottom line is that poor strategic decisions limit fruitful practices at farm level (Makhuvha, 2015). Managers should use adequate tools and techniques in their daily operations in order to maintain profitability.

Effective decision making is challenging in agricultural systems, as there are limits to natural and financial resources, mostly at farm level. In addition to that, farm systems are diverse, complex and exposed to high risks and uncertainty. In order to realise profitable production systems; strategic, effective and efficient decisions are imperative. This is best done with the use of tools and techniques that support planning for the most likely future consequences of decisions before implementing them. At farm level, it is the managements' responsibility to make sure that financial performance and profitability are improving. By nature the geographical location of game farms could be remote and isolated. This in itself could cause added logistical challenges considering the typical client profile.

1.2 Research question

Farm systems are complex by nature. In game farming, complexity is enhanced by the influence of investment requirements, interrelationships of biological, physical and economic aspects, and exposure to high risks and uncertainties in production. These factors increase the farm burden and put management under a lot of pressure concerning farm profits (Makhuvha, 2015).

Despite these challenges, game farming is growing and has been widely adapted in extensive traditionally sheep and cattle production areas. Farmers have converted from livestock systems to game farming, and some of the reasons for the transformations are associated with wildlife's ability to conserve natural resources (habitat use). Other motivation include; a lifestyle and the ability of wildlife to sustain in arid and semi-arid conditions (a major characteristic of the country's climatic conditions). Carruthers (2010) states that the knowledge regarding the realisation of the importance of wildlife on its habitant is amongst the greatest agricultural transformations in South Africa.

But, game farming is seen as a lifestyle investment and therefore carried out by relatively wealthy investors outside of farming. It is uncertain whether a current livestock farmer will benefit from such a shift and over what period. Since the researched trend shows the price of game in South Africa has changed considerably.

Therefore, an investigation is required to understand the financial and managerial implications of switching from livestock to game farming. This could add to the rate of transformation if it can be proved that it has viable financial returns for a current farmer to shift. The general problem is thus a lack of understanding on the financial and managerial implications for the current livestock farmer to make such a shift. The current farmer has certain limitations regarding financing, knowledge and market access. The Beaufort West area is well-known for mutton production, but also game. This area was selected to serve as a basis for this study as it is a contemporary issue.

The question of this research is what are the expected financial and managerial implications of converting from sheep to game farming in Beaufort West, Karoo?

1.3 Objective of the Study

The general objective of the study is to determine the financial implications of shifting from sheep to game farming in Beaufort West, Karoo.

In order to reach the above-mentioned general objective, the following specific objectives need to be met:

- To determine the practical and cost implications of changing from livestock to game farming.
- To assess the whole farm financial implications over the longer term.

1.4 Significance of the study

There is still scant knowledge regarding farm-level financial and managerial implications of converting from livestock to game farming at farm-level commercial farming in South Africa. Game farming is paramount to the South African economy in general and the Karoo region in particular. It contributes to employment, food supply (low fat and lean meat), income generation and as conservation practice (precious flora and fauna). Game farming also presents a recreational value for many. It is important to investigate and quantify current financial performance and profitability in livestock farming systems and then investigate and quantify the financial implications of moving to game farming operations.

This study intends to generate some insight from which farmers can draw. This could thus assist them in making informed decisions with improved knowledge in their daily operations. The ultimate objective is to quantify financial performance in the whole farm system as result of the transformation. The study is a localised one and the results obtained will directly provide useful information and financial figures to real-world farm-level farmers in their complex decision-making process and solutions to challenges when facing similar problems. It could provide a checklist for producers who consider a similar option.

1.5 Proposed Method

An overview of literature was undertaken in order to understand the origins and development of game farming in South Africa. This was done by tracing history and transformation from livestock production systems in African and South African context. This was done to develop a clear understanding of the financial implications of converting from livestock to game farming using a typical farm budget model to interpret the findings.

As farm systems are complex in nature, complexity therefore forms an important aspect that needs attention. According to Checkland (1993), complexity in farm systems come from interdependency and interconnectedness of biophysical and financial components. In the real world, farmers face problems relating to future developments and anticipation of projections and their consequences. This has led to researchers and economists to ascertain methods, elucidations and methodologies that are necessary in investigating and providing solutions and answers to agricultural economic ideas and issues. These experts have developed and established ways of constructing and simulating models and adapt their uses in order to assist them in tackling challenges arising in agricultural milieu (Hoffmann, 2010).

The departure of investigation in this study is to capture a farm's physical and financial components using multi-period farm budget models in order to investigate financial and managerial implications of converting from sheep production to game farming at farm level in the Beaufort West area. Multi-period farm budget models are useful because of their capability to assess strategies and views in physical and financial terms. Other advantages are that plans and strategies are examined before implemented in real world situations, which saves time and resources. It is paramount to note that budgets play a central role in financial planning purposes and not used in up drawing plans. Budgets are also useful in numerous investigations in various operations because of their simplicity to use and their experiential approach in examining strategies (Hoffmann, 2010). The use of budget models has increased due to technological innovations such as computers and software (Rehman & Dorward, 1984; Poole & Buckley, 2006). Budgets also play a major role in closing the gaps existing in many disciplines, for example between researchers and producers in the agricultural economics field (Smathers, 1992; Nuthall, 2011).

In order to address and understand complexity in real farm situations, the systems thinking approach plays a crucial role. The system thinking approach is useful for sustainable management practices (farm practices) because of its ability to deal with components in a system as a whole rather than in isolation. However, its other advantage is that it is applicable across many disciplines (Bosch et al., 2013; Nguyen & Bosch, 2013). It integrates specified information into the whole system (Hirooka, 2010). In this research, physical and financial farm components in a typical whole farm situation are incorporated using budget models and examined as one thing.

1.6 Delimitations of the Study

The study focuses on one sheep breed and three game species. There are however more sheep breeds and a variety of game species in South Africa. The choice was made because not all species sustain the harsh climatic conditions in the Karoo (semi-arid) and legislation permits certain game species to be transported and kept in various areas.

The reason for including only one breed is that merino is most common in the country and adapt well in the Karoo region. Other livestock such as cattle and goats were not included because goats do not have a significant economic contribution to the economy of the area, and few cattle are farmed with in the Karoo due to harsh conditions experienced.

Other challenges faced by the researcher includes, but is not limited to lack of data on the game farming industry. Another limitation is the commercial production due to time and financial constraints. The study is also limited to the Beaufort Karoo area, which is a very small part of the country located in the great Karoo region in the Western Cape Province.

1.7 Thesis Outline

Chapter 2 gives an overview of the livestock and game industries. The motivation is to show trends and other relevant information that help in describing and analysing the problem in detail. Chapter 3 reviews literature related to the study, it also gives historical background on the development of game farming in South Africa and African context, together with its relationships to the livestock sub-sector and legislation that shape the wildlife industry in South Africa. The purpose was to show evidence of existing literature focusing on South Africa and limited literature illustrate that marginal research had been carried out in this area; it motivates the need of conducting research on the subject. Chapter 4 gives a description of the approach, methods and techniques used to collect and gather data in constructing a whole farm budget model. The major purpose was to illustrate, develop the structure and elucidate the work of budget model used. Finally yet importantly, chapter 5 discusses, evaluates and reports the empirical findings and ends by giving a summary, recommendations and concluding remarks.

CHAPTER 2
Overview of game and livestock industries

2.1 Introduction

The main aim of this study is to determine the financial implications of switching from sheep farming to game farming. This chapter aims to establish the potential benefits (or costs) of game farming. It presents the game farming industry in the context of South African agriculture, focusing specifically on the Beaufort Karoo area of the Western Cape Province. The chapter also reviews literature on livestock industries in South Africa and the global context, to explore opportunities and challenges of the sector in order to determine its importance.

2.2 Description and analysis of South African Agriculture

South Africa's agricultural sector is dual in structure (Tregurtha & Vink, 2008; Tregurtha et al., 2010; Mudavanhu, 2015). It consist of commercial as well as smallholder communal farmers. Smallholder communal farmers are those that farm in homeland areas and produce mainly for family consumption and include the emerging smallholder farmers that sell their surplus to the market. Commercial farmers produce solely for market purposes (Agricultural statistics, 2008). According to Greenberg (2015), 237 commercial farms accounted for 33% of total agricultural income in 2007 and 2 330 farms contributed 53% to the gross agricultural income in 2005. In contrast, the contribution of small scale and emerging farmers are insignificant (Tregurtha & Vink, 2008; Tregurtha, Vink & Kirsten, 2010).There are approximately three million smallholder farmers using 15% of the country's agricultural land contributing less than 40% of marketed outputs (Anseeuw et al., 2012). The reasons for variations in land ownership and share of market outputs by these distinct groups of farmers are differences in access to financial, institutional and technical facilities, which benefits commercial producers the most (Mudavanhu, 2015). Game farming requires large initial investment capital in the form of processing licenses, setting up infrastructure, and buying stock. Legislation and authorities stipulate these, and other essential requirements. Smallholder and emerging farmers therefore find it difficult to participate in game farming practises.

Western Cape agricultural activities accounted for 14.4% in 1997, 14.5% in 2007 and 14.2% in 2012, respectively to the provincial economy (Western Cape Government, 2014). Agricultural activities in the Western Cape consist of wheat, canola, livestock, vegetable, and viticulture, poultry, fruits, wine and table grapes. A significant contribution comes from sheep in the drier areas, cattle along the Western coast, and piggery and poultry in major towns. Agriculture plays an important role in the economy of South Africa. It is a primary employer and it contributes approximately 10% of formal jobs, and in addition to that, it supports several industries directly or indirectly (Agricultural statistics, 2008). Based on the aforementioned, the agricultural sector plays an imperative role from an economic perspective, thus agricultural activities significantly contribute to an increase in economic growth of the country.

Agricultural practises have significant environmental impacts. Climate change has become a major challenge and there is shortage of water in South Africa. There is 1.3 million hectares of arable agriculture land relying on irrigation practices, utilising 50% of underground water sources (Fanadzo, 2012). More agricultural land to game farming could mean better chances of restoration of biodiversity given that farmers are stocking sustainable rates.

In terms of natural resources, South Africa consists of 2.76 million hectares of cultivatable land of which 82% is under commercial use (AGRI-SETA, 2010). The commercial sector has always been productive, making use of the best agricultural practices to maintain land productivity. GCIS (2010) indicates that close to 85% of the land is dry and depend on natural rainfall. Given the aforementioned, there is strong evidence that shows that water availability is a major challenge. Most of the country's land is however quite dry, and is classified as semi-arid, especially the Western part of South Africa which is relatively dry and suitable for extensive farming only. This can potentially contribute to farmers considering wildlife farming, especially those that are in the semi-arid areas such as the Karoo.

Table 2.1 indicates that South African agriculture, forest and fisheries contributed R94 408 million to value addition in 2016, which is 2.4% of the total value added to the entire economy. Value added is the total value of outputs less value of intermediate consumption during the production period.

Table 2.1: Agriculture's contribution to value addition at basic prices from 2010 to 2016

Year	Total value added (R million)	Contribution to value addition (Rmillion)	% contribution to value addition
2010	2 494 860	52 001	2.1%
2011	2 724 400	55 478	2.0%
2012	2 932 879	59 934	2.0%
2013	3 183 433	63 321	2.0%
2014	3 418 061	70 755	2.1%
2015	3 625 467	72 235	2.0%
2016	3 869 460	94 408	2.4%

Source: South African Yearbook (2015-2016)

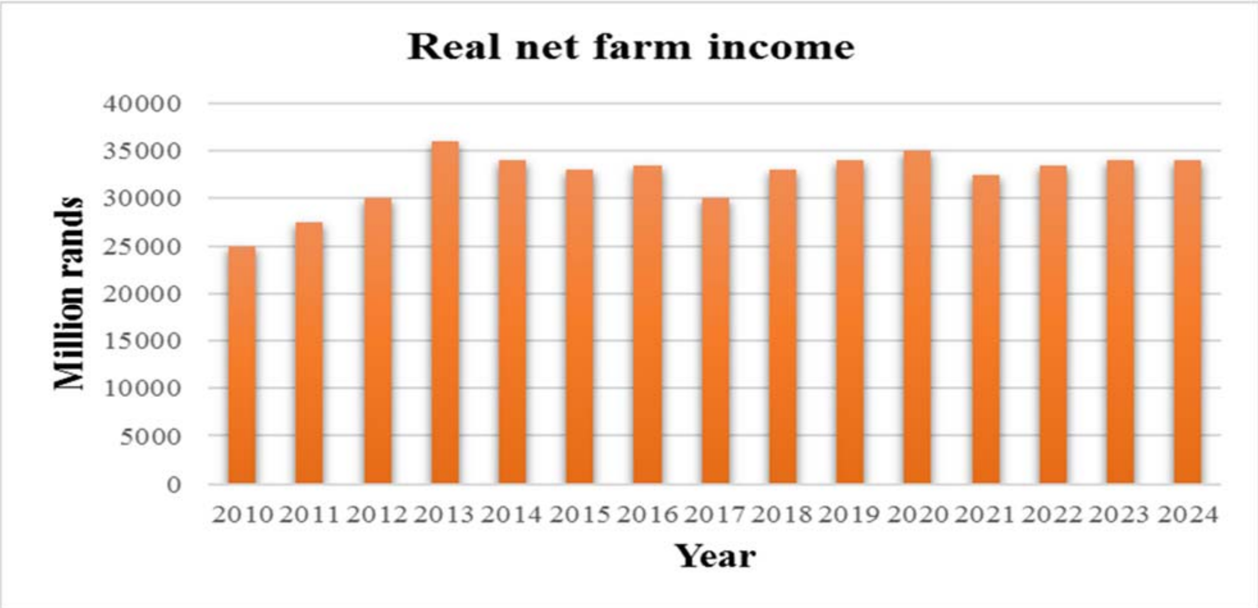

Figure 2.1: Real net farm income from livestock production from 2010 to 2024 projection
Source: BFAP (2016)

The real net farm income peaked at R36 billion in 2013 but seems stable between R30 billion and R35 billion as shown in Figure 2.1. According to USD (2017), real net farm income counts the value of those inventories that are part of prior year income adjusted to inflation.

2.3 Overview of South Africa's livestock industry

2.3.1 Importance of the industry

The livestock industry is important to the global economy in general and South Africa in particular. Statistics show that a third of global protein requirements come from livestock products (Livestock in Development, 1999; United Nations, 2009). Benefits from livestock industry are numerous, ranging from socio-economic aspects to the supply of essential nutrients and ensuring food security. An estimated 17% of food energy and 33% of protein requirements consumed in South Africa come from livestock products (Sere, 2009). Animal nutrients are essential in people's lives. Food shortages and poor balanced diet reduce life expectancy and increase death rates.

South Africa's livestock industry also plays an important role in the conservation of biodiversity and employment creation, which is similar to the economies of many other nations (Meissner, Scholtz & Palmer, 2013; Scholtz et al., 2013). An estimated 48% of South Africa's agricultural outputs, in value terms, come from livestock products and services (South African yearbook, 2014-2015). In addition, numerous industries directly or indirectly depend on livestock production. It is estimated that 2 125 000 people depend on livestock industry directly and indirectly (South Africa yearbook, 2012-2013; DAFF, 2010).

The sheep industry is important to the economy of South Africa. Over the past 10 years, the average gross production value from mutton amounted to R2 588 million. Gross value from mutton production is mainly determined by price and quantities produced (DAFF, 2011).The wool industry employs more than 35 000 workers (DAFF, 2010). Wool production is labour intensive in shearing which significantly increases the overhead costs.

The red meat industry contributes significantly to the economy of South Africa and should remain like that in the future (BFAP, 2016). South Africa has a large population moving from low to middle class income earners and as a result, meat consumption is increasing. The red meat industry face numerous challenges that include; disease outbreaks, stock theft, droughts, land degradation and competition from cheaper products such as poultry (white meat).

South Africa has an abundance of natural resources that support livestock production systems (Landman, 2013). There is an opportunity to increase production scale. However, the stocking rates needs to be in balance with the carrying capacity of the veld to prevent overgrazing which can lead to veld degradation. Most land degradation occurs mainly due to overgrazing; a major challenge mostly experienced in communal homelands areas. Farmers should practise rotational grazing because it allows vegetation to complete its morphological processes. Lastly, a challenge facing livestock production is water shortage.

2.3.2 Domestic production of livestock

South Africa has approximately 70% of suitable agricultural land for extensive livestock production. Livestock production systems dominate the country's agriculture and use a significant quantity of marginal land (southafrica.info, 2016). Livestock production is common throughout the country, but certain provinces dominate in livestock numbers, income generation, job creation and land use. Climate, availability of underground water and grazing pastures are essential determinants of livestock production in South Africa.

Cattle, sheep, goats, pigs and chicken are amongst the most common livestock animals produced in South Africa. These animals vary throughout the country. The Eastern Cape, Free State, Kwazulu-Natal, Limpopo, North West, Mpumalanga and Northern Cape are the main producers of beef cattle, respectively (AGRI-SETA, 2010). Climatic conditions in these provinces are suitable for cattle production. The Free State, North West, Kwazulu-Natal, Eastern Cape, Western Cape and Mpumalanga are significant producers of dairy cattle (AGRI-SETA, 2010). South Africa produced 2 650 million litres of milk between 2010 and 2011 which is estimated at 0.5% of milk produced globally (DAFF, 2012).

The Eastern Cape, North West, Mpumalanga, KwaZulu-Natal, and Free State are significant producers of both beef and milk cattle. According to statistics, there are 27 popular livestock breeds in South Africa (South Africa yearbook, 2012-2013). Relationship of livestock to their environment is important. Livestock are water dependent and climate change is a challenge in South African agriculture. The Karoo region is semi-arid and receives very low rainfall. Studies reveal that indigenous livestock breed such as Afrikaner, Nguni and Bosmara, Damara sheep, Red-headed Boer goats, White Savannah and Kalahari Red sustain and adapt in water shortage conditions (South Africa yearbook, 2012-2013).

In 2011, Mpumalanga province accounted for 23% of the 14.1 million cattle in the country, making it the largest producer of beef cattle. Whereas Free State and Gauteng accounted for 20% and 13% respectively, making them second and third largest producers. Commercial producers own 60% of those beef cattle (South Africa yearbook, 2012-2013).

Cattle numbers have been increasing in Mpumalanga; in 2007 there were 5 278 785 of which 4 404 485 were for beef and the remaining were for milk production (Census of commercial agriculture, 2007). Beef production fluctuated above 700 000 tons per year between 2012 and 2014, and increased to 800 000 tons per year after 2014. Projections are that beef consumption will remain at 800 000 tons until 2024. It will be only a slight increase from previous years, due to competition coming from cheaper meat protein alternatives, chicken and poultry (BFAP, 2015).

Production of sheep and goats in South Africa utilises about 590 000 km² of land (Landman, 2013). The Eastern Cape, Northern Cape, Free State, Western Cape and Mpumalanga are major sheep and goats producing regions (AGRI-SETA, 2010; South Africa yearbook, 2014-2015).

Sheep production face challenges such as outbreak of diseases, drought occurrences, predators, stock theft, high feed prices and high labour costs (Landman, 2013). South African sheep numbers decreased, between the 1970s and 1990s, from 32 million to 30 million heads, and stabilized at 24.5 million in 2011 (Nchor, 2011). DAFF (2011) states that 86% of the 24.5 million sheep heads are found in the Eastern Cape, Northern Cape, Free State and the Western Cape. Current commercial sheep farms are estimated at 8000 (South African yearbook, 2014-2015), producing wool, meat and milk. Sheep meat production fluctuate at 100 000 tons between 2012 and 2015 and is projected to remain the same until 2024 (BFAP, 2015)

Gross value of animal products contributed 49% to total gross value of agricultural production between 2013 and 2014 (DAFF, 2015). Table 2.2 shows the gross value of selected animal products.

Table 2.2 Gross value of selected animal products in South Africa from 2008 to 2014

Year	2008/09 R(x)1000	2009/10 R(x)1000	2010/11 R(x)1000	2011/12 R(x)1000	2012/13 R(x)1000	2013/2014 R(x)1000
Wool	1 083 604	1 415 246	1 607 481	2 087 639	2 435 839	2 740 676
Mohair	197 249	202 947	216 730	227 855	291 053	423 926
Cattle and slaughtered calves	13 658 886	15 065 757	16 146 715	19 297 479	20 495 591	22 717 904
Sheep and goats slaughtered	3 394 898	3 596 053	3 987 079	4 526 435	4 648 444	5 404 750
Other livestock products	4 159 198	4 325 054	4 723 501	5 323 219	5 588 080	6 060 993

Source: DAFF (2015)

Figure 2.3 depicts variation on average auction price of merino wool and other wool sheep breed and the reason for price variations might have been due to high preference of merino wool relative to other wool due to its good quality.

Figure 2.2 illustrates that annual wool auction sales peaked at 3 billion Rand.

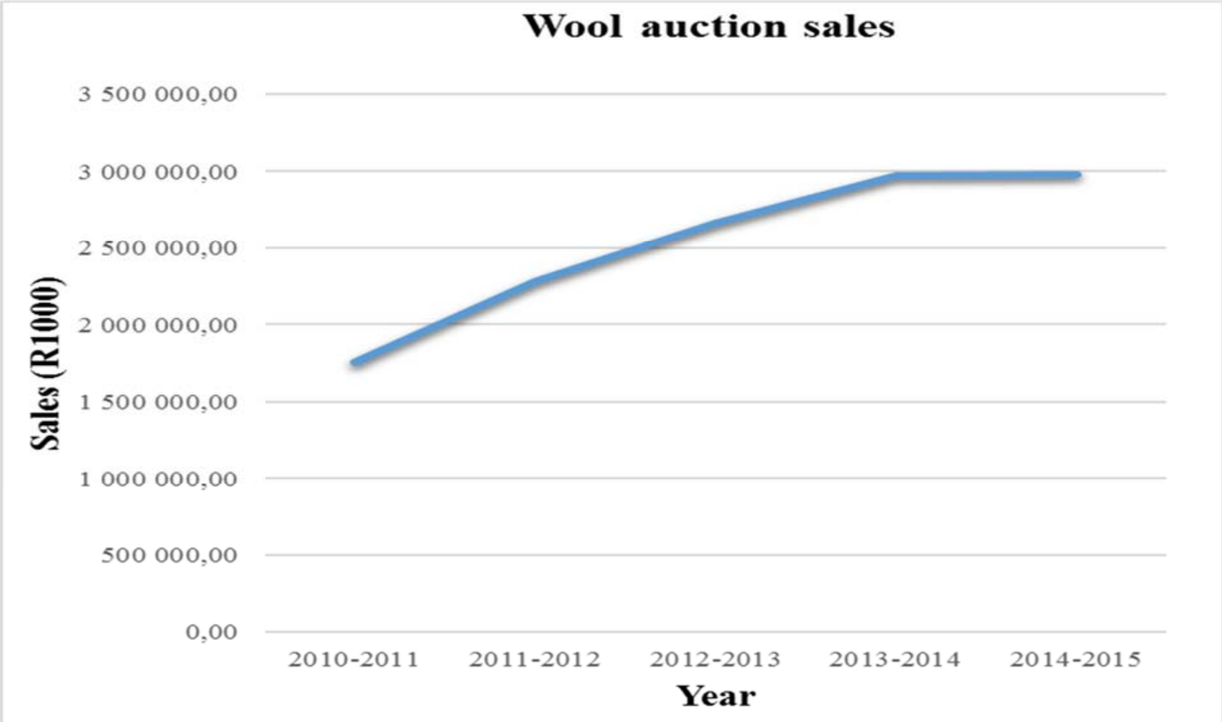

Figure 2.2: Wool auction sales from 2010 to 2015 in South Africa
Source: DAFF (2015)

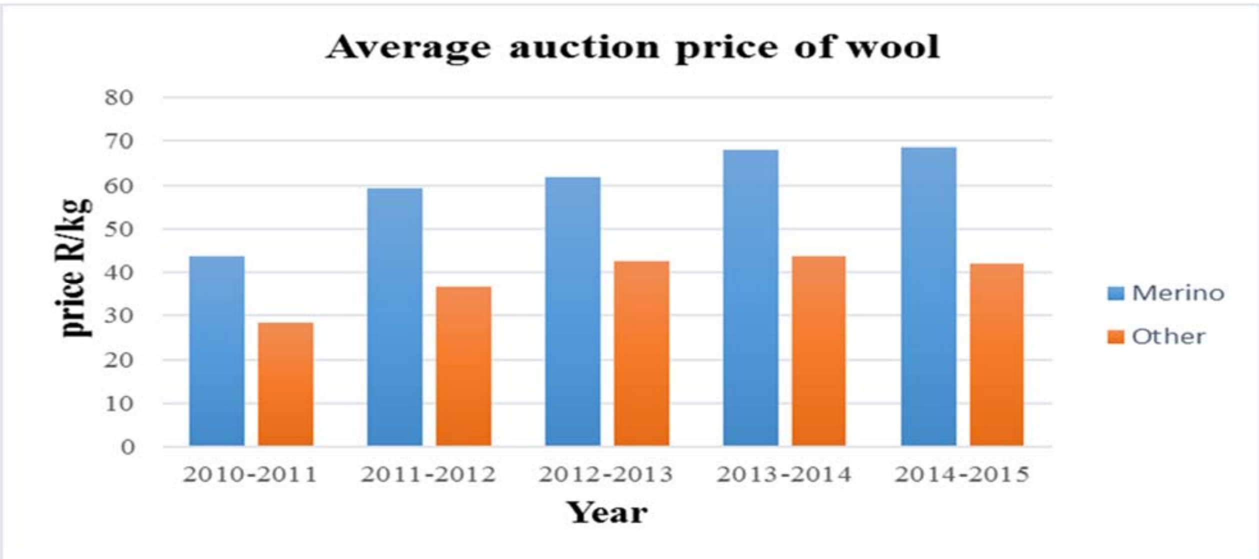

Figure 2.3: Average wool auction price in South Africa from 2000 to 2015
Source: DAFF (2016)

Table 2.3 depicts that cattle, sheep, goats, pigs, chickens and other poultry numbers in 2016 was 66 171 194. The statistics shows the importance of poultry and livestock sector to the economy of South Africa.

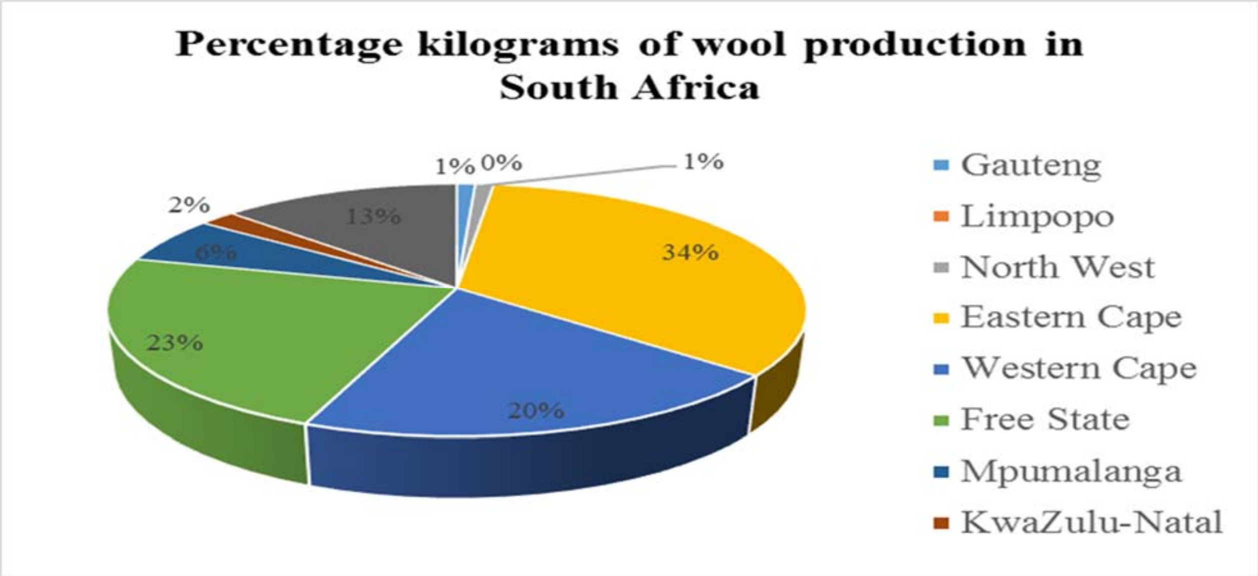

Figure 2.4: Wool production between 2013 and 2014
Source: DAFF (2015)

Table 2.3 Numbers of livestock at household level in 2016

Province	Cattle	Sheep	Goats	Pigs	Chickens	Other poultry
Western Cape	692 495	2 282 396	182 669	104 979	295 507	185 187
Eastern Cape	2 819 086	7 605 248	3 221 829	536 108	3 841 174	291 982
Northern Cape	591 607	4 279 133	554 254	13 099	314 007	120 833
Free State	1 869 583	2 509 463	131 532	148 470	1 056 509	73 197
KwaZulu-Natal	2 498 209	549 943	1 930 175	201 826	6 406 289	170 632
North West	2 207 342	840 180	538 991	127 078	2 128 239	95 856
Gauteng	509 804	217 406	202 091	141 650	1 911 589	129 978
Mpumalanga	1 508 508	945 118	337 217	194 238	1 938 282	143 835
Limpopo	1 237 493	250 279	731 888	135 369	4 056 632	164 714
South Africa	**13 934 125**	**19 479 166**	**7 830 644**	**1 602 816**	**21 948 229**	**1 376 214**

Source: Stats SA (2016)

Table 2.4 indicates that in 2014, 21 202 000 sheep were owned by commercial producers, comparing this with sheep numbers at household level in Table 2.3, there is a difference of 1 722 834.

Table 2.4: Sheep owned by commercial farmers in SA from 2004 to 2014

Year	Sheep numbers				Total (000)
	Merino (000)	Karakul (000)	Other woollen Sheep (000)	Other Non-woollen Sheep (000)	
2004	11 383	22	4 583	6 301	22 289
2005	11 771	22	4 226	6 217	22 236
2006	11 463	24	4 062	6 396	21 945
2007	11 552	35	4 161	6 176	21 924
2008	11 612	23	4 338	6 022	21 995
2009	11 473	25	4 242	6 177	21 917
2010	11 251	25	4 160	6 057	21 493
2011	11 163	24	4 128	6 010	21 325
2012	11 256	25	4 110	6 036	21 227
2013	11 329	24	4 187	6 049	21 589
2014	11 125	24	4 112	5 941	21 202

Source: DAFF (2015)

2.3.3 Domestic consumption of livestock

Net consumption of red meat in South Africa increased by 3.6% from 1 400 000 tons between 2013/2014 to 1 450 000 tons between to 2014/2015 (Figure 2.5). Net consumption account for total domestic consumption minus losses in transport and distribution networks.

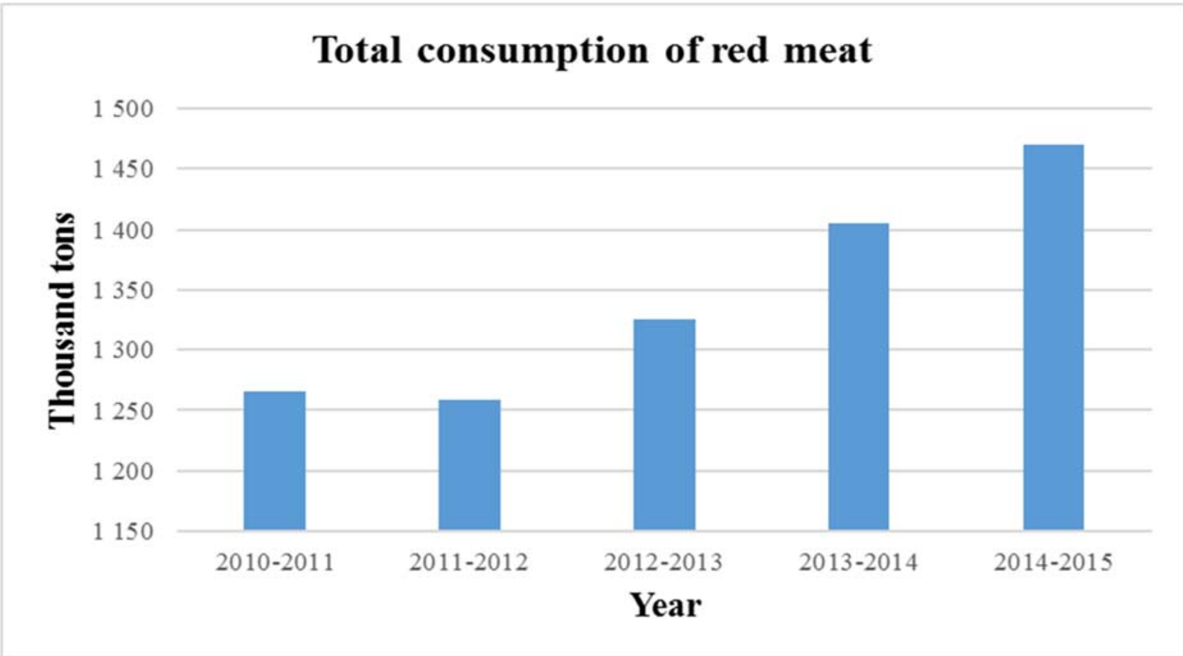

Figure 2.5: Total net human consumption of red meat in South Africa from 2010 **to** 2015
Source: DAFF (2016)

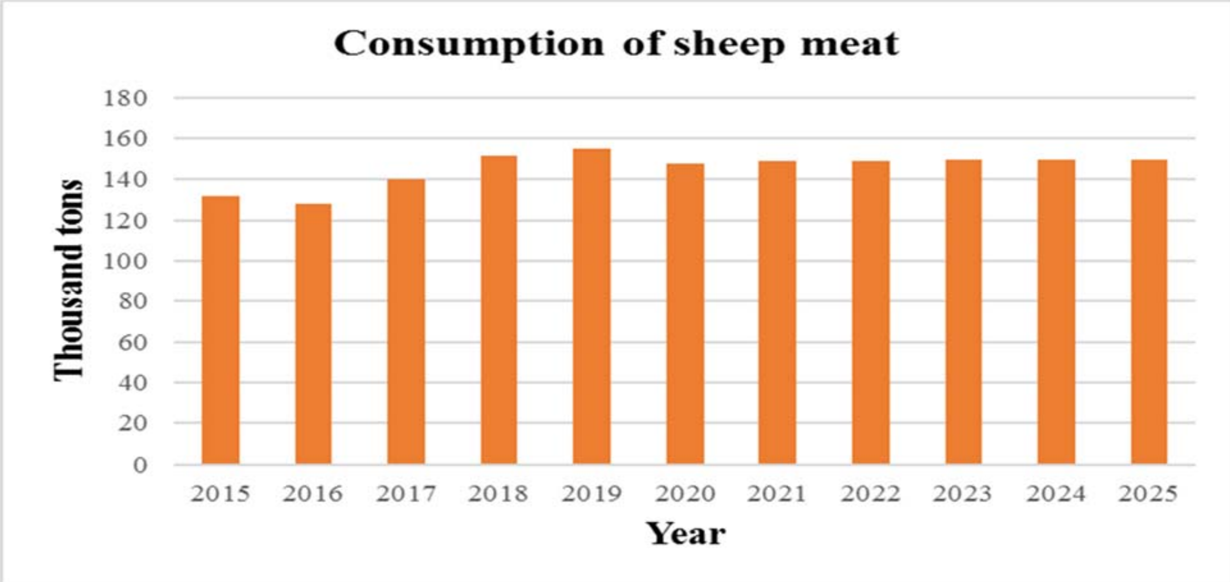

Figure 2.6: South African consumption of sheep meat from 2015 to 2025 projection
Source: BFAP (2016)

Figure 2.6 shows that sheep meat consumption is projected to fluctuate between 140 000 tons and 160 000 tons per annum after 2019.

2.3.4 Global production and consumption of livestock

Prior to deregulation of agriculture, markets and globalization become increasingly important. The United States of America is the leading producer of beef with a current production of 11.8 million tons per annum, which amount to 19% of world production. The European Union, Brazil and China follow with the world's share of beef production of 16.85%, 12.88% and 9.8% respectively. This shows that consumption of beef is increasing on the global scale; significant demand comes from developed countries because of high-income earnings per capita (BFAP, 2015).

BFAP (2015) states that increase in beef production is because of the increases in livestock production. Current global cattle production estimated to be 1.4 billion heads, and is to remain stable in the next few years (BFAP, 2015). Current global commercial dairy cattle heads have increased significantly between 2013 and 2014. The reasons for the increase are due to decreases in mortality rates because of good veterinary services, improved breeding systems, lower feed prices and improved management systems. The Unites States of America accounted for 30.3 million beef cow heads in 2014 (BFAP, 2015).

There are projections that beef production capacity will increase in the near future internationally. This will be a recovery from the decline between 2007 and 2009 where it dropped from 58.6 million tons to 57.4 million tons. In 2015, beef production rose to 59.2

million tons (BFAP, 2015). The decrease was caused by drought experienced mainly in the major grain producing countries in the developing world. Oil prices also increased sharply which resulted in higher prices of agriculture inputs, such as fertilizers required for grain production. Grain is an essential stock feed. Increase in oil prices also increases transport cost that increase agriculture costs in general. The projection of increases in global meat production of 10%, could hold if feed prices remain stable.

Meat markets are important for various countries and they depend on the extent of policies. The proposed Trans-Pacific Partnership has the potential of increasing meat trade and diversification of risk in the meat business. In the South African context beef consumption is expected to increase by 27% to 850 000 tonnes while poultry consumption its close substitute is projected to increase by 50% reaching 2.56 million tonnes by 2022 (BFAP, 2016). The variation in consumption between the two is a result of the relative affordability of poultry as an alternative source of protein. In the last ten years meat consumption in South Africa has increased rapidly, driven by increased consumer disposable income, urbanization, improvements in standards of living and changing consumer dietary needs and tastes (BFAP, 2016).

In 2013, global beef consumption increased by 0.73% to 57.2 million tons in 2014. With the United States of America consuming the largest share of 11 million tons produced, 20% of world consumption. Brazil, China and the European Union consumed 13.85%, 3.5% and 11% of the world’s share of consumption respectively (BFAP, 2015). The United States of America, Brazil, China and the European Union are significant consumers and producers of beef. This is because of the presence of a large number of middle class consumers, advanced technology and improved agriculture with top class management systems (BFAP, 2015).

Global sheep numbers were 1.18 billion in 2013, and currently China has 187 million heads making it the largest producer and is projected to increase its sheep heads at an average rate of between 1% to 1.62% for the next five years (BFAP, 2015). The European Union produces 96 million heads of sheep, while Australia and India produce 150 million heads combined with each accounting for an equal share. However, sheep heads have decreased in the EU and Australia at a rate of about 1.62% and 3.4% respectively in the previous five years, mainly because of climate change leading to drier conditions within those countries. Projections are that in the next few years, global sheep numbers will rise and a significant contribution will be imminent from developing countries (BFAP, 2015).

The wool industry has an important role in the global economy. In the 1980s, China dominated the global wool production, and in 2010, its wool production quadrupled from 100 thousand tons in 1961 to 400 thousand tons (Massy, 2011). The increase was due to a rise in the global demand. Between 1980 and 1994, Chinese wool manufacturers increased sharply in their technological advancement leading to an increase of import of 17.8% per annum. This was due to increases in domestic demand because of a rise in household incomes (Bardsley, 1994).

In the 20th century global wool prices rose sharply because of increase in quantity demanded and later stagnated because of competition from inexpensive synthetic fibre and cotton. This adversely affected the Australian wool industry which is a major driver of world wool prices (Massy, 2011). China, Italy, Turkey and Pakistan are significant producers and importers of wool following Australia, their total imports account for 76% of global wool trade. China alone accounts for 58% of global wool imports (BFAP, 2015). Wool production has been increasing significantly since 2008, responding to rising wool prices (BFAP, 2015).

In the South African context, 2004 was the worst year in the country's history of wool production; production was 18% lower than the preceding three decades. South African wool is amongst important sheep products that has a significant contribution to farm income. Return on wool investment is currently plus or minus 30%, because of high labour costs in wool shearing (BFAP, 2015). Moreover, pressure has also come from depreciation of the rand and losses from vermin. On the other hand, the weakening of the Rand can benefit the South African wool industry by boosting exports prices in the short run. Increase in exports would mean that South African farmers would have the potential to generate higher income returns from foreign earnings (BFAP, 2015).

Global mutton production was 8.7 million tons in 2014. Currently, China's production is 2.1 million tons and it is the largest producer accounting for a quarter of global production. Projections are that Chinese demand for mutton will rise in the near future and potentially increase its production (BFAP, 2015). There is also a projection that Australia will increase slaughtering of its breeding stock, which will decrease its mutton production and could pave way for lamb production. New Zealand's mutton production decreased in 2013 mainly because of harsh and deprived production standards. In 2014, the EU and New Zealand mutton production was 900 000 and 620 000 tons respectively (BFAP, 2015).

2.3.5 Challenges facing the wool, sheep and beef industries

As stated in the previous sections, the world wool price rose significantly during the twentieth century because of increasing demand (Conradie et al., 2013). Since Australia dominates world wool supplies, its corporate association introduced the wool reserve price as a stand attack and was an effort to calm world wool prices on the other hand (Bardsley, 1994). The association faced challenges in setting wool prices since its wool producers administered it (it sets high standards that decreased wool prices to 700 cents per kilogram). The reason for significant price decreases were due to high levels of built up stocks (Richardson, 2001). This affected global wool industries largely; mainly because Australia account for a larger share of global wool production and therefore drove the world wool prices down and it is still driving wool prices. The period is termed, "Australia's biggest business disaster" (Massey, 2011). In South Africa wool prices declined from R60 to R40 per kilogram because of the aforementioned scheme's consequences. This also resulted is an unstable relationship between the Rand and wool, and prices fluctuate between R20 and R40 per kilogram, *inter alia* contributing to rising mutton prices of 0.38% per year (DAFF, 2011).

In South Africa, lamb and mutton production is mainly on extensive grazing systems. BFAP (2016) states that significant reduction in flock numbers are experienced on producers with limited pastures; reducing ewe numbers. On the global context, during the first quarter of 2016, sheep producers also reduced their finishing of lambs compared to 2015; as a result, a projection is that the price of lamb will increase but only slightly by end of 2017.

Most of the challenges that the South Africa's beef industry face come from increase of production costs, unpredictable droughts, livestock diseases, stock theft, food safety legislation, decreasing beef supply and profitability. External factors such as un-solidified and volatile national political environments and the reduction in foreign direct investment also put pressure on the industry (Phillips, 2013).

2.3.6 Extensive sheep production in Karoo

The Karoo area experiences water shortages because of low mean annual rainfall and high temperatures. The Karoo is a semi-arid region. Its climate conditions result in goats and sheep being the most viable livestock enterprises. Shortage of rainfall and underground water, predation, stock theft and longer distance to markets are amongst the challenges facing livestock producers. Historically shortage of irrigation systems and large capital required for water reservoir construction were considered as the major challenges (Conradie, Piesse & Thirtle, 2009).

Karoo livestock numbers exceeded its grazing capacity in the past years (Roux, 1981). A balance of stocking rate and veld carrying capacity is paramount in livestock systems. Overstocking causes overgrazing resulting in degradation of biodiversity and loss on investments. Degradation of biodiversity can ultimately contribute to climate change, resulting in erratic rainfall and unsustainable farming systems in the future.

During the past decade, Karoo sheep production systems were characterised by low productivity growth. This resulted to the industry failing to keep up with weakening terms of trade. Pressure also came from the promulgation of animal welfare legislation. This caused a robust, adverse relationship between share of extensive sheep output and total factor productivity performance (Thornton, 2010). These challenges meant that urgent decisions were needed. Laingsburg and Prince Albert are amongst the regions that responded rapidly, with some sheep farmers moving to horticulture systems and other alternatives. In the early years of the change in land use, from livestock to other alternatives, preserved fruits, wine and vegetable products contributed three% of the region's output from Laingsburg, and later rose to 37% after some years (Conradie et al., 2013).

On the other hand, products such as canned fruits, wine and vegetable from Prince Albert contributed 16% of the region's output by the end of 2002, from 5% in the 1950s (Conradie et al., 2013). Shifting away from low productivity entails management efficiency and effectiveness in decision-making process is important. Farm managers need to adjust to new systems and novel ideas. However, time invested to start generating significant outputs shows switching between systems requires investment in human capital.

Switching from sheep to fruit production in the Karoo, results in sheep cooperatives expanding to include fruit grower services (Conradie et al., 2013). Cooperatives have significant contribution to the generation of better ideas, access to finance and economies of scale from selling products and buying inputs.

Numerous factors force Karoo sheep producers to consider other land uses, this include climate, topography, workforce education and changing of market conditions (Conradie et al., 2009). Historically the Karoo area lacked the technological innovation. Breeding systems were improving, but with low rates, while sheep survival increased due to improvements in veterinary services (Conradie et al., 2009).

Free grazing on natural veld and pasture is one of the cheapest ways of producing sheep (Louw, 2012), but challenges come from sustainability and profitability aspects (Landman, 2013). Profitability in sheep systems is determined by kilograms of wool, lamb and mutton per hectare and per Rand invested (Warn et al., 2006), which depend on quality of management and food supplements (Coetzee, 2010). In these systems, lambs are most vulnerable. Challenges come from lack of adequate food, exposure to harmful conditions such as climate, and high risk of predation and diseases. Some of these problems can be averted by providing shepherds. Shepherding is useful in extensive systems, but increases labour costs (Goddard et al., 2006). Other challenges in sheep systems come from lameness; predominantly due to foot rot, endoparasites and ectoparasites causing chronic stress and pain to the flock (Dwyer & Bornett, 2004). It is important for extensive systems to keep sheep breeds that have a high genetic resistance.

The choice of a sheep system is determined by the availability of market for products; wool, mutton and lamb as well the efficiency of a production system. Intensive systems require high lambing percentages compared to extensive ones in order to be profitable. There are factors that determine the choice of a production system which include the availability of feed, type of veld and carrying capacity. Smaller farms require high lambing percentage to be profitable and thus more intensive management (Smith, 1999).

<u>Extensive sheep systems on range land</u>

Extensive systems are mainly associated with high rates of predation and stock theft, this implies that exceptional management is a prerequisite (Botha, 2009; Van Niekerk, 2010; Nel, Van Pletzen & Groenewald, 2010; Kingwill, 2011 & Wessels, 2011). An estimated 80% of South Africa's livestock land use is under extensive system (PGSA, 2010; Anonym, 2009). Extensive systems are subject to high mortality rates due to the aforementioned factors. These systems mainly requires a production rate of one lamb per ewe per year in hot summer and cold winter conditions (Nel, 1980; Calldo, Melville & Calldo, n.d.). Lambs are ready for the market in autumn when their average body size reaches the range of between 35-40 kilograms (DURAS, 2008). An extensive system normally has higher mortality rates because of less human involvement in monitoring.

<u>Semi-extensive production system: natural veld and irrigated pastures</u>

This system requires additional feed supplemented by irrigated pastures, to lug ewes throughout winter or to use fodder strategically during the lambing period (Landman, 2013).

Merino sheep production mainly utilise this system, ewes and lambs are kept on grass during wintertime. Usually, lambs are sold straight off the veld in February. Purchasing and maintenance of pasture is on a yearly basis, however, this increases production costs (Smith, 2004).

Intensive sheep production: irrigation pastures and silage system

The intensive system with irrigated pastures requires a high stocking rate as well as good animal health and excellent management to aid the financial viability (Coetzee, 2010). Wool production is 70% more than in a natural veld system (Bezuidenhout, 1987). Furthermore, the wool fibre thickness is resilient (Calldo et al., n.d.). Upgrading pastures and provision of essential structures increase wool profitability through increasing the value of wool more than costs (Hall et al. 1997). Irrigation systems increase production but there is a need for efficient ways in order to reduce water costs. Due to the semi-arid nature, this is not common for the Karoo.

The silage system is a novel idea in South African sheep production; many farmers have not yet adopted it and are still resisting. The silage system is mainly suitable in areas that rely on irrigation systems (Landman, 2013). Silage is a livestock feed produced from maize and peas. Its major advantage is it can be stored for a long period after harvest and used later. The system requires provision of feed on a daily basis and sheep live in kraals, so there is no need for larger spaces (LPP, 2006). The silage system is labour intensive and this reduces returns (Hutton, 2008). Silage can be bought when its price are low and used in the future; this means profitability can be improved. The lack of sufficient rainfall and /or irrigation water would disqualify this system for the arid Karoo area. A bulky commodity, like silage, will also be too expensive to transport from the main irrigation areas, because of the remoteness of this area.

2.4 Overview of South African game industry

2.4.1 Importance of game farming industry

South Africa's game farming industry has registered significant growth since 2000, yielding numerous benefits to the economy. It contributes to the physical, economic and social facets of the country. Close to R20 billion is generated annually (Brink et al., 2011; Berem, 2015). However, contrary to the aforementioned, in 2010 it contributed about R7.7 billion to agriculture's contribution to GDP (Bothma & Du Toit, 2016).

Game farming restores the natural environment relative to livestock and crop production systems, given that farmers maintain sustainable stocking rates. In addition, sustainable game farming promotes the survival of species (Broughton, 2016). There are also benefits from consumption perspectives, ranging from provision of healthy foodstuff in the form of high quality meat which has a low fat content (Lana, 2016), to benefits from improved hunting and tourism services.

The presence and emergence of game farming activities can potentially result in development in rural communities. The development can be in the form of training and employment of the neighbouring communities, construction of roads, rural electrification and telecommunication systems of which this development rarely take place in the livestock producing area. Game farming activities employ three times more people than livestock. More than 100 000 jobs have been created as a result of game farming practises (Steyn, 2012). Game farming contributes to financial progress in community development in the case of the creation of conservancies (Bothma & Du Toit, 2016).

South Africa consists of a wide variety of game species that attracts overseas tourists and clients. An estimated income of between R60 million and R200 million was generated from international tourists and clients in 2014 (Gouws, 2014). In 2013, R7 million came from the export of blesbok; kudu; impala; and springbok meat to Europe (Van der Merwe 2013). This increase in income provides evidence for the progression of the economic contribution of game activities.

Game farming links with other industries because of several economic activities. According to Broughton (2016), 80% of local tourism income come from hunting and eco-tourism activities. Ecotourism activities include game drives, sightseeing and photography. Ecotourism activities contributed 4.75% to the game industry's gross income in 2002. Game farming is an upcoming industry with more growth potential. The reason is that South Africa is a favourable tourist destination in Southern Africa and Africa (Broughton, 2016).

Hunting is an important economic pillar of the South African game farming industry. It is a culture of harvesting wildlife using rifles, bows and other essential means to obtain trophy, fresh meat, biltong and salamis. Trophy and biltong hunting are the chief hunting activities in South Africa. Trophy hunting involves harvesting of wildlife for horns and skins, while biltong hunting involves harvesting wildlife for meat (Van der Merwe, Saayman & Krugell, 2004). International hunters, mostly prefer trophy hunting, while biltong hunting mainly caters for local clients. Biltong and trophy hunting activities generated R6.6 billion between 2009 and 2010. In 2007, recreational hunters in the Northern Cape alone generated R600 million (Bothma & Du Toit, 2016). The numerous activities within the game industry create the need for large investment capital, efficient management, proper decision-making tools and good relationships with stakeholders. These factors are important in maintaining and promoting sustainable and profitable operations.

Hunting activities vary within provinces in South Africa. Limpopo is currently the leading hunting destination (Steyn, 2012). Hunting activities in Limpopo contribute R2.6 billion of its economy annually. An estimated 9 700 jobs have been created by hunting activities in this province (Steyn, 2012). Hunters prefer different species and hunting prices vary between animals. International hunters prefer sable antelopes. Prices for hunting are often segmented between international hunters who often pay more than local hunters (Steyn, 2012).

Local biltong hunters prefer to hunt impala, springbok, kudu and eland. They pay lower prices compared to those paid by international clients who, mainly prefer trophy animals. In the Eastern Cape, hunting income contributes close to 60% of the income generated by the game industry. In 2005, R274 million was generated which increased to R392 million in 2009; projections are set to generate more income in the province (Steyn, 2012).

Markets play an important role in the game industry. The South African game industry relies on private and auction markets. In 2012, live animal auction sales realised above R900 million and private sales are estimated to have generated more than double that. Income from private animal sales grew by 42.4% between 2009 and 2012 (Bothma & Du Toit, 2016). However, it is important to note that live animal sales are characterised by high costs involved in the capturing of animals and feeding costs. Wildlife operations in general contributed 14.58 units to the economic employment multiplier in 2013 and this include both private and public wildlife operations (Cloete & Rossouw, 2014). Game farming generated an estimated income of R 4.7 billion per year since 2006 (Dry, 2009; NAMC, 2006). Statistics show that private wildlife contributes a larger share of the wildlife income, while state owned national parks and game reserves account for an insignificant amount. Table 2.5 indicates the revenue generated by the sector and gives clear evidence of its importance to the economy of South Africa.

Table 2.5: South Africa's wildlife income by some of its subsector's in 2014

Subsector	Income
Hunting industry (amount includes only value of animals, it exclude lodge costs, food and hunting fees	R2.6 billion
Private live sales	R2.5 billion
Live animal sales both private and public	R4.3 billion
Meat production	R610 million

Source: Adapted from Endangered Wildlife Trust (2016)

2.4.2 Domestic production of game

The major game producing areas are Limpopo, North West, Mpumalanga, Free State, Eastern Cape, Karoo and Kalahari areas in the Northern Cape and the thorn shrub areas of Kwazulu-Natal. The Karoo area is the six largest producer in the Western and Northern Cape (SouthAfrica.info, 2008; AGRI-SETA, 2010).

There are numerous views to the development and origins of game farming in South Africa. The history of private wildlife, in general, dates back to the 1960s (Steyn, 2012; Du Toit, 2007). It is important to note that wildlife did not have the monetary value then, as it does currently. Despite this, game farming was important, even then, currently it is regarded as an economically viable agricultural system. It is still in an early phase of development compared to other livestock sectors. As a result, efficiency gains would bring further significant economic benefits to the country. The South African government recognised game farming in 1987, and accepted and acknowledged it as an important agricultural activity that has the potential of improving the economy (Gouws, 2014). The number of game farms and species today in South Africa are more than in the 1960s, and currently South Africa has about 16 million game animals on game farms (Gouws, 2014).

Game farming has more real value in the 21st century compared to the beginning of the previous century, mainly because of its recognition and support from the government. This has resulted in the establishment and development of private game farms. Other reasons are establishment of well-defined property rights to own land. Land ownership is amongst one of the drivers of the private wildlife industry in South Africa supported by the availability of a variety of wildlife resources that motivate and give a platform to capitally strong investors. South Africa has a well-developed market, infrastructure and communication systems. Availability of conducive markets promote local and international demand of wildlife goods and services such as tourism, venison meat and trophies. Markets support and sustain the industry through generating viable returns (Krug, 2001).

South Africa's game farming industry has grown in terms of; size of land utilisation, economic aspects and number of producers. According to Gouws (2014), significant growth occurred after 2008. Cloete et al. (2007) states that the area occupied by game farmers who have permits increases at an average rate of about 5.6% per year.

South Africa is a country with an abundance of arid and semi-arid dry agricultural land that has not yet been utilised to its full capacity. That land is mostly suitable for livestock production. This implies that the country's economy has the potential to grow further if the land can be utilised for game farming. As stated by Gouws (2014), game farming has the potential to utilise 80% of the country's marginal land that is under livestock use of this land, currently 20% is under actual game farming practices.

Private wildlife systems occupy 13% of agricultural land. These systems comprise of 5000 game farms and more than 4000 mixed game and livestock farms, while state owned systems utilise 6.3% of agricultural land (ABSA, 2003; Palmer et al*.*, 2006). The difference in share of agricultural land between these distinct wildlife systems explains and shows the importance of private wildlife to the country's economy.

South Africa had 10 000 game farms in 2013 of which 6 000 were exempted to operate after having been approved of having acceptable fencing meeting the legislative requirements. However, the remaining 4 000 did not qualify for operational exemptions since they did not pass the requirements (Bothma & Du Toit, 2016). Game farming requires large capital investment mainly in game fencing, purchasing of stock and developing farm systems. Fencing is the most expensive infrastructure requirement that inhibit farmers from operational exemptions, as most farmers lacks finances. As a result, capitally strong and lifestyle investors more commonly participate in game farming.

Current game farm numbers are estimated to be 11 500 occupying 20 million hectares of land (South African yearbook, 2015-2016). These farms contain four times more animals compared to those found in state owned game reserves and national parks (Gouws, 2014). In general, wildlife operations, both private and state-owned systems, use close to a third of potential livestock grazing land (Bothma, 2002). On the other hand, wildlife operations (state and private) use far less land than that used for livestock production.

Wildlife numbers increased from 575 000 in the 1960s to 19 million heads in 2007 (Carruthers, 2008) and in 2013 it was close to 18 million heads (Bothma & Du Toit, 2016). Increases were associated with herd building and developments in breeding systems. This was also due to increasing investment in research and development, better veterinary services and availability of veld for grazing. The decreases experienced between 2007 and 2013 were due to decrease in demand because of the 2008 worldwide economic recession. The recession resulted in depreciation of the Rand resulting in game products and services becoming more affordable to overseas clients.

According to Van der Merwe (2013), private game farmers owned 16 million heads of game, while four million belonged to the state. This gives 20 million animals in South Africa in 2013, a more optimistic figure than 18 million suggested by Bothma & Du Toit (2016). Table 2.6 displays a profile of investors and ownership of game species in South African farms. Educated, informed and capitally strong people invest the most in game farming. Half of these individuals possess academic qualifications.

According to (Steyn, 2012), the breeding of high valued species such as sable, roan antelope, buffalo and rhinoceros receive more investment preference; these species attract wealthy business investors. In addition, investors that understand the stock exchange have more incentives to invest in game business, as they are aware of the potential of generating high returns.

Table 2.6: A profile of game investors and game ownership as projected until 2025

Category of species	Percentage share
Higher value species (sable &roam, antelope &disease free buffalo)	30%
Plain species	25%
Species such as nana, lechwe & bontebok	40%
Colour variants	5%

Source: (Dry, 2015)

2.4.3 Domestic use of live game

The peak of wildlife auctions were in 2014 and 28 000 animals were sold as indicated in Figure 2.7. Generally the numbers fluctuate between 15 000 and 28 000. According to Taylor et al., (2016), buffalos sell most highest values followed by sables, while Impala and blue wildebeest sell for the least value.

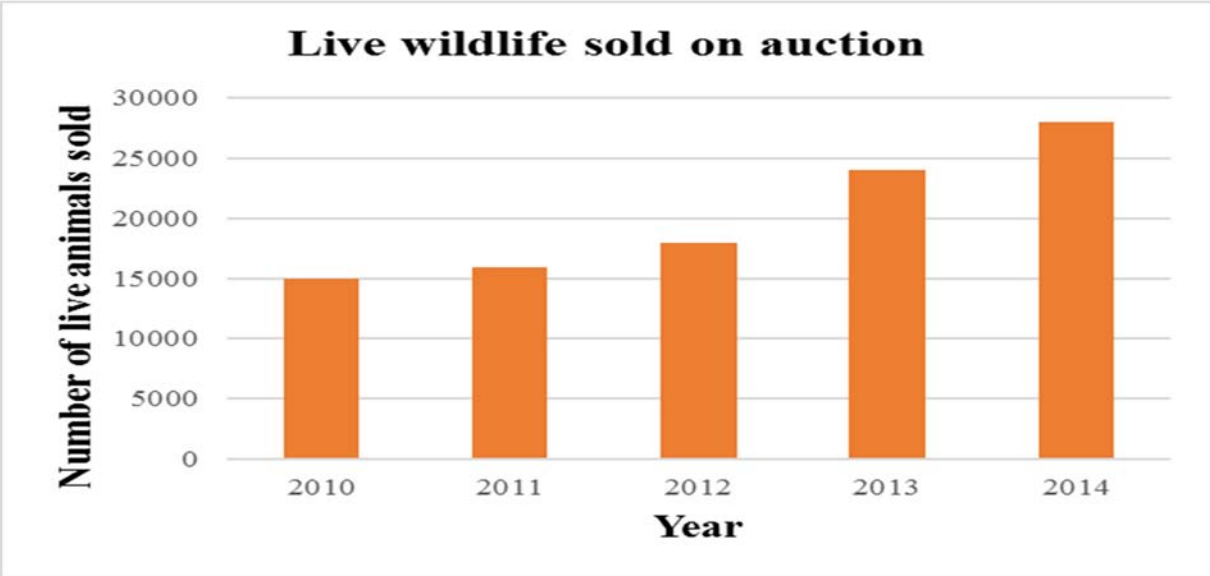

Figure 2.7: Numbers of animals sold on South African auctions from 2010 to 2014
Source: Taylor, Lindsey & Davies-Moster (2016)

2.4.4 Western Cape wildlife production areas

Statistics pertaining the size of wildlife producing farms in the Western Cape is displayed in Table 2.7. An overall of 265 205 hectares were occupied by wildlife farms. Table 2.7 illustrates the importance of the Central Karoo as a game farming area within the Western Cape Province.

Table 2.7: Land occupied by wildlife farm in the Western cape in 2011

Area	Size of land in hectares
Cape Winelands	73 885
Overberg	83 150
Eden	58 520
Central Karoo	206 677
West Coast	28 315
Cape Metropole	3 559
Other municipality areas	18 460

Source: Van Hoving (2011)

The number of wildlife (units) farms in South Africa and their size in hectares is presented in Table 2.8. 10 364 154 hectares of agricultural land were utilised for commercial use and the number of wildlife units were 5 061 in total.

Table 2.8: Wildlife producing units in 2011

Province	Number of wildlife producing units/private farms	% of total wildlife production units	Size in hectares	% of total area	Average size Of units
Free state	180	3.56%	147 743	1.43%	821
Limpopo	2 482	49.04%	3 325 652	32.09%	1 340
Northwest	340	6.72%	364 935	3.52%	1073
Mpumalanga	205	4.05%	276 016	2.66%	1346
Gauteng	72	1.42%	82 076	0.79%	1140
Kwazulu Natal	90	1.78%	168 841	1.63%	1876
Eastern Cape	624	12.33%	881 633	8.51%	1413
Northern Cape	986	19.48%	4 852 053	46.82%	4921
Western Cape	82	1.62%	265 205	2.56%	3243
Total	5061	100.00	10 364 154	100.00	2 047

Source: Van Hoving (2011)

2.4.5 Typical Karoo game production systems

Intensive and extensive systems are notable game farming systems practised in the Karoo region in particular, and in the Western Cape Province in general. Intensive systems rely mainly on the influence of people for efficiency. Human activities are essential in performing daily operations. The operational responsibilities include administration of the system, continual supply of feed, health monitoring, breeding planning, predator control and strategic planning. Intensive systems usually involve farming with a few species enclosed in a fenced smaller piece of land. The animals can include plain, rare and high value species, depending on the owner’s choice, climatic conditions, vegetation and legislative requirements (Bothma, 2002). Intensive systems are characterised by high running costs that come from feeding and labour which have impact on profitability. Profitability in this system is a function of availability and affordability of feed, management efficiency and effectiveness.

On the other hand, extensive systems are characterised by self-sustenance of animals with very little human involvement. The animals depend mostly on themselves on natural grazing and browsing in a large fenced piece of land. Although the Karoo region accommodates both systems, intensive systems are most common (Bothma, 2002). The major challenge within extensive systems is stock theft, diseases, predators and substantial costs incurred mainly when performing game counts. These issues are however mainly a result of little human involvement in daily operations. Losses from animal injuries and illness often take time to notice. These challenges reduce profitability and negatively affect financial performance. Extensive and intensive systems are subject to demand on game products such as meat, skin, feathers, hides and horns, and services such as hunting and tourism (Bothma, 2002). This means that the availability of markets is a prerequisite for sustainability. It is therefore farm management's responsibility to ensure the best services to improve profits.

2.5 Essential components and features of a game farm

This component discuss some key features of a game farm in terms of investment requirements. These are all important factors to consider if one would convert from sheep to game.

2.5.1 Fencing costs

Fencing is amongst the most expensive game farm infrastructure. The cost of erecting game fencing depends mainly on the plan and materials used. These materials are determined by animal type, topography and climatic conditions (Bothma & Du Toit, 2016). In addition to that, the shape of the farm plays a significant role in determining fencing costs, circumference of farms that have the same surface area vary depending on the shape of the farm. For example, circular farms (if they exist in reality) would have a smaller surface area to those that are square, while rectangular shaped ones are the most expensive to construct a fence (Bothma & Du Toit, 2016). An economic shape of a game farm in terms of fencing costs is the square one, with 10 kilometres long sides (Dothma & Du Toit, 2016). In this study, a typical rectangular farm is used and with the information given above it is clear that its fencing costs are high.

2.5.2 Height of game fencing

The height of game fencing is an important cost contributing factor, and it is mainly determined by the type of animals kept in. Game can be categorised into numerous classes in terms of their potential to move under or through fencing. Most animals can choose to cross fencing when they are under some kind of pressure or stress (Bothma & Du Toit, 2016). Therefore, game fencing has to be able to safeguard and prohibit animal movements. Animals such as kudu, impala, eland and waterbuck jump over the fencing while warthog, bush pig, duiker, steenbok, klipspringer, gemsbok, springbok sable antelope, red hartebeest, black-backed jackal, caracal, cheetah, leopards and lions scuttle under or through fencing. On the other hand, huge animals such as African savannah buffalo, white rhinoceros, black rhinoceros, giraffe, waterbuck, eland, blue wildebeest and sable antelope bulls can break through fencing (Bothma & Du Toit, 2016). Game fencing required for animals that jump through needs to be at least 2.25 m to 2.4 m high, with about 17 to 21 strands of wire. However, in game farms that contain animals that dig under the fencing, it is advisable to use diamond pig or jackal wire mesh or to put netting at the foot of fencing. This has the advantage of guarding the movements of predators and keeping them out of the farm. On the other hand, farms with animals that cannot jump fencing should use a 1.5 m mesh fencing with a strand of 150 mm mesh, with another 150 mm above (Bothma & Du Toit, 2016).

2.5.3 Posts

There are three forms of posts mainly used in game fencing, namely straining, line and droppers. Straining posts support line posts and droppers. They can either be made of iron or wood. The posts have certain advantages as well as disadvantages. For example, wooden posts are mostly more protected in sandy or loose soil areas than iron ones, they have a shorter life span and are less resistant to fire. While, iron posts are more resilient to lightning and fire, and can be constructed faster and easier than wooden ones. Their disadvantage however is that they rust quickly in humid conditions and are more expensive to acquire, less secure and are loose in sandy soil areas (Bothma & Du Toit, 2016). In the Karoo region, climate and soil does not have much negative effects on wooden posts.

2.5.4 Wire

High-strain smooth wire, moto champion or frontier campeon wire, veld span, line and strong wires are commonly used. Light and thick galvanized wire is also useful but they depend on climatic conditions. Heavy galvanized wire is useful in humid areas, whilst lightly galvanized wire is useful in dry regions. Other wire types such as smooth high strain is cheaper, easier to erect and more robust, however, barbed wire has the advantage of being more noticeable to animals. Its disadvantage is that it is expensive, challenging to straighten, consumes time and can injure animals (Bothma & Du Toit, 2016).

2.5.5 Electric fencing

Its central purpose is to keep game animals inside the fence and prevent those from outside getting in. Electric fencing can be used alone or in combination with normal wire fencing. It safeguards animals such as elephants, hippopotamus, baboons and predators. Its major disadvantage is that it increases electricity costs. Its efficiency was revealed in a study in the Eastern Cape farm where it was noticed that the activities of black jackal trying to dig holes below the fencing dropped by 93% as a result of the use of a 1,3 m electric fencing (Bothma & Du Toit, 2016).

If one compares the costs of installing electric fencing with its effectiveness, one can conclude that it is cheaper to install. It requires less input for erection, reduces activities of thieves, poachers and animal losses. There are aggressive animals such as giraffe bulls and warthogs that can damage it and in this regard, its usefulness depends on the type of animals kept. Electric fencing experience problems from biological elements such as plants that can grow against the wire, which can cause short circuits, resulting in veld fires. However, these biological developments can be reduced by the use of weed killers which in turn increase weed herbicides and labour costs (Bothma & Du Toit, 2016), but which reduces profitability.

2.6 Converting a livestock farm to a game farm

When converting a livestock farm to a game farm there are important things that need attention. Firstly, the farm has to comply and meet provincial legal requirements. Secondly, fencing requirements are important, as fencing has to meet the requirement criteria of conservation authorities; usually a 2.4 m high fence with 21 strands of wire is typical (Bothma & Du Toit, 2016). In addition, inside fencing, that divides livestock farm into camps and features such as livestock troughs and feeding pens are removed. Game structures such as waterholes have to be constructed. New roads for tourists, cottages, tracks for game drives, firebreaks, capture bomas, holding pens, hunting camps and lookout towers have to be constructed. Other structures depend on the purpose of the game farm and its activities. For the purpose of this project, all the structures are essential. It is also important to train staff and hiring of additional labour has to be within the neighbourhood to develop and improve relationships with the community (Bothma & Du Toit, 2016).

2.7 Conclusion

The chapter provided an overview of livestock and game farming industries, to show trends and importance of these industries to South African and the global economy. The first paragraph describes the nature of the South African agriculture. The importance of the livestock and game farming industries in the South African and global context was indicated. These include job creation, supply of meat protein, community development and conservation of the natural environment. The role of legislation and policy in game farming was analysed. The chapter also discusses the Karoo sheep and game farming systems. Literature reviewed shows that even though extensive sheep system is the cheapest way, its exposure to numerous challenges reduce farm profitability. The chapter concluded by describing and analysing the essential structures and features essential in constructing a game farm and when converting a livestock farm to a game farm. It has been clear that legislation and provincial requirements, lack of resources and complexity in systems are among major constraining factors in joining the game farming industry.

CHAPTER 3
Literature review

3.1 Introduction

This chapter reviews literature on historical origins and the development of wildlife industry from a South African context and an international perspective. The first section outlines and describes the political, socio-economic developments and legislations that shape and influence the wildlife industry. The chapter also contextualizes and reviews empirical studies on wildlife and livestock industries in South Africa and the global context and their relationship with the biophysical-socio-economic and political environment. Existing research on the financial implications of converting from livestock to game farming in South Africa has been given marginal attention. Global studies are thus also reviewed to investigate financial and managerial implications of such a conversion and this will help in re-thinking of alternative strategies. The chapter ends by describing sources of risk, risk balancing and agricultural finance providers in South Africa.

3.2 History and development of game farming in South Africa and African context

In broad terms, the South African game industry is characterised by the phases presented in Table 3.1.

Table 3.1: Stages in the development of wildlife industry

Phases	Features
Pre-modern economy	Use was limited by costs and ability to harvest it
Frontier economy	Control of wildlife was centralized by the state Commercial use was largely restricted and costs of harvesting was greatly reduced by technology
Wildlife is nationalized	Profits increased by market but few rules or norms to control use
Sustainable approach	Utilisation of wildlife by land holders and later by commercial farmers

Source: Child et al. (2012)

Table 3.2: Some of the policies and legislations in the South African wildlife industry

Number	Wildlife Acts
1	Animals Protection Act, No. 71 of 1962
2	Fencing Act, No. 31 of 1963
3	Veterinary and Para-veterinary Professions Act, No. 19 of 1982
4	Conservation of Agricultural Resources Act, No. 43 of 1983
5	Environment Conservation Act, No. 73 of 1989
6	Agricultural Product Standards Act, No. 119 of 1990
7	South African Abattoir Corporation Act, No. 120 of 1992
8	Tourism Act, No. 72 of 1993
9	Marketing of Agricultural Products Act, No. 47 of 1996

Table 3.2 (cont.)

Number	Wildlife Acts
10	Animal Improvement Act, No. 62 of 1998
11	National Environmental Management Act, No. 107 of 1998
12	Animal Health Act, No. 7 of 2000
13	Meat Safety Act, No. 40 of 2000
14	Firearms Control Act, No. 60 of 2000
15	Animal Identification Act, No. 6 of 2002
16	Protected Areas Act, No. 57 of 2003
17	National Environmental Management: Biodiversity Act, No. 10 of 2004 • Hunting Norms and Standards • Threatened and Protected Species • Alien Species • Translocation • Bios prospecting • Environmental Impact Analysis • Tourism Standards National Environmental Management

Source: Dry (2009) & NAMC (2006)

The utilisation of private wildlife in South Africa is through game farming and game ranching practises (Pollock & Litt, 1969). According to Andrew et al. (2013), game farming involves farming with a few wildlife species in an adequately fenced small piece of land for commercial purpose. Pollock & Litt (1969) define game ranching as the keeping and management of a variety of wildlife species on an enclosed piece of land, usually a natural environment where scientific management practices are applied, with no plans of domesticating them. The terms game farming and game ranching are synonymous for the purpose of this study. In addition, wildlife would refer to state owned game reserves and national parks as well as private owned wildlife, while game farming/ranching/private wildlife would mean private ownership and management.

There are numerous ideas pertaining to the origins of game farming in South Africa. There are views that game farming started between 1894 and 1898 in the Transvaal and Zululand, respectively, with animals such as springbok, blesbuck, impala and kudu found on small pieces of land, and in other cases, they co-existed in conjunction with other farming practices (Pollock & Litt, 1969).

The deregulation of the agricultural sector post-apartheid era, and developments in eco-tourism activities together with environmental sustainability programs played a vital role in growing game farming (Zulu, 2015). The role game farming has in South African agriculture was formally acknowledged and accepted in 1987, that is when the state realised its significance to economic growth. The government supported this initiative by allowing full participation after realizing its ability to operate at full capacity (Gouws, 2014). This is one of the important influences from the state. More significant growth within the industry were brought about by the promulgation of the restricted private wildlife ownership policy which was legislatively backed by the Game Theft Act 105 of 1991, amended by Act 18 of 1996 and Act 62 of 2000. Policy and legislation have direct influence in the wildlife industry of South Africa. The passing and signing of the proposed game meat scheme by the South African government, has the potential of enabling significant availability of healthier game meat on the markets. It is also within the intention of the scheme to enable and check the availability for an essential infrastructure for game related activities, such as slaughtering facilities, storage and handling materials (Van der Merwe, 2013).

Carruthers (2010) states that history and development of the private wildlife industry in Africa would be incomplete without acknowledging the works of researchers from America, namely Dasmann & Mossman in1964. Their research aimed at investigating the possibility of the co-existence of livestock and wildlife species on the same piece of land under the same management system. However, before this, a major belief in Africa was that stopping to farm with wildlife would promote livestock production. Furthermore, this would promote other forms of agriculture. The results from the study revealed that the two can co-exist and it adds knowledge and wisdom regarding the habit use of wildlife in nature. Today the knowledge is amongst one of the greatest agricultural contributions in Africa. In South Africa, it is referred to as the “1960s conservation revolution” (Carruthers, 2010).

3.3 Game and livestock production systems

There are various opinions and views on the possibility of game and livestock systems to retain viable economic benefits together or in isolation. Walker (1976) argues that game farming requires large investment capital in setting up and developing infrastructure consisting mainly of fencing and purchasing game stock. Walker (1976) emphasised that high value and rare species are expensive to buy and keep. Pollock & Litt (1969) argue that game farming has several economic and environmental advantages to cattle production. They further stated that game animals survive and move in scattered groups and sustain in water shortage conditions whereas other forms of livestock require constant supply of water. In addition, game animals are more resistant to diseases; they can survive better in tsetse fly areas where cattle cannot (Pollock & Litt, 1969). This implies that farming with livestock would require more water supply, vegetation, veterinary services and chemicals, which increase costs and reduce profits.

The co-existence of livestock and game on the same piece of land results in game animals competing with other livestock animals for grazing pastures and transmit diseases such as the dangerous foot and mouth disease to cattle and snot sickness which can transfer from wildebeest to cattle (Carruthers, 2010). Du Toit (1982) states that game farming practices are more productive and supportive to the natural environment. Therefore, a mix of a variety of game species would be more beneficial (given that they do not exceed the carrying capacity). This is because different game species have different feeding habits, so their impact on vegetation is heterogeneous. In addition, most game farmers practice rotational grazing which allow vegetation to complete its physiological process (Allen et al., 2011). Liversidge (1981) mentions that, even if game animals were to graze continuously on the vegetation they would not cause much effect. Liversidge (1981) further states that it is important for farmers to maintain a balance between the grazing area and stocking rate. The stocking rate determines the extent of vegetation destruction. The advantage of having larger grazing areas is that they allow vegetation to recover faster than smaller ones.

3.4 Financial implications of converting from livestock farming to game farming

3.4.1 South Africa

Cloete et al. (2007) analysed financial implications of switching from cattle to game ranching in the Northern Cape. Comparative economics were used in assessing profitability and financial feasibility of the conversion. The study also used a combination of ecological and enterprise budgets to generate data. The purpose of the ecological model was to determine composition of game species and determine optimum combinations from calculations performed using linear programming technique. The main objective of the study was to give solutions to the question of whether game ranching was financially superior to farming cattle in that province. The results emanating from the ecological model were used in conjunction with those from enterprise budgets in order to calculate the net present value (NPV). Enterprise budgets were used to calculate the gross margins of different sources of income to get the gross margin value per unit of money invested. The study also used scenarios. The results from the first scenario revealed that game farming could be profitable and that there are possibilities of generating higher gross margins per hectare when farming with game compared to farming with cattle. Cloete et al. (2007) mentioned that generation of higher returns with game is not always the case because of large capital requirements in game farming.

The results from scenario two revealed that the conversion can be more profitable over a 15-year period but there is a need to have better access to adequate initial capital for that to hold. The results from scenario three revealed that the conversion could be even more profitable. The conclusion was that a combination of exotic and common game species offers the best means of conversion, but access to external sources of finances is a prerequisite for the conversion to be financially feasible. However, investment with limited game species is financially feasible, whereas high-value game species is financially unfeasible, mainly during the first few years of the project. This is due to the high probability of not covering borrowed finances used to purchase game stock. Results also revealed that hunting and live game sale activities are the province's economic pillars (Cloete et al., 2007).

Pollock & Litt (1969) state that investing in livestock animals is more costly compared to that with game. This is because livestock investment requires more development costs in dam construction, water points, boreholes, fencing, inoculation and dip tanks. Game ranching incurs lower development costs compared to livestock. The weakness of Pollock & Litt (1969)'s argument is that the study was conducted long time ago in the 1960s. Technology improved compared to back then, therefore costs of constructing dams, water points, boreholes and dip tanks are cheaper. In reality, fencing costs are higher in game farms than in livestock farms. Presently in the farm situation, investment and developments costs in both livestock and game farms depend on farm size and the number and type of animals kept. Generally, running costs are higher in livestock systems than in game farming while investment costs are higher in game than in livestock systems. The arguments presented by Cloete et al. (2007) of only using fencing as the main infrastructure needed in the conversion are contentious because there are several features that are important for such a conversion.

Musengezi (2010) investigated the financial and economic profitability of commercial wildlife initiatives on private game reserves in the Eastern Limpopo. The study used policy and institutional matrix in the analysis. The first objective was to measure the effects of wildlife policies on the profitability of game ranchers. The results revealed that game ranching is more profitable but there are challenges from political uncertainties faced at times, which pose negative impacts on game ranchers (Musengezi, 2010). The results also revealed that wildlife land use in Limpopo is increasing compared to that used for livestock and crop production, which is decreasing. The reason for the decrease is mainly due to unfavourable climatic conditions (Musengezi, 2010). Policy and legislation have significant influence on profitability and sustainability of wildlife in South Africa. It is therefore paramount for policy makers to implement stable policies that promote development of the industry.

A social accounting matrix (SAM) model was used to investigate economic impact of hunting activities in the Limpopo province. Assessments were on inputs, outputs, multiplier effects, and forward and backward linkages using 2009 national survey data for biltong and trophy hunting activities. The results revealed that the Limpopo province is the leading hunting destination in South Africa, resulting in hunting activities generating significant income for the province. Employment creation in the province is largely a result of hunting activities. Limpopo has high poverty levels and hunting was realised to be an important tool useful in addressing and helping eradicate poverty (Van der Merwe, 2014). Biltong hunting has significant potential of generating more income and it is projected to remain like that in the near future. The results also revealed linkages within the province in which; certain services can benefit from hunting, these include; trade, accommodation, agriculture, transport and communication, manufacturing and financial services. The conclusion was that hunting activities has a significant role in overall economic growth in the Limpopo province, through development in infrastructural and super-structural factors. It also contributed to the conservation of precious fauna and flora (Van der Merwe, 2014).

Van der Merwe (2014) recommends that leaks in the Limpopo province needs to be prevented and this can best be done through conducting business with local people. This would include hiring local labour and local inputs procurement. It is important for game farmers to establish and maintain good relationships with their hunting clients through providing adequate supply of preferred species. It is also essential to provide better services as it provides value for money for the respective hunters. Van der Merwe (2014) further mentions that government should work together with the private sector in order to equip game farmers and their employees with essential skills, as this increases flow of income in the province in particular and grow the economy of South Africa in general.

What is important to note is the role of a sufficient planning horizon. A strategic change to a farming system needs to be financially analysed over the long-term. Van Rooyen (2012) states that sheep production in the Karoo has been important since the previous century, and by that time, it was already regarded as one of the economic pillars of the Karoo systems. Van Rooyen (2012) further states that agricultural systems should reshape landscapes. Karoo sheep production systems have negative impacts on productivity and this has been caused by persistent degradation of veld resulting in decreasing profitability in sheep systems. The decrease in profits has resulted in some experts denoting springbok farming as a viable alternative to sheep farming in this region. Research undertaken at Graaff-Reinet argue that springbok farming has the potential to reverse undesirable environmental effects on ranches and this is applicable to all areas in Karoo with similar climate conditions and economic administrations (Van Rooyen, 2012). On the other hand, sheep systems will be economically and environmentally unsustainable in the future, even though they are able to cover their current financing obligations. Recommendations were that the government should support farmers with incentives to help them convert their current sheep farms to springbok farming (Van Rooyen, 2012).

Loss of biodiversity through continuous grazing by livestock implies that persistent keeping of sheep in semi-arid regions would result in extinguishing and worsening the ecosystem (Van Rooyen, 2012). According to Van Rooyen (2012), the use of rotational grazing and a suitable carrying capacity in sheep grazing camps have actually benefited and helped to develop the Karoo ecosystem in the past few years. However, it is important to note that sheep farming have not contributed to the deterioration of Karoo ecosystems yet. Sheep are less likely to choose the same vegetation compared to springboks, which implies that replacing Karoo sheep systems with springbok could worsen the ecosystem (Van Rooyen, 2012). The current sheep farming systems are more profitable than springboks but in the future sheep farming will be economically unsustainable. This is a result of the future decreasing of natural productivity of land, which would result in farmers needing more supplement feeds, thereby increasing farm costs and reducing profitability (Van Rooyen, 2012).

There is a discourse if springbok farming can potentially improve the future Karoo economy and sustain its ecosystem. Research conducted on a 5000-hectares Karoo springbok farm revealed that springbok meat production is profitable, but the government has to support farmers through direct yearly subsidies of approximately R13 per hectare. These funds can help them in converting their livestock farms to springbok farming. There is also available support in form of tax discounts from the South African Revenue Services (SARS) on condition that farmers have systems that benefit the economy and restore biodiversity, to be eligible for the support (Van Rooyen, 2012). Critics of game farming argue that regardless of subsidies, springbok farmers would always receive lower profits compared to sheep farmers (Van Rooyen, 2012). Substantial capital is required in establishing adequate infrastructure in game farms and developing access to markets. Springbok business face several challenges stemming from complexity in marketing its meat because of inconsistency in the supply chain that affect retailers concerning stock levels. This result in losing sales and potential clients due to customer dissatisfaction (Van Rooyen, 2012).

Farming with springbok offers outstanding relative ecological and economic effects compared to sheep farming but with lower financial returns. Springbok farming offers greater potential to return more economic derivatives that come from management of biodiversity compared to sheep farming. Other benefits come from springbok hides that are high valued thus increasing profits (Van Rooyen, 2012).

3.4.2 Financial implications in Africa

Barnes & De Jager (1996) investigate economic and financial incentives for wildlife use on private land in Namibia and the implications for policy. Cost-benefits analysis models were developed and used to assess the economic and financial efficiency of private wildlife land use. The results revealed low profits in cases of both livestock and game production for consumptive use and wildlife production for non-consumptive use. However, the aforementioned activities proved to be economically efficient and to have positive contributions to national income. The study suggest that private landholders could generate high profit if they group together and form conservancies. The profit would come because of economies of scale expected in the future. Wildlife production for non-consumptive wildlife viewing generated higher economic net value added per unit of land compared to livestock-wildlife production for consumptive use for large conservancy operations. The Namibian policy to promote wildlife use and the development of wildlife conservancies on private land appeared to be economically sound.

3.5 Game farming and the bio-physical environment

There are several contradicting and supporting ideas and views on the relationship between game farming and the environment. The spatial extent and distribution of game farming was evaluated in the Eastern Cape Province. The results revealed that the area used for game farming increased drastically and was significant after 1996, it increased by a rate between 20% to 25% of the 116 500 square kilometres studied. The growth was mainly a result of diversification of hunting species (Smith & Wilson, 2002; Van Der Waal & Dekker, 2000).

Moolman & Cowling (1994) analysed the impact of elephants (mega-herbivores) and goats on the endemic flora in the South African succulent thicket. The results revealed that effect of goats on vegetation grazing was larger; goats destroy the vegetation relatively more compared to elephant activities. Extensive goat grazing activities showed a massive destruction of highly nutritious succulent shrubs. The shrubs require about 275 days to recover. On the other hand, elephant's activities showed moderate impact on plants and they did not reduce the highly nutritious shrubs (Moolman & Cowling, 1994). In support of the findings of Moolman & Cowling (1994), Lindsey et al., (2009), state that game farming is an environmentally sustainable land use practice compared to livestock production. The reasons given by Lindsey et al. (2009) are that game species have dissimilar feeding patterns; as a result, their destruction to the environment is heterogeneous. Another important conclusion was that the impact of elephants is heterogeneous even in areas with vegetation of similar characteristics.

Dasmann & Mossman (1964) state that during the 1950s in Eastern Africa, wild animals were living in harmony with their environment, with less grazing, less erosion and wild animals were well adapted to it. The situation was however different in neighbouring trust lands where livestock animals were domesticated. In these areas, land was of poor quality due to overgrazing and degradation was profound (Dasmann & Mossman, 1964). Talbot et al. (1965) support Dasmann & Mossman (1964), arguing that historically, African savannah grasslands and woodland areas had different varieties of wild herbivores and the land was more productive than in tribal areas where domestic herbivores were found.

Brynard (1958) analysed the relationship between large herbivores and vegetation in the Kalahari Gemsbok. In the study area, 10% of the area show evidence of overgrazing and the remaining 90% of the dune veld was under grazed. Research carried out by Morris (1958), revealed that the dune veld was under-grazed while the riverbed was more overgrazed. Research by Leistner (1959) revealed that the influence of game distribution on the vegetation shows that some game species favour particular soil and vegetation types. For example, springboks prefer vegetation found on calcareous soil, while gemsboks prefer sand veld and grass.

In 1998, Van der Waal & Dekker (2000) evaluated the extent and impacts of game ranching on natural resources and the socio-economic environment of the Northern Cape Province.

Game ranching activities were found to have a significant contribution to the economy of the province mainly driven by hunting and live game sales. These activities generate substantial foreign currency and attract investors from other provinces and as well as other countries (Van der Waal & Dekker, 2000).

Topping (2011) evaluated the management of wildlife using various farming practises in Western Europe. The study found that organic practices have potential and can increase distribution and abundance of wildlife but it is not always the case, and under the best circumstances, the gains are relatively low. The conclusion was that greater improvements in biodiversity is based on a good selection of wild life species and is achievable through implementing of true extensive agricultural management practices that are linked to management of habitants.

Damania & Bulte (2007) investigated the economics of wildlife farming and conservation of endangered species. The study used the basic poaching model. The results revealed that policies used in conserving endangered species could contribute more to the threatening of wildlife stocks under certain circumstances (Damania & Bulte, 2007). The reasons are that protecting wildlife from anti-poaching activities is expensive; as a result, the opportunity cost of conserving their habitants increases.

The supply chain effect in provision of safe game meat to consumers was analysed and identified by Bekker (2011). South Africa's game meat industry is growing but before the meat reaches the consumers, it passes through a complex supply chain. Bekker (2011) identified loopholes in the supply chain that have a negative impact on game meat consumers and concluded that the formulation of inconsistent policies and regulations from responsible authorities can lead to the collapse in the control of game meat safety. Moreover, some stakeholders in the value chain have little knowledge with regard to the supply chain of game meat (Bekker, 2011). Jooste (1983) investigated the potential of game farming as a supplementary activity in the Karoo area. The empirical result emanating from this study showed that game farming had the potential of further growth compared to the previous decade, but challenges such as lack of scientific research, lack of management directives and the presence of transmissible diseases threaten the industry and poses risks that hamper it from reaching its full potential. The recommendations were that more effort is needed in research to improve game management systems, prevention and treatment of transmissible diseases that limit the industry to reach greater heights (Jooste, 1983).

3.6 Risk balancing in farm systems

The previous sections have shown that the conversion to game farming could provide some real ecological benefits to the farm system. It was also shown that such a conversion often requires a large initial capital investment. In other words a producer must enter a period of increased financial risk to eventually lower production risk. This research is not focused on risk as such, but it illustrates the need for a longer-term assessment.

Risk balancing is the adjustment on instruments of total risk. The adjustment happens because of the occurrence of identical shocks on the balance between business and financing risks (i.e. the total risk) (Gabriel & Baker, 1980). Maximization of profits and business survival are important from a business perspective, this implies the need of a balance between the amount of business and financing risk. The balance should therefore not exceed the estimated levels (Encarnation, 1964; Halter & Dean, 1971). Cheng & Gloy (2008) analysed the trade-offs between risks and return on farm assets. They found that some policies and instruments used to reduce risk at farm level usually increase the financing risk and therefore increases the total risk to farmers. This is mainly because financing risk will not be in balance with the business risk.

3.7 Agricultural finance providers

The South African yearbook (2012-13) states six sources of agricultural credit and finance providers to farmers in South Africa. These include commercial banks (50%), agricultural cooperatives and agricultural business (12%), Land and Agricultural Development Bank (21%), private creditors (8%), other creditors and financial institutions (9%) and the state (1%). These statistics clearly shows the importance of the private sector in the agriculture of the country (South African yearbook, 2012-13). Financing come at a cost, which is the interest of payments. The credit market functions well, but the cost of credit in South Africa is relatively high compared to other developed countries.

3.8 Conclusion

This chapter reviewed literature on the financial implications of converting from livestock to game farming. It also included legislation that influences the wildlife in South Africa together with history and development of wildlife farming in both South Africa and internationally. It mainly focused on explaining the relationship between wildlife and other forms of livestock farming. The last sections explain the inter-relationship between game and the biophysical environment. Risks in farming as well agricultural finance providers was described.

Literature has given marginal attention on financial implications of converting from livestock farming to game farming. Various studies showed that a conversion to game farming, away from domestic livestock could be beneficial at the farm level. Currently the ecological benefits are more prominent, specifically from a research perspective. The challenge is that the benefit of an ecological gain normally translates to decreased production risk, but could come at an initial period of higher financial risk. Therefore, this study intends to bridge some of the knowledge gap by researching the financial implication of converting from sheep to game farming at farm level operations in the Beaufort West, Karoo area.

CHAPTER 4
Financial Implications of converting from livestock to game farming

4.1 Introduction

The main aim of this research is to establish the financial implications of converting from domestic livestock production to game farming in the Beaufort West area. The impact and potential benefits of game farming have been explored in previous chapters.

This chapter gives a description of Beaufort West Karoo, it also describes the materials and methods used to gather and analyse data. The techniques applied in the process of constructing the whole farm budget model, are given together with the model simulation process. This is aimed at helping the identification of key factors farmers would consider when switching from sheep to game farming. This chapter also presents the systems thinking approach as the underlying principle in modelling agricultural systems.

Farm-systems has a complex nature due to the influence of biophysical and socio-economic components, connected together in whole farm system. Complexity has contributed to agricultural economists, and various academic disciplines to try to conduct research that incorporates farm physical and financial components together (Hoffmann, 2010). Budget models were used to perform empirical investigations, because of their ability to capture farm physical and financial components together. This is in order to understand and analyse managerial and financial implications of converting from sheep to game farming at farm level in Beaufort West, Karoo. The chapter concludes with the financial results obtained from the modelling exercise.

4.2 Description of the Beaufort West Karoo

Beaufort West is located in the Western Cape in the semi-arid central Karoo region. It is the capital of the Karoo region situated along the N1 road. Beaufort West is the oldest town in the region established in 1818. Its population is 34 854 and its density is 600 people per square kilometre. The Karoo region biome dominates large peripheries of three Cape Provinces (i.e. Eastern, Northern and Western Cape) and the Southern Free State. This biome is characterised by the presence of sheep, goats, and game animals produced at a commercial scale (Rubidge, 2011).

Rubidge (2011) states that game farming practises do well in the Karoo because of better access to cheaper inputs, low population density, unsophisticated land occupation, desire for quality lifestyle by farmers and the vastness of the region. Game farming can be feasible in isolation and in combination with livestock in the region. With regards to livestock production, mainly sheep is significant for the economy of the region. Karoo land values vary relatively with rainfall, and it can be as low as R1 000 per hectare in the driest areas (Rubidge, 2011).

4.3 A typical farm description

Farm size is vital in a typical farm description because it determines the other essential factors such as fixed improvements and investment in livestock. Factors such as; production area, land utilization, mechanisation requirements, capital investment requirements and number of permanent labour and fixed costs, depend on the size of the farm. A change in farm size would change other factors. It is important to describe a typical whole farm situation because it contains incorporated physical and financial components where special relationships exist (Hoffmann, 2010).

The physical component in a whole farm situation play a considerable role to farm financial performance. Important physical aspects include the land ownership (i.e. owned, rented or a combination) and land use patterns. Ownership of farmland affect profitability that is if rented land is used, this has stern consequences on repayment of financing obligations, since some of the money will be used for paying land rentals. This also has an impact on expected cash flow of the whole farm (Hoffmann, 2010).

A description of land utilization is important because it also influences the financial performance of the whole farm (Hoffmann, 2010). In this study, a typical whole farm description represents the physical factors of Beaufort West, Karoo farm situation and then shows connections with its financial aspects accommodated in budget models. Farm size and carrying capacity of the veld will directly influence stocking numbers. In game farming, this is important because they differ in preference to grass or leaf eaters.

4.4 Financial farm description

The description of a typical farm expresses physical farm elements in financial terms. The inventory, or farm asset register, indicates the total value of capital invested in assets (Hoffmann, 2010). Key inventory include; land, fixed improvements, machinery, equipment and animal stock. Their quantities depend on the size of the farm and farm activities. Inventory items in the model automatically change if the size of the farm change. It is vital that land and movable items are used as base for the layout and investment of movable assets and its lifespan (Hoffmann, 2010).

4.5 Data Collection

The data collection process included key role player interviews, semi-structured interviews and personal site visits. Direct discussions were with chosen interviewees from various areas of expertise, including animal scientists, agricultural economists, livestock specialists, game specialists, farmers, farm managers and other professionals from relevant agro-industries. Interviews allow free exchange of information between the researcher and these key informants. Sarah (2002) defines an interview as a strategy of getting individuals to talk about what they know about the subject in a discussion. Internet sources, books, published literature and farmer's weekly magazines were utilised to gather data on prices, social interactions, population composition, and essential information on wildlife and sheep systems. Questions included in the questionnaires were on prices of animals, value and size of land, carrying capacity, price and number of vehicles, machinery, labour information, fixed improvements and sources and cost of finances.

4.6 Systems thinking and complexity in agriculture systems

A system is a set of structured elements connected together in a logical way and acts as a whole (Giddens, 1979). A system is also defined as an organized gathering of different components such as biological, social, economies and bodies where special relationships exist (Tinbergen, 2012; Schumacher, 2011). Systems have seven levels namely: cells, organs, organisms, groups, organizations, societies and supernatural systems (Scholz, 2011).

Agriculture systems are complex in nature. Effective decision-making in such systems is challenging. When addressing and solving problems in farm systems, effective decision-making is important and best done with the aid of sophisticated tools and techniques (USAID, 2008). Effective decisions cause inclusive growth, but there is a need for mutual relationships amongst stakeholders. Mutual relationships improve practices and brings broader investment opportunities and substantial financial benefits (USAID, 2008). For agricultural systems to be successful, innovation is a prerequisite and to achieve this, economics, technology and biology need to be integrated. Managers need to monitor their decision-making process regularly (Shadbolt & Martin, 2005).

Complexity in agricultural systems stem from the interdependency and connection of numerous components, biophysical, financial as well as various stakeholders with different interests, risk and uncertainties and global dynamics (Checkland, 1993). Complexity also increased through diversification in crop and livestock systems, technological advancement, improvement in products, extension of existing products, and fluctuation of currencies (Hoffmann, 2010). In summary, system components are interrelated and the alteration of one has a systematic effect on the others and/or the overall system (Checkland, 1993). The use of the system thinking approach is important in order to explore and recommend successful and sustainable practices to relevant stakeholders (Foran et al., 2014; Banson et al., 2014).

In the real world situation, farmers face challenges in dealing with future developments as well as anticipating future prospects and upcoming consequences. This has incentivised agricultural economists and various stakeholders to design better methods, solutions and approaches to evaluate and explain concepts in agricultural systems. As a result, systems thinking that underpins ways of model construction and simulations were formulated and modified. This can assist in dealing with problems that arise in complex agricultural situations (Hoffmann, 2010).

The use of systems thinking approach dates back to the 1940s (Kerzner, 2013). Currently, system thinking applies in numerous disciplines such as natural resources, human resources, innovation, social theory, environmental conflict management, community development, health, agricultural production and education (Bosch et al., 2013; Nguyen & Bosch, 2013).

Traditional scientific system approach contributes to the present day knowledge base. But the drawbacks are however, that insufficient knowledge is yielded when used in complex systems (Hirooka, 2010; Piepenbrock, 2009). Analysis break down system components into individual units, then deal with them in isolation. In reality components in a system are interrelated and need to be addressed as a whole. Acknowledging that alteration in one influences the ‘whole’ systematically. The conventional approach views behaviour of elements in systems as linear, while in reality system elements are nonlinear (Hirooka, 2010; Larsen, Ryan & Abraham, 2008).

Interrelationship of farm system components require the use of systems thinking in problem solving where specialised knowledge is incorporated into the study of the whole system. System thinking works with the help of technological innovations such as computers (Hirooka, 2010).

The proficiency of systems thinking is imperative when dealing with challenges facing policy makers, researchers and other relevant stakeholders. It also support research in situation with lack of tools, scant information and knowledge in the present day, complex environment (Roux, 1981).

Systems thinking is three pronged and consists of hard, soft and complex approaches. Hard system thinking defines a system as components with well-defined boundaries and objectives, consisting of different parts that convert inputs to outputs by working together to achieve shared goals. This approach is mostly useful in technologically oriented disciplines. It emphasises quantification of elements using facts and it describe things using concepts such as boundaries, hierarchies and structures and observes the parts of elements, not the whole component. Its major weakness is that it neglects dynamics in systems. Some of its tools are crop growth modelling and multiple-goal programming (Van Keulen & Schiere, 2004).

On the other hand, soft system thinking takes over where emphasises is on the use of mind-sets. It defines a system as a paradigm with subjective boundaries that reveal intricate occurrences while emphasizing wholeness, interrelationships and emergence properties (Van Keulen & Schiere, 2004). It defines objectives and goals in systems by looking at the context of the system, for example when defining goals in mixed farming system. They reflect societal goals rather than individual farmer goals. Lastly, it emphasizes that the system works as a whole when viewing things, addressing challenges and opportunities (Van Keulen & Schiere 2004).

Lastly, complex system thinking plays an important role in circumstances where both hard and soft approaches fail to cope. It bases on the notion that in the real world stakeholders have different realities because of developments in the future. It therefore incorporate interrelationships, risk, uncertainties and dynamics in systems and then provide tools and techniques where changes in inputs and outputs flow result in the re-designing and re-engineering of the whole system (Van Keulen & Schiere, 2004).

4.7 Modelling and simulation

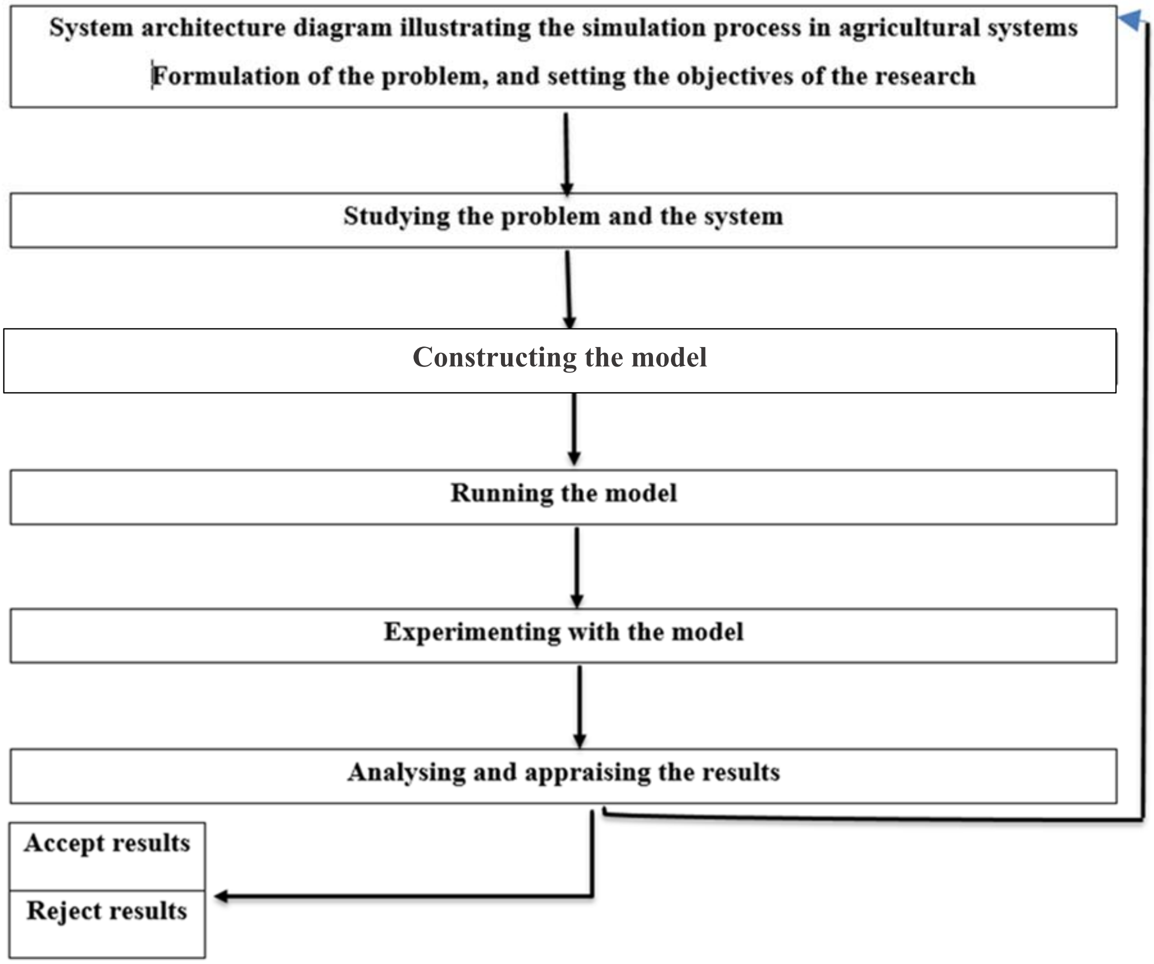

Figure 4.1: Systematic architecture depicting the simulation process
Source: Adapted from Strauss (2005)

Modelling is a noble technique used in the decision-making process to simplify real world situations (Rehman & Dorward, 1984). The drive behind constructing and using models is to help in describing things that are problematic to picture in real situations. In model construction, elements in systems are broken down into several parts connected to the whole system and then used to evaluate future events in real world situations. Theoretical models can be mathematical, logical or verbal representations of the problem designed by the entity for a particular purpose (Kleijnen, 1995).

Figure 4.1 shows the simulation process in the complex agricultural system. When designing and using simulation models, verification and validity are important aspects. Verification involves evaluation of the soundness of a simulation. The validation process takes place during model running and experimenting phase. It involves evaluating the data produced to check if it reflects real world situations. It uses measures such as t-test statistics and graphs to compare simulation results versus real data. Validation is a contemplation enquiry where regression models test the likelihood of risk occurrence and uncertainty using techniques like Monte Carlo (Kleijnen, 1995). Inspection of semi-output results are done during simulation process and checking of statistical outputs to see if they satisfy outcomes of the analysis (Kleijnen, 1995).

Simulation is a process of using models to replicate connections between elements and human beings in the real world situations. Simulating models use scenarios to predict the most likely behaviour of elements and human beings in the whole system (Knott, 2015). For the purpose of this study, interconnections in sheep and game farming systems is presented in the form of budget models and represent a typical farm.

Kleijnen (1995) conducted a study that investigated the rationale of model validation and verification in system analysis. Attention was on the use of statistical techniques since they replicate objective quantitative data about worthiness of the simulation model used. The results revealed that verification and validation of simulation models are valuable and need assessment and they provide reliable knowledgeable information. There is a need for good documentation of simulation models.

According to Balkhausen, Banse & Grethe (2008), model simulation has an important role to play in the field of agricultural economics. Simulation models are reliable and can be a good representation of real farm situations. Simulation saves time and is cheap to use because practically it is not easy to construct a real physical farm model of a whole farm system. In a research conducted in the European Union to investigate the use of economic simulation models in evaluation of polices, eight economic models were used: AGLINK, AG-MEMOD, CAPRI, CAPSIM, FAPRI, a combination of partial equilibrium economic models as well as the GOAL and GTAP, which is a combination of both partial and general equilibrium models (Balkhausen et al., 2008). The first goal of the research was to provide an indication of outcomes of the simulation model based on assumptions of decoupling direct payments. The second goal was to examine the effects of assumptions on different models and their impacts on results. The results revealed that type of model used in the simulation process has a logical impact on the outcomes. The conclusion was that models have to rely on assumptions proposed on their specific purposes, but theoretical and experiential foundations are important to get effective and meaningful results (Balkhausen et al., 2008). In this research, the budget models were built from data collected to represent a typical farm in Beaufort West Karoo. The data was simulated using computerized models to give a reflection of the real world financial situations.

4.8 Types of models

Deterministic and stochastic models are the main model types used and the choice of model is mostly determined by the type of a system to be modelled (Strauss, 2005). In the analysis of financial and managerial implications of switching from sheep to game farming deterministic models are used, because of their ability to evaluate explicit variables or to simulate specific situations. They are used in conjunction with a systems approach using planned variables and relationships within the systems that have constant values. Deterministic models do not work on probabilities. Moreover, price of inputs in the models are constant and permanent while risk elements are included in scenarios (Strauss, 2005).

4.9 Approaches to modelling

The process of modelling relies on using normative and positive approaches. “What is?”, “What was?” and “What will be?“ are the main questions of concern in positive approaches. Positive approaches rely intensely on current and historical variables in predicting certain outcomes. Normative approach best suits deterministic models in describing the nature of the systems not what should be done (Hoffman, 2010).

4.10 Budgets models

Budget models are a form of simple simulations used in the evaluation of plans in physical and financial terms. Budgets play an important role in management analysis and their major advantages is that they are simple to use and have an experimental approach in the decision making process. Technological developments such as computers have improved their reputation and usage (Rehman & Dorward, 1984; Poole & Buckley, 2006). Their acknowledgement in many disciplines makes them a useful tool in problem solving. Budgets close the knowledge gap between academics and producers. Budgets can be used to estimate income and expenditure to predict most likely profits (Smathers, 1992; Nuthall, 2011). The success in budget usage is mainly because of their exposure for public accountability (Rubin, 1990).

Budgets can be either descriptive or normative. The use of normative theory dates back a century. Historically, budget users underestimated the use of normative theory and as a result, budgets use did not bring change and solutions. In the United States of America when policies were adapted in government Federal Reserve, normative theory was underestimated and did not give viable solutions back then. Normative theory focuses on the provision of advice centred on a narrow range of remarks and solutions based on values rather than on observations (Rubin, 1990).

On the other hand, descriptive theory puts emphasise on close clarifications. It describes changes, arrangement of events and their bases and confines distinctions accounted together with homogeneousness across origins. In budget use, knowledge gaps are created if the influence of descriptive theory is too feeble in giving explanations or if guidance from normative theory is not well adapted (Rubin, 1990).

Rubin (1990) stated that history reveals a wider gap between the budget theory and use, irrespective of whether descriptive or normative theory is used. He argued that use of normative theory has been fruitful in setting goals to guide performance, but descriptive theory has been feeble and incapable of giving clear vision when hypothesising meaning. The results use of normative theory could offer incomplete information in giving predictions about future trends, unless budget theory is also able to express recommendations that disclose the complexity of modern multi-functions. The use of descriptive theory shows significant improvements (Rubin, 1990).

Complexity in agricultural systems resulted in agricultural economists and other experts adapting and using administrative techniques to make useful decisions when addressing and solving problems. Administrative techniques can be either diagnostic or planning techniques. Diagnostic techniques help farm managers to recognize and define initial problems; they analyse historical events, plans, explore techniques and evaluate future prospects (Rehman & Dorward, 1984; Poole & Buckley, 2006). In the field of agricultural economics, planning techniques with budgeting can be useful in linking alternative solutions to strategies in order to boost and enable production of food and services consumed domestically and for exportation (Rehman & Dorward, 1984; Poole & Buckley, 2006).

4.11 Theory on whole farm Model

Diversification in farm systems help to minimize risk and uncertainties. Risk and uncertainties are a function of changes in climatic conditions, global competition, impact of exchange rates, socio-economic and the political environment on farm systems. In addition, components independent of the farm systems also have some impact (Hoffmann, 2010).

These elements increase the intricacy of farm operations and for successful operations; the use of the systems approach is important (Hoffmann, 2010). FAO (1989) states that the systems approach is crucial in examining the broad farm context situation.

Whole-farm budget model helps to view the farm system as a whole enabled by its ability to display all the elements of the farm system as a single interrelated component (Hoffmann, 2010). Whole-farm budget modelling is a technique used for financial planning purposes by relating physical and financial components. Whole farm budgets helps to show net farm income and loss by subtracting fixed costs from whole farm gross margin value. Whole farm budgets are also useful in calculating return on investment income and measure profitability using net present value (NPV) and internal rate of return of capital investment (IRR). This becomes possible by adapting to the use of multi-period budget model (Hoffmann, 2010). In addition, calculations are performed easily in computer spreadsheets showing relationships between components in the whole farm. Budgets are also useful for benchmarking because of their comparability and their ability to simplify complex farm systems. Other advantages of using budgets are its inclusion of a large number of variables and still being able to accommodate relationships. Farmers need to be familiar with budget models and be comfortable to use them; they can be a useful tool (Hoffmann, 2010). The necessity of simulating the whole farm lies in the effect that changing an enterprise can have on infrastructure and/or other enterprises. For example bringing in game could affect infrastructure like fencing and game handling equipment. But there could also be some legislative and administrative costs involved with accreditation.

4.12 Applying whole farm budgeting

4.12.1 The whole farm multi-period budget model

Several factors play a role in the financial features of farm systems. However, all components that affect prices of inputs and outputs also affect profitability. In addition, farm managers have greater influence on farm profitability. Factors such as farm yields, price of products and inputs have large influences (Hoffmann, 2010).

Multi-period budget models are developed to capture whole farm elements in a way that lead to prediction of the effects certain factors have on farm profitability. Multi-period budget models are constructed to determine current financial situations in a sheep system. The financial implications of converting to game farming system could be predicted easily. This allows for assessment of influences of alternative strategies.

Throughout the budgeting phase, standard accounting principles was adhered to. Budget models use standard financial criteria such as internal rate of return (IRR) and net present value (NPV) to measure profitability of whole farm systems.

Budget models plays an important role as a decision making technique because of its ability to vary all factors in the system, their interrelationships and still being able to show the most likely farm financial situation as intended. Budget models can perform their purpose efficiently irrespective of complexity in farm systems. By using budgets, complexity can be captured and dealt with so that the financial situation in typical farms is reflected. Budgets generate useful information because of their use of standard accounting principles and methods when performing calculations (Hoffmann, 2010). Figure 4.2 indicates the components of a whole farm budget model. The sophistication of the whole farm model lies in the relationships between physical/biological factors and financial outcomes. This is achievable in spreadsheets through a sequence of formulas.

4.12.2 Input data components

Budget models accommodate the price and quantities of materials and those of resources used in sheep and game systems. There include machinery, equipment and inputs directly allocated to specific systems such as feed, dosage, fuel and chemicals. Input data components are presented in the form of tables in Excel spreadsheets. Excel spreadsheet tables also contain value of units of sales, medicine and feed. Spreadsheet tables also show items such as inventory prices and quantities as well as calculations of values of fixed and overhead costs. The input data components contain the livestock and game system carrying capacity, input and output costs, and financing costs and amounts. Importantly, the values in the spreadsheet tables can be changed at any time. In this instance, Microsoft Excel was used as the spreadsheet programme. In the model construction values and quantities are separated, which allows for separate manipulation of either or both. Costs associated with keeping animals are determined by their prices and the carrying capacity of the area. Prices for livestock and game species are for 2016 and was obtained through the interviews. Machinery costs are included in the inventory sheet and then placed in the asset register sheet. Constant prices was used for this exercise and a real interest rate was used.

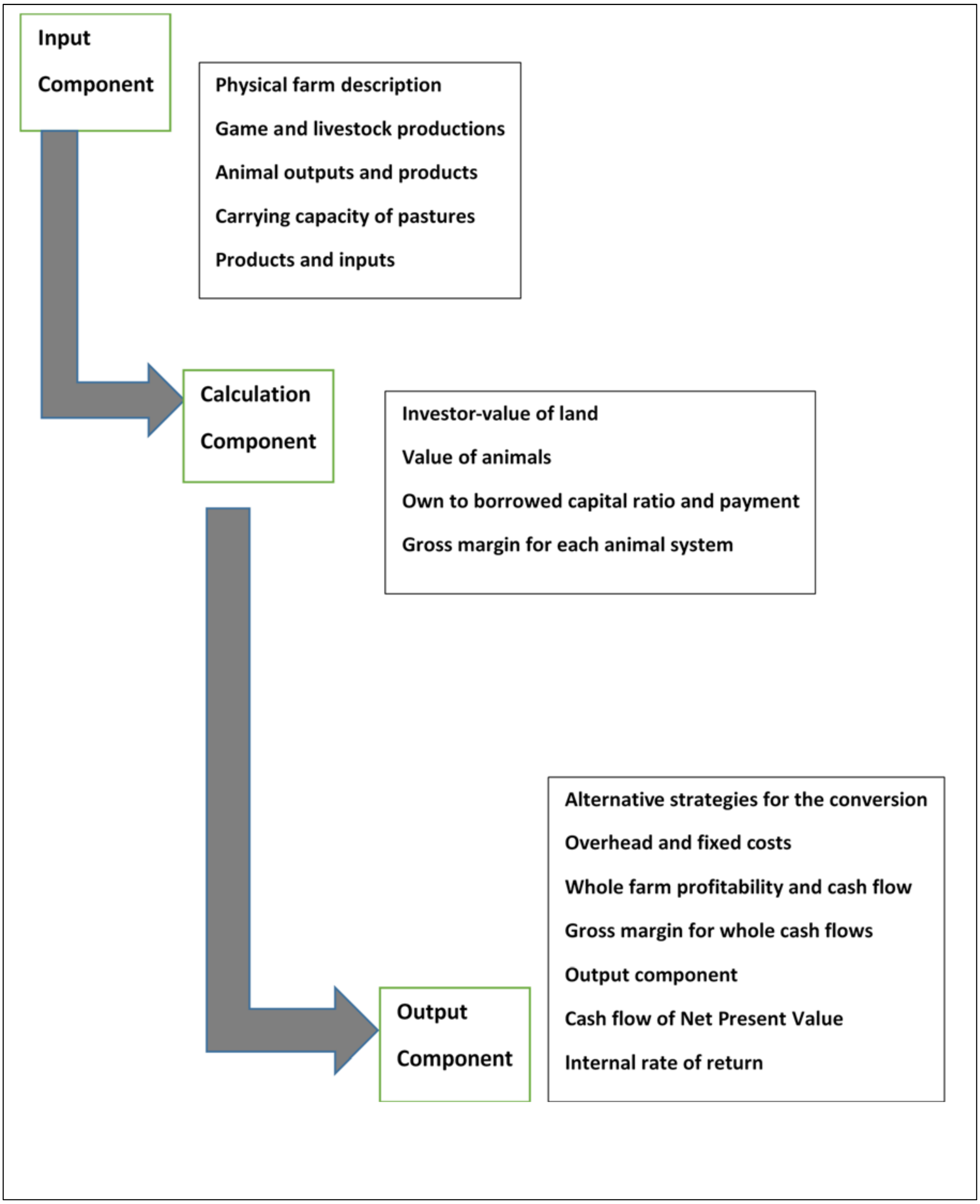

Figure 4.2: A graphical representation of components of the whole farm multi-period budget model
Source: Adapted from Hoffmann (2010)

4.12.3 Output data components

In the output component, net cash flow is calculated in the multi-period budget model. Variable costs, fixed costs, overheads, expenditure, capital investments and asset replacement are incorporated to calculate IRR and NPV. Revenue received is the same on a yearly basis for the duration of the projects when the farm is in equilibrium regarding assist structure on farming operations. Cash flow calculations are for a 20-year period. Both IRR and NPV are useful profitability indicators and they are useful in comparing projects that have commenced even at different times with dissimilar investment capital. In this instance a sheep farm is compared with a game farm. The land size and grazing capacity will remain constant but investment in fixed improvements and operational costs as well as revenue changes.

Gross and net profit margins calculations

In order to calculate gross margins, separate budgets were compiled, one for sheep and one for game. There was an assumption that rainfall and climate patterns were uniform. The whole farm gross margin and net farm profit came from a calculation sheet performed in the income statement. Total revenue from sale of products and services were summed together and costs incurred per annum were then deducted from total revenue. In this instance revenue from game include hunting daily fees, the meat and accommodation. Variable costs are deducted to get the gross flow. Then overheads cost is deducted from gross flow to obtain net flow before capital. Capital items are then included. In year one the full capital investment requirement for the project is taken into account. In the other years only items that need replacement is included. The budgets were precisely simulated in accordance to different alternative strategies used when converting from sheep to game farming.

Overhead and fixed cost calculation sheets

The overhead and fixed cost of the whole farm display items such as cost of labour (permanent and casual), licenses, insurance, fuel, maintenance costs of vehicles and fixed improvements, electricity costs, communication cost and administration costs. The cost does not change with the level of output; they remain fixed throughout the budget period. Owner remuneration is also included in fixed costs.

Profitability and affordability as evaluation criteria

The main purpose of calculating profitability in sheep system was to show its current financial position and then analyse financial and managerial implications of the alternative, which is game farming; putting into account the alternative strategies used. The factor of inflation was incorporated using constant prices with real interest rate used in the multi-period budget models in profitability calculations. Overhead and fixed costs did not change for the duration of the project. The costs came from discussion and similar values are used. Affordability is measured in terms of cash flow and the break-even year.

4.12.4 Calculation component

The calculation component includes different calculations and interrelationships existing among various inputs used to generate profitability and affordability in the multi-period budget models. Standard accounting principle is applied in the construction and performing of calculations. It also shows the duration of the project as well as its activities. The calculation component consists of the sequence of equations that translate physical/biological factors and activities into financial outcome.

Amortization table

The amortization table shows the repayment plan the business would use to clear its financing obligation. An assumption was that 40% of the capital requirement was borrowed and the real interest rate is 6%. The amortization table also shows instalments, interest, and the portion of capital paid and balance owed at the end of each year.

4.12.5 Inventory calculation sheet

The major purpose of the inventory is to determine the capital requirement expected in the 20-year period; the duration of the project. The inventory also calculates the costs associated with ownership of assets, such as insurance and maintenance amount of depreciation. The 2013, 2014, 2015 Guide to machinery Cost was used to determine prices of new items. Replacement period of fencing was after 12 years; adapted from the Ph.D. thesis of Hoffmann (2010); maintenance was on yearly basis.

The size and composition of stock determine the capital investment requirement in livestock. The size of the herds are determined from carrying capacity of the area. It is important to note that carrying capacity varies with area as well as from year to year depending on rainfall. Carrying capacity was assumed to be constant. Assumptions were also incorporated with regard to the ram's and ewe's replacement policy and ram to ewe ratio. The assumptions were 3 to 4 ewes per ram and replacement of bulls and rams were after every three years. Ewe to ram ratio for sheep farming system was 35:1.

4.13 Assumptions on the typical Beaufort West Karoo farm

The arrangement of calculations in the budget model were described in the previous section. All the following assumptions and values were discussed through interviews and follow up discussions with the various role players. The first assumption was the size of land which was agreed to be 3 500 hectares for a typical farm. The farmland was assumed to be owned which means there are no rental (leasing) costs. Sheep production was assumed as the current system the land is used for and the farmer intends to convert to game farming. Therefore, the implications that the decision has on whole farm financial performance was unknown and will be known only after investigations using budget models. This is in line with exploratory research. The farm was assumed to have proper fencing and essential infrastructure required in sheep and game systems. The last assumption was homogeneous farmland that does not change in size over time.

4.13.1 Inventory

The inventory comprised of land and buildings, fixed improvements, machinery and installations, sheep and game stocks. The value of the land in Beaufort West, Karoo varies in relation with the rainfall. The wider area experiences similar climatic conditions so land has a similar value. Land value came from consultations and interviews with experts and it was agreed to be R2 000 per hectare. Therefore, the value of the whole farmland was established at R7 million. Land constitutes a larger proportion of capital investment requirement and in game farming; fencing was the highest cost component of fixed improvements. Machinery maintenance and replacement, and size and capacity depend on the size of the land. In other words, the model can easily be adapted to show results for different farm sizes.

Initial capital investment in the sheep system was R13.6 million. That includes investment in land, improvements, fencing, livestock, machinery and equipment. While in game system, initial capital investment was slightly above R20 million that includes land, improvements, equipment and machinery, fencing and purchasing of stock. Table 4.1 reveals the inventory for a sheep system whereas Table 4.2 shows inventory for a game system. More details regarding inventory is in the Annexure. Sheep systems use 50% of its initial capital to purchase land while game system used 34%. The variation is because of different initial capital required in these systems. The initial capital required in game farming double that in sheep system. The ration of own to borrowed capital was assumed at 60:40. The main difference between the inventories of these two systems were mainly on fencing and animals stock. The quotation of fencing and animals was obtained from the department of agriculture using 2016 constant prices.

Table 4.1: Inventory for a sheep system

Inventory Items	Current value in Rands
Offices	35 200
Irrigation equipment	8 666.66
Shearing equipment	12 000
Workshop and shed	35 200
Kraal	7000
Feeding places	19 600
House and cottages	704 000
Water troughs	5 600
Engine pump	13 000
Fencing	916 666.66
Truck 2.0 tonne	168 000
Ripper	9 000
Mouldboard Plough	7 490
67 KW tractor (2)	4 27 521
Trailer	45 933.33
Ford Ranger	224 000
Farm Bike (Suzuki)	11 120
Office furniture & equipment	15 300
Tools	108 000
Value of flock	3 837 500
Land value	7 000 000
Total value of Inventory	13 610 798

Table 4.2: Inventory for a game system

Inventory Items	Current value in Rands
Offices	48 000
Workshop and sheds	32 000
Water points	75 000
Houses and cottages	640 000
Improvements to house and cottages	48 000
Fencing	7 500 000
Roads	90 000
Bomas	100 000
Visitor facility	15 000
Dam	200 000
Amenity value	10 000
Slaughtering and packing facility	75 000
Amarok (1)	176 000

Table 4.2 (cont.)

Inventory Items	Current value
Ford ranger(1)	192 000
Land rover(1)	415 960
farm bike(2)	22 240
Offices furniture and equipment	22 500
Tools	108 000
Tractor (2)	213 760.50
Trailer (1)	45 933.33
Golf cart(2)	60 000
Value of game Stock	3 472 000
Value of Land	7 000 000
Total value of inventory	20 561 394

The game farming system encloses three species namely: gemsbok, kudu and springboks while the sheep system consists of only the merino breed. Large variations were experienced in fencing costs. The quotation for the game fence investment requirements depend on herd size and composition, which is determined by the carrying capacity of veld and pastures. These compositions came from assumptions made on the ram to ewe ratio and replacement policy. For the Beaufort West area 5 hectares of pasture assumed to carry one small stock units of livestock (SSU) of sheep. While 25 hectares of veld is assumed to carry one large stock unit of game (LSU). Game numbers were determined by dividing 3 500 hectares (which is the size of farm) by 25 hectares carrying capacity to give 140 large stock units of game (Bothma & Du Toit, 2016).

Van Oudtshoorn (2007) & Meissner (1982&1983) define a livestock unit (LSU) (here in referred as one large stock unit) as an animal that weighs 450 kilograms. Given the aforementioned, one gemsbok is equivalent to 0.5 LSU, whilst springbok is 0.2 LSU and 0.89 LSU for Kudu respectively. The proposed composition for game is 40% of the land being allocated to gemsbok, 24% of the farmland allocated to springboks and 26% allocated to kudu. The farm thus carries 100 gemsboks, 218 springboks and 97 kudu without exceeding the carrying capacity.

For the sheep system, a fixed lambing system is assumed and one-ram mates with 35 ewes. The assumption on conception rate was 95%. It is the number of ewes that lamb per number of ewes mated expressed as a percentage. The assumption on lambing rate was 95%, and defined as number of lambs born per ewe. Lambs lived with ewes until they were ready for the market. They were ready for the market at five months old. Wool, mutton and lamb were the sheep products produced and sold. Lamb mortality rate from birth to weaning assumption was 12% due to high predation in the Karoo and a further five% envisaged after weaning.

A 95% lambing rate was assumed in a game system and the mortality rate was five%. The weaning rate was 95% for all species. Hunting was the chief economic activity. Lastly, the output values and validation of results was agreed at through consultation with experts.

4.13.2 Prices and costs

Sheep feed consisted of purchased and own farm produced. Feed production cost was R69 302 that include kikuyu, smuts finger grass (dry land) veld and oats. Purchased feed costs amounted to R59 149 which included lambing licks (including transport), summer phosphate licks and costs of finishing lambs in the feedlot. Annexure A displays price and costs in detail.

4.13.3 Machinery, infrastructure and implements

Replacement of game fencing was after 12 years and repairs were on annual basis. Since Kudu jump and gemsbok and springbok crawl underneath, the height of fencing was between 2.4m high with 21 strands of wire. Tractors are used to carry grass, food to bomas and broken material and equipment to the workshop in a game system. There are differences on implements such as irrigation equipment, kraal, feeding troughs, water troughs, fencing and paddocks previously used in a sheep system replaced by water points, game fencing, new roads, bomas and visitor friendly amenities when moved to game farming.

4.13.4 Dynamics in the Budget Model

The whole-farm budget model was established in Excel spreadsheet program and connected with a sequence of equations. These equations helped to replicate the interrelationship in whole farm systems. The importance of the systems approach when dealing with complexity in farms systems was explained previously. A sequence of equations with connections that show relationships in whole farm budget components. These relationships have an impact on outputs of the budget model and whole farm profitability when the financial variables are changed. Various formulas and functions were used in an Excel spreadsheet program to help link relationships among numerous components in the farm budget model.

The models show relevant items that determine the physical and financial extent of the whole farm situation. These items are incorporated in the first part of the budget model. The items included farm characteristics, inventory and farm stock, historical cost of machinery and input prices. The sheet also contained inputs used to calculate gross margins, net profits and whole farm profitability. All cells in gross margin calculations and whole farm multi-period budget cash flow sheets contain numerous formulas that have been used in the first sheet to calculate profit margins. Therefore, alteration of input data in the first sheet resulted in a sequence of changes occurring which affect that net annual flows determining internal rate of return (IRR). An example of the above situation is that any alteration in prices of inputs impact gross margin and has an effect on whole farm net annual cash flow. The importance of using budget models is that one set of data variables can be used whilst other variables remain constant.

4.13.5 Gross margin and net profit analysis

The budget models were used to calculate total revenue received, gross and net profit margins. Gross and net profits margins are key measures when assessing the financial stability and overall strength of the system. It is often easier for a business to increase its profitability by reducing costs than by increasing sales, especially in current operational environments that are very competitive.

Table 4.3: Revenue generated by the sheep production system

Total Revenue (R)	Per Ewe (R)	Per S.S.U. (R)
989 768 (Wool)	990	862
452 714 (Lamb/mutton)	453	394
1 442 482 (Grand total)	1 442	1 257

Table 4.3 shows that lamb/mutton and wool contributed 31.4% and 68.6% respectively to total income.

Table 4.4: Gross margin and net profit generated by the sheep production system

	R/whole farm	R/Ha
Total Income	1442482.25	412
Gross profit margin %	77	77
Net profit margin %	64	64

4.13.6 Income generated from game farming

The results from the budget model (income statement) revealed that game farming generates a net profit of R949 912 per year and R270 per hectare. Biltong hunting contributed 57% of the income while trophy hunting accounted for 9%; animals sold for meat accounted for the remaining percentage. Detailed information is provided in Annexure A.

4.13.7 Analysis of whole farm financial performance of converting from sheep to game farming

The current financial performance of a sheep system and financial implications of switching to game farming were analysed using the internal rate of return (IRR), expected cash flow and investment in inventory. Internal rate of return and cash flow calculations are done in the multi-period budget sheets, refer to Annexure C.

Firstly, the average nominal interest rate was 11%, the inflation rate was 6% and the real interest rate was 5.7% (Statistics South Africa, 2016; South African Reserve Bank, 2016). The results from the budget model showed an internal rate of return (IRR) of 4.02% for the sheep system. An internal rate of return of 4.02% shows that a typical sheep system in Karoo is profitable. Figure 4.3 indicates that yearly cash flow are positive and amount to R800 000 per year on average.

The results from a typical game farming model revealed an internal rate of return (IRR) of 5.86%. An IRR of 5.85% illuminates that an investment in game farming over 20 years is profitable and more attractive to investors. Figure 4.4 indicates that yearly cash flow are positive and amount to R1.8 million on average per year. This amount is the average of both cash inflow and outflow divided by 20 years, duration of the project. A larger portion of cash generated in year 15 was spend in replacing the assets. In year 10, asset replacement costs exceeded cash generated and this resulted in the cash flow becoming insignificant as indicated by Figure 4.4.

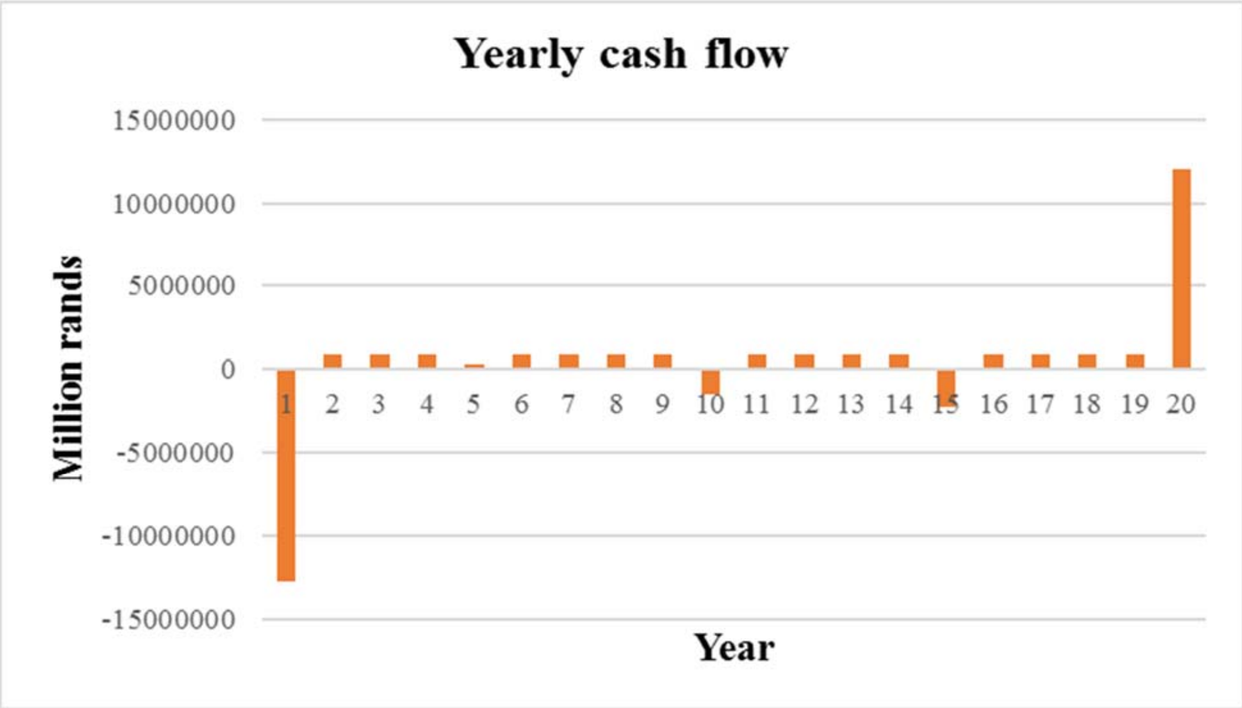

Figure 4.3: Projected yearly cash flow in a sheep production system

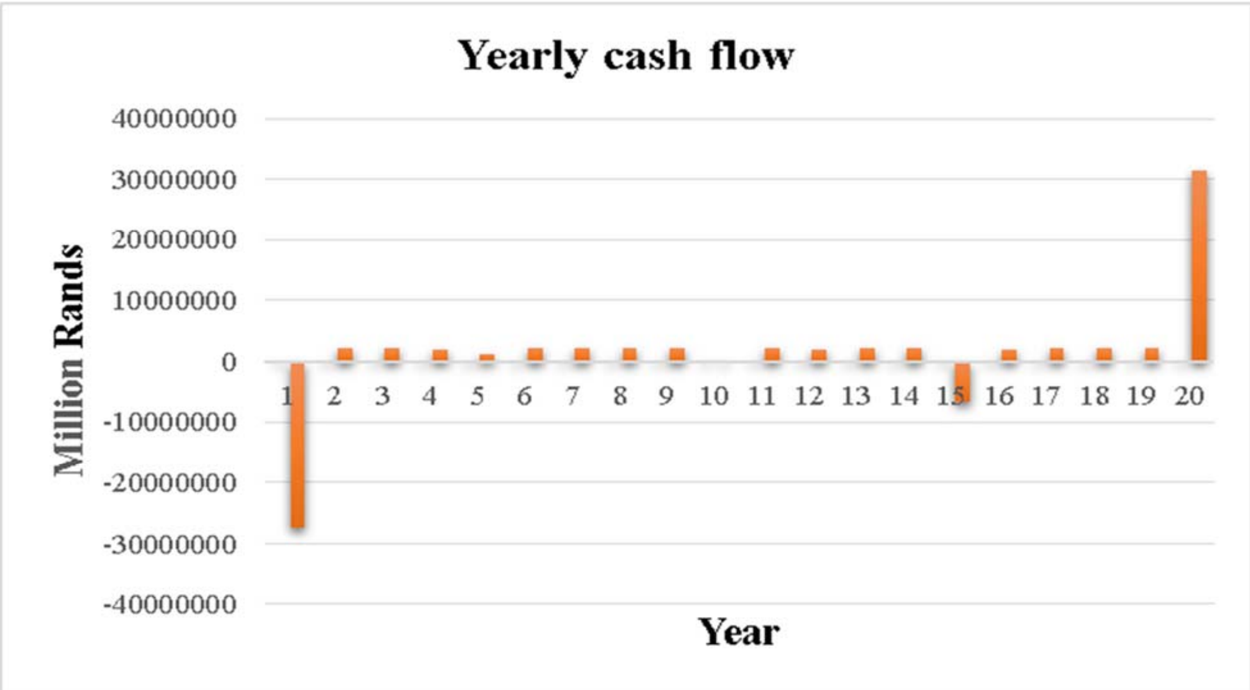

Figure 4.4: Projected yearly cash flow in a game farming system

4.13.8 Analysis of financial and managerial implications through scenarios

This section provides an analysis of financial and managerial implications of converting from sheep to game farming in the Karoo region using scenarios. Therond et al. (2009) state that scenarios are a visual depiction of possible future situations. Scenarios have joint features;

they start from an original situation (the current one) and then study the state of actions and consequences causally connected to demonstrate a final state in a determined period. In model simulation, scenarios show differences in assumptions used in fabricating models (Tomasello et al., 2005).

One of the reasons for using scenarios in research is that they investigate and show the effects of 'what if' questions. For example, when investigating the impact of whole farm profitability in the event of a drought occurrence, they calculate impact of a five % increase in the mortality rate. For the purpose of the research, the principle of (*ceteris paribus*) is used and it refers to the effect of one economic variable on other variables, while other variables are kept constant (Knott, 2015). Three scenarios were formulated to define the sensitivity of various factors that are most likely to change in assumptions. With the help of budget models, it becomes easy to examine the impact of change in various assumptions on whole farm profitability. The scenarios used are drought occurrence, decrease in carrying capacity and increase in game prices.

Under normal conditions, an assumption is that the mortality rate in the Karoo region is two%. This value was arrived through consultation that involved professionals from various disciplines such as animal science, agricultural economics, wildlife managers and producers as well as well as farmers and farm managers. The drought scenario applied in the budget model assumes that because of the drought occurrence in Karoo, the mortality rate increases from two% to five%. The aim was to assess the impact on whole farm profitability using the IRR. Table 4.5 reveals that IRR decreases. Therefore, a drought scenario decreases whole farm profitability.

Table 4.5: Scenario 1 where there is a drought situation

Increasing mortality rate/drought			
Mortality rate	2%	Increases to 5%	Mortality rate change by 3%
Whole farm profitability	Actual IRR	New IRR	Relative Change in IRR
	5.85%	Decreases to 5.53%	5.79%

The carrying capacity of Karoo game farms is 25 hectares of veld carrying one large stock unit of game (Bothma & Du Toit, 2016). However, during discussion and consultations possibilities of 50 hectares carrying one large stock unit was recognised. The carrying capacity scenario therefore assumed 50 hectares carrying one large stock unit of game. The aim was to assess the impact on whole farm profitability using IRR. The scenario also came because of other views on carrying capacity explained in literature. Table 4.6 reveals that IRR decreases, therefore, a scenario with carrying capacity decreases whole farm profitability.

Table 4.6: Scenario 2 change in carrying capacity

Decrease in carrying capacity			
Carrying capacity	25ha:1LSU	50 ha : 1LSU	Change in carrying capacity
Game farming system profitability	Actual IRR	New IRR	Relative Change in IRR
	5.85%	decreases to 2.41%	142.73%

Table 4.7: Scenario 3 higher prices of game

Profitability in whole game system	**Actual IRR**	**IRR**	**Relative Change in IRR**
	5.85%	Increases to 7.45%	12. 48%

In South Africa, game animal prices and services vary from place to place and from season to season. The scenario came from discussion and consultations and the experts agreed on the value. The scenario evaluated the impact of high game prices on whole farm profitability. Results indicated in Table 4.7 reveals that IRR increases. Therefore, higher game price increases whole farm profitability.

4.14 Conclusion

Financial and managerial performance of typical farms in Beaufort west Karoo were established using numerous parameters developed and validated to represent the most likely situation. The parameters were used to analyse the impact of change in external factors using scenarios. Budget models are dynamic; as a result, complexity in whole farm situation can be incorporated easily and accommodated. The budget models were used to determine current profitability in a typical sheep system and implications of converting to a game farming system. The results showed that sheep production is profitable from an IRR perspective. The game farming system showed a higher IRR. Which shows that it is more profitable to convert from sheep to game farming.

The inventory requirement indicated that more than double is required in game farming than in sheep farming. Also, game farming is associated with high fencing costs as well as development of infrastructure. In general, game farming has higher capital investment requirements and this means that access to external sources of funds is a prerequisite for the conversion to be successful.

The budget model investigated most likely effects on whole profitability in change in external factors. Three scenarios were selected because of issues noted during consultations and discussion with experts. Results showed that a decrease in carrying capacity had the highest negative impact on whole farm profitability. Drought occurrence decreases profitability relatively lower than carrying capacity. Lastly, the scenario with higher prices of game showed a positive impact on profitability.

CHAPTER 5

Conclusions, Summary and Recommendations.

5.1 Conclusions

An investigation of the financial and managerial implications of converting from livestock farming to game farming was the focus of this research. It was undertaken because the rate of conversion is growing in geographical terms in South Africa, yet not much is known regarding the financial performance of such a transition especially within the Karoo biome area of Beaufort West. Game farming is a complex practise due to its exposure to risk and uncertainties together with a huge initial capital requirement. In South Africa, game farming is mainly practised by high-income or lifestyle investors. This study aimed to assess whether or not, it is profitable for current livestock farmers in the Karoo biome area of the Beaufort West region to convert from sheep farming to game farming. To date, there is lack of published and peer reviewed literature at farm level that shows the financial and managerial implications of such a conversion. In order to address the main research question (objective), two specific research goals were pursued namely;(i) to determine the practical, and cost, implications of changing from livestock to game farming and (ii) to assess whole farm profitability in the long-run.

The literature review undertaken in this study, showed that game farming offers several socio-economic and environmental benefits compared to sheep systems. Amongst these benefits are the generation of higher incomes, employment creation and conservation of biodiversity. In the literature review, the possibility of co-existence between livestock and game animals in the same farm, under the same management, was found to be feasible as long as sustainable stocking rates are maintained. In addition, the literature review recognised that game faming requires a lager investment capital. It was further acknowledged that game animals are more resilient to stress conditions such water shortages. Some livestock animals cannot survive because they require a constant supply of water.

Amongst the sheep systems utilised in the Karoo area, grazing on the natural veld was found to be the cheapest way of producing sheep, but challenges come from sustainability and viability facets. It was also noted that extensive sheep systems are more vulnerable to predators and stock theft.

In contrast to the fact that game farming provide higher income than livestock farming, some studies argued that springbok production in the Karoo biome area generates lower returns relative to sheep farming. This was mainly attributed to substantial capital requirements in establishing the game farms. However, springbok production provides more ecological benefits than sheep farming. Moreover, it was also shown in the literature review, that game farming practises are more productive and support the environment more than livestock production. This is because most game farmers practise rotational grazing systems.

This study used key informant interviews, semi structured interviews and internet sources to gather data. The interviews allow free exchange of information and ideas between the researcher and interviewees. A multi-period budget modelling technique was used in the analysis. The budget models were used because of their ability to capture whole farm components in a manner that assists in making predictions on effects that various farm factors have on farm profitability. Budget models were also used because they use standard accounting criteria (i.e. internal rate of return (IRR) and net present value (NPV)) to measure and quantify profitability in whole farm systems. The budget models are valuable decision making techniques because of their ability to simultaneously assess all elements in the system. Through a sequence of interrelationships and it is able to display the most probable farm financial situation (Hoffmann, 2010).

The research results and findings applied to the methodological approach and analytical framework where presented in a comprehensive and robust manner. The impact of the managerial and financial implications were analysed using internal rate of return (IRR). The results from the sheep system revealed a 4.02% internal rate of return, average annual cash inflow amounting to R800 000 and investment and assets replacement capital of approximately R 13.6 million. A 4.02% internal rate of return showed that the sheep system is profitable. The results from the game farming model revealed an internal rate of return of 5.86%, yearly cash inflow amounting to R949 912 on average and approximately R 29.4 million in investment capital and assets replacement. A 5.86% internal rate of return for game farming revealed that converting a sheep system to a game farming system over a 20-year period is more profitable. Three scenarios, namely; (i) occurrences of drought, (ii) change in carrying capacity and (iii) change of game prices, were assumed relevant to game farming and were also simulated. Of these scenarios, only the higher game price scenario showed a positive effect on whole farm profitability while the other two, drought situation and decrease in carrying capacity scenarios, decreased the whole farm profitability. From this evidence it seems that converting from sheep to a mixed game farm is more profitable over the longer term. Despite of the initial high capital requirements it can generate a higher return on investment.

5.2 Summary (thesis overview)

In this thesis, the financial and managerial implications of converting from livestock farming to game farming were examined. The importance of this issue is embedded in the economic importance of sheep as well s game farming, but also wider effects such as ecological sustainability and employment.

Chapter 2 provided an in depth background and review of game and livestock farming industries. Literature showed that agriculture practises have both negative and positive impact on the natural environment. Currently, South Africa is experiencing water shortages and the country could benefit in that regard if some of its agriculture land is used for game farming practises. It was noted that the livestock and game farming industries are significantly important both in the global and South African economy. The livestock industry provides socio-economic as well as ecological conservation benefits. Both, the global and South African red meat production and consumption was found to be increasing.

With an increasing awareness of healthy foods, game could present a good altenative source of meat. The Karoo biome utilise both extensive and intensive systems for game and livestock production. It appears that game farming is increasing in popularity in present day South African agriculture and is expanding geographically. Switching farming systems expose farmers to several challenges, and the conversion should be done with proper planning, otherwise it could lead to unintended consequences such as reduced profits. The review of literature also showed that hunting is the economic pillar of the game farming industry in South Africa. Currently, the Limpopo province is the leading hunting destination. South Africa has an abundance of arid and semi-arid land that needs to be utilised to full capacity and putting that land under game farming activities would improve the economy, and sustain the environment. The need for a large investment capital in developing infrastructure, particularly purchasing and erecting fencing as well as buying game was highlighted in the review. The importance of provincial requirements when a livestock farm is converted to a game farm was noted, to be essential for farmers. This is in order to be granted an operating licence by the South African government.

Chapter 3 revealed the importance of policy and legislations and research on the history and development of game farming in Africa and South African. This is to provide context in order draw lessons from experiences of other countries. Literature showed that development of private wildlife farming in Africa should acknowledge the research conducted in Zimbabwe formerly known as Rhodesia. The research proved the ability of game to coexist with livestock in the same farm. It also illuminates the habitat use of wild life animals to the natural environment. In South Africa, there has been numerous views on the origins of game farming industry. The first game farms have been between 1894 and 1898 in Transvaal and Zululand. Literature also showed that game farming was formally recognised in 1987, by the South African government. The deregulation of the agricultural sector post-apartheid era led to improvements in eco-tourism activities and conservation. Sustainability agendas and numerous policies have played an important role in growing the South African game farming industry. Private wildlife in South Africa is utilised through game farming and game ranching activities. If livestock and game animals are produced on the same farm, they compete for grazing pastures, while diseases can be transmitted to livestock. An investment in game farming could provide ecological benefits, but converting a livestock farm to a game farm require a large initial capital investment in establishing and developing essential infrastructure. More than half of the external sources of finance available for South African farmers come from private financial institutions.

Chapter 4 showed how the multi-period budget models were developed and used in analysing financial and managerial implications of converting from livestock farming to game farming in Beaufort West Karoo, in South Africa. The analytical framework for the above-mentioned methodological approach, quantified whole farm financial performance, using profitability indicators such as internal rate of return (IRR) and net present value (NPV). The relationship between the variables in the model was also discussed and it has been shown how the variables are interconnected. The profitability indicators were discussed, focussing on, how they are used to measure whole farm feasibility. The other part of the analysis used scenarios to investigate the impact of those external factors that change in assumptions and three scenarios were simulated.

The main aim of the research was to assess if it is profitable for a current livestock farmer to convert to game farming in the Beaufort West-Karoo biome area in South Africa. Interviews and internet sources were used to collect data. Multi-period budget models were developed and used to analyse the results, using the IRR and NPV to measure and quantify the feasibility of whole farm systems. The results revealed that sheep farming is profitable but converting to game farming is more profitable and attractive to investors. Amongst the scenarios simulated, the higher game prices scenario, showed an increase in profitability whilst the drought occurrence and change in carrying capacity scenarios showed a decrease in profitability.

5.3 Recommendations

It is recommended that the approach used in this study should be applied in other areas of the country to see if similar results can be obtained. Further studies should also include other game species (exotic) apart from those utilised in the study and other livestock animals. It is recommended that future studies should be conducted on different farms characterised by different sizes and tenure, than the one used in this study. The results obtained in this study are only applicable to the Beaufort West, Karoo biome area. As a result, the empirical findings coming from this research, should not be treated as a "one size fits all" approach and thus a detailed analysis should be conducted in other areas before making any decisions.

In this study a current farm type, sheep farming, was basically presented as the "alternative" for game farming. It could be insightful to develop, and financially assess, alternative conversion strategies. These could include initially farming with only springbok "in combination with sheep". This would lessen the initial investment requirements, because investment in high, and expensive, fences would be postponed.

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Annexure A: Income statements

Income statement showing gross and net profit for a sheep production system

REVENUE FROM SHEEP SALES											
	Number	**Mass/ Unit (Kg)**	**Total Mass (Kg)**		**Dressing %**	**Price (R/kg)**	**Total Revenue (R)**	**Per Sheep Sold (R)**	**Per Ewe (R)**	**Per S.S.U. (R)**	**R/Ha**
Lambs	500	42	21 000		52.00%	60	655 200	833	655	571	2 978
Cull Ewes	277	55	15 235		52.00%	40	316 888	403	317	276	1 440
Cull Rams	10	85	850		52.00%	40	17 680	22	18	15	80
Total number sold	787										
Total Value of Lamb/ Mutton sales							989 768	1258	990	862	4 499
REVENUE FROM WOOL SALES											
		Number	Wool	60 % clean	Total Wool	Price	Total	Per Sheep Shorn	Per Ewe	Per S.S.U.	R/Ha
		Shorn	(Kg/ animal)	wool	(Kg)	(R/Kg)	(R)	(R)	(R)	(R)	(R)
Rams		50	6.5	3.9	195	85	16 575	7	17	14	75
Ewes		1 025	4.5	2.7	2 767.5	85	235 238	96	235	205	10 69
Old Ewes		277	3.75	2.25	623.25	85	52 976	22	53	46	241
Replacement Ewes		311	3	1.8	559.8	85	47 583	19	48	41	216
Lambs		787	2.5	1.5	1 180.5	85	100 343	41	100	87	456
Total Shorn		2 450									
Total revenue from wool sales					5 326.05		452 714	185	453	394	2 058

TOTAL REVENUE FROM LIVESTOCK											
								Total (R)	Per Ewe (R)	Per S.S.U. (R)	R/Ha
Sheep Sales								98 968	990	862	4 499
Wool Sales								452 714	453	394	2 058
Total Revenue								1 442 482	1 442	1 257	6 557
Sheep Feed Cost											
Farm produced feed	Area	Stocking Rate	D.M. Yield		Total Quantity	Fod-der Cost	Total Cost	Per Ewe	Per S.S.U.	Cost/Ha	
	(ha)	(S.S.U./ ha)	(m.t./ha)		(m.t)	(R/ha)	(R)	(R)	(R)	(R/ha)	
Oats/Rye (Strategic Irrigation)	5	15	8		40	5 247	26 235	26.24	22.85	119.25	
Veld	200	0.3	1.5		300	0	0	0	0	0	
Kikuyu	8	15	10		80	3 496	27 968	27.97	24.36	127.12	
Smuts Finger Grass (Dryland)	7	15	6		42	2 157	15 099	15.01	13.15	68.63	
TOTAL	220				462		69 302	69.30	60.37	315.00	
Purchased Feed Costs	Quantity (kg)	Cost/Unit (R)	Ration Unit (m.t.)		Transport Unit (Tons)		Total Cost (R)	Per Ewe (R)	Per S.S.U. (R)	Cost/Ha (R/ha)	
Lambing Lick (Including Transport)	12.3	2 754	1				33 874.20	33.87	29.51	153.98	
Other purchased feed + cost of finishing*	432	10					4320	4.32	3.76	19.64	
Summer Phosphate Lick	5.5	3 311.6	1				18 213.80	18.21	15.87	82.79	
Transport Cost (50km @ R154.00/t)	17.8	154			5.5		2 741.20	2.74	2.39	12.46	
Total Purchased Feed Cost (e)							59 149.20	59.15	51.53	268.86	

TOTAL FEED COSTS (d + e = F)							128 451.20	128.45	111.89	583.87	
FINISHING OF LAMBS IN FEEDLOT											
Number of lambs	1		500								
Kgs when taken in	30										
Kgs %	36								**LAMBS IN FEEDLOT**		
Kgs when taken out	42							Price for meat	60		
								Price for wool (Feedlot/Abattoir)	2		
Battle of averages	43%							Age sell (moths)	8		
Battle ok kgs	47%							Weight	42		
								Battle %	47%		
Growth per day(gs)	0.275							income meat	1 184.4		
% change in body per day	5%							Revenue Wool(Feedlot/A battoir)	39.48		
									1 223.88		
Days in and out	43.64							Kg. wool shorn	1.2		
Kgs of feed eaten per day	1.8		900					Rand per Kg greasy	100		
									120		
Kgs of feed eaten in feedlot	78.54		39 272.72						1 343.88		
Number of 50kgs of fodder	1.57		1.57					Shave costs	10		
Price of 50kgs of pills	220							Work	3		

Price of feed / kg	4.4							Medicine	3		
								Transport	5		
Cost of Feed Eaten in Feed Lot	R345.60		172 800					Feed cost	345.6		
									977.28		
Kgs feed eaten : kg body weight	6.54										
kgs feed eaten (kg beef up)	13.93										
Cost of food compared to kgs of meat produced	Kilograms	Price									
cost of feed compared to 1kg											
feed	13.92	4.4									
meat	1	62									
Cost of feed : meat picked in feed lot											
feed	78.54	4.4	345.6								
meat	5.64	62	349.68								
Profit (loss) per sheep fed			4.08								
Loss for Total sheep fed			2040								
OTHER ALLOCATED COSTS FOR EXTENSIVE WOOL-MUTTON SHEEP											
		Quantity	Cost/Unit				Total Cost	Per Ewe	Per S.S.U.	Cost/Ha	
			(R)				(R)	(R)	(R)	(R)	
Veterinary: R37/ewe/ annum		1000	37				37 000	37	32.23	168.18	
Shearing:		1382	12				16 584	16.58	14.44	75.38	

1382 sheep/annum											
Transport: 1067 animals		1 067	14.26				15 215.42	15.21	13.25	69.161	
Marketing: (see Appendix 1)							91 431.83	91.43	59.83	415.60	
Purchase of Rams		7	7000				49000	49	42.68	222.73	
TOTAL OTHER ALLOCATED COSTS (G)							209 231.25	209.23	162.44	951.05	
TOTAL ALLOCATED COSTS (F + G = H)							337 682.45	337.68	274.33	1 534.92	
GROSS MARGIN FOR EXTENSIVE WOOL-MUTTON SHEEP											
							Total (R)	Per Ewe (R)	Per S.S.U. (R)	Per Ha	
GROSS INCOME (C)							1 442 482.25	1 442.48	1 256.52	6 556.74	
FEED COSTS	TOTAL FARM PRODUCED FEEDS						69 302	69.30	60.37	315.00	
	TOTAL PURCHASED FEEDS						591 49.20	59.15	51.52	268.86	
TOTAL FEED COSTS (F)							128 451.20	128.45	111.89	583.87	
OTHER ALLOCATED COSTS (G)							209 231.25	209.23	182.26	354.50	
TOTAL ALLOCATED COSTS (H)							337 682.45	337.68	294.15	785.45	
COST OF FEED IN FEEDLOT							172 800	172.80	150.52	785.45	
GROSS MARGIN (C - H)							1 104 799.80	1 104.7998	962.37	5 021.82	
NET PROFIT FOR THE YEAR							926059.8	926.06	6 257.16	4 209.36	
GROSS MARGIN %							76.60	64.20	76.60	76.59	
NET PROFIT MARGIN%							64.20	64.20	497.98	64.20	

Income statement showing gross and net profit for a game farming system

Trophy hunting packages per plain animal	Prices	Number of animals hunted and culled	Total revenue per day	Total revenue for per annum	Revenue per hectare	Revenue per LSU
Daily rates				5		
2X1hunters	500	21	10500	10 500		
Non-hunter observer	500	16	8000	8 000		
Riffle hire per day (2to 3 of them)	0		0	0		
cameramen per day (videography)	0		0	0		
Prices of trophy per animal						
Kudu	40 000	5	200 000	200 000		
Gemsbok	36 000	5	180 000	180 000		
springbok	21 257	11	233 827	233 827		
Total trophy hunting cost per day	98 257					
Biltong hunting						
Prices per animal						
Kudu	6 000	34	204 000	204 000		
Gemsbok	5 500	35	192 500	192 500		
Springbok	2 500	77	192 500	192 500		
Day fees per hunter	500	50	25 000	125 000		
Non-hunter	400	50	20 000	100 000		
Total			12 66 327	1 446 327		
Animals sold for meat						
Kudu	6 000	48	289 800	289 800		
Gemsbok	5 500	50	275 000	275 000		
Springbok	2 500	108	270 500	270 500		
Total				835 300		
Total				2 515 454		
These costs include all the process including slaughtering facilities;						
Less variable costs						
Licks				15500		
Feed supplements				70 000		
Medication and veterinary				0		
Total				2 429 954		
Gross profit				1 360 827	388.81	3 279.10
Net profit				949 912	271.40	2 288.94

Annexure. B Multi-period budget models

A multi-period budget model for a sheep production system

Multi-period budget																				
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Income/sheep	1442482	1442482.25	1442482.25	1442482.25	1442482.25	1442482.25	1442482.25	1442482.25	1442482.25	1442482.25	1442482.25	1442482.25	1442482.25	1442482.25	1442482.25	1442482.25	1442482.25	1442482.25	1442482.25	1442482.25
Other income	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Directly allocable variable costs																				
Farm pro-duced feed costs	69302	69302	69302	69302	69302	69302	69302	69302	69302	69302	69302	69302	69302	69302	69302	69302	69302	69302	69302	69302
Pur-chased feed costs	59149	59149	59149	59149	59149	59149	59149	59149	59149	59149	59149	59149	59149	59149	59149	59149	59149	59149	59149	59149
Veterinary	37000	37000	37000	37000	37000	37000	37000	37000	37000	37000	37000	37000	37000	37000	37000	37000	37000	37000	37000	37000
shearing	16584	16584	16584	16584	16584	16584	16584	16584	16584	16584	16584	16584	16584	16584	16584	16584	16584	16584	16584	16584
transporting	15215	15215	15215	15215	15215	15215	15215	15215	15215	15215	15215	15215	15215	15215	15215	15215	15215	15215	15215	15215
Mark-eting	91432	91432	91432	91432	91432	91432	91432	91432	91432	91432	91432	91432	91432	91432	91432	91432	91432	91432	91432	91432
Purch-asing of ani-mals	49000	49000	49000	49000	49000	49000	49000	49000	49000	49000	49000	49000	49000	49000	49000	49000	49000	49000	49000	49000
Total directly alocatable var-iable costs	337682.45	337682.45	337682.45	337682.45	337682.45	337682.45	337682.45	337682.45	337682.45	337682.45	337682.45	337682.45	337682.45	337682.45	337682.45	337682.45	337682.45	337682.45	337682.45	337682.45
Non-directly a locatable variable costs																				
Bank costs	3 000	3 000	3 000	3 000	3 000	3 000	3 000	3 000	3 000	3 000	3 000	3 000	3 000	3 000	3 000	3 000	3 000	3 000	3 000	3 000
Aud-iting fees	15 000	11 000	11 000	11 000	11 000	11 000	11 000	11 000	11 000	11 000	11 000	11 000	11 000	11 000	11 000	11 000	11 000	11 000	11 000	11 000
Stat-ionery	1 200	1 200	1 200	1 200	1 200	1 200	1 200	1 200	1 200	1 200	1 200	1 200	1 200	1 200	1 200	1 200	1 200	1 200	1 200	1 200

Tel, and com-munication	20 000	7 000	7 000	7 000	7 000	7 000	7 000	7 000	7 000	7 000	7 000	7 000	7 000	7 000	7 000	7 000	7 000	7 000	7 000	7 000
Repair and maint-enance	25 409	25 409	25 409	25 409	25 409	25 409	25 409	25 409	25 409	25 409	25 409	25 409	25 409	25 409	25 409	25 409	25 409	25 409	25 409	25 409
Elect-ricity	24 000	24 000	24 000	24 000	24 000	24 000	24 000	24 000	24 000	24 000	24 000	24 000	24 000	24 000	24 000	24 000	24 000	24 000	24 000	24 000
Bank char-ges	3 000	3 000	3 000	3 000	3 000	3 000	3 000	3 000	3 000	3 000	3 000	3 000	3 000	3 000	3 000	3 000	3 000	3 000	3 000	3 000
Water costs	25 000	8 000	8 000	8 000	8 000	8 000	8 000	8 000	8 000	8 000	8 000	8 000	8 000	8 000	8 000	8 000	8 000	8 000	8 000	8 000
Total non-var-iable over-heads	116 609	82 609	82 609	82 609	82 609	82 609	82 609	82 609	82 609	82 609	82 609	82 609	82 609	82 609	82 609	82 609	82 609	82 609	82 609	82 609
Fixed overheads																				
Admin	5 000	5 000	5 000	5 000	5 000	5 000	5 000	5 000	5 000	5 000	5 000	5 000	5 000	5 000	5 000	5 000	5 000	5 000	5 000	5 000
Mun-icipa tax	6615	6615	6615	6615	6615	6615	6615	6615	6615	6615	6615	6615	6615	6615	6615	6615	6615	6615	6615	6615
Lic-enses	8 425	8 425	8 425	8 425	8 425	8 425	8 425	8 425	8 425	8 425	8 425	8 425	8 425	8 425	8 425	8 425	8 425	8 425	8 425	8 425
labour costs	124 000	124 000	124 000	124 000	124 000	124 000	124 000	124 000	124 000	124 000	124 000	124 000	124 000	124 000	124 000	124 000	124 000	124 000	124 000	124 000
Total over-heads	1440 40	1440 40	1440 40	1440 40	1440 40	1440 40	1440 40	1440 40	1440 40	1440 40	1440 40	1440 40	1440 40	1440 40	1440 40	1440 40	1440 40	1440 40	1440 40	1440 40
Total costs (Var-iable and over-heads)	598 332	564 332	564 332	564 332	564 332	564 332	564 332	564 332	564 332	564 332	564 332	564 332	564 332	564 332	564 332	564 332	564 332	564 332	564 332	564 332
Capital investment + asset replacements	13 610 798	0	0	0	5739 00	0	0	0	0	2414 642	0	32 980	0	0	3182 800	0	0	0	0	2414 642
Yearly cash flow	-12 766 647	878 151	878 151	878 151	304 251	878 151	878 151	878 151	878 151	-1 536 491	878 151	845 171	878 151	878 151	-2 304 649	878 151	878 151	878 151	878 151	12 074 306

Internal Rate of Return (IRR) 4.02%
Inflation rate 6.00%
Nominal interest rate 11%
Real rate 5.71%

A Multi-period budgetmodel for a gamefarming system

Multi-period Budget																				
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Revenue from trophy hunting	233827	233827	233827	233827	233827	233827	233827	233827	233827	233827	233827	233827	233827	233827	233827	233827	233827	233827	233827	233827
Revenue from biltong hunting	1446327	1446327	1446327	1446327	1446327	1446327	1446327	1446327	1446327	1446327	1446327	1446327	1446327	1446327	1446327	1446327	1446327	1446327	1446327	1446327
revenue from culling	835300	835300	835300	835300	835300	835300	835300	835300	835300	835300	835300	835300	835300	835300	835300	835300	835300	835300	835300	835300
Total revenue generated	2515454	2515454	2515454	2515454	2515454	2515454	2515454	2515454	2515454	2515454	2515454	2515454	2515454	2515454	2515454	2515454	2515454	2515454	2515454	2515454
Directly allocatable costs																				
Mark-eting	12000	12000	12000	12000	12000	12000	12000	12000	12000	12000	12000	12000	12000	12000	12000	12000	12000	12000	12000	12000
Licks	15500	15500	15500	15500	15500	15500	15500	15500	15500	15500	15500	15500	15500	15500	15500	15500	15500	15500	15500	15500
Feed Supp-liments	70 000	70 000	70 000	70 000	70 000	70 000	70 000	70 000	70 000	70 000	70 000	70 000	70 000	70 000	70 000	70 000	70 000	70 000	70 000	70 000
Total allocatable costs	97500	97500	97500	97500	97500	97500	97500	97500	97500	97500	97500	97500	97500	97500	97500	97500	97500	97500	97500	97500
Non-directly allocatable costs																				
Bank costs	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000
Auditing fees	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
Stationer	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200
Tel. and communication	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000
Repairs and maintainance	95000	95000	95000	95000	95000	95000	95000	95000	95000	95000	95000	95000	95000	95000	95000	95000	95000	95000	95000	95000
Elec-tricity	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	60000	20000	20000	20000	20000	20000	20000	20000	20000	20000
Water costs	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000
Total non variable overheads	138200	138200	138200	138200	138200	138200	138200	138200	138200	138200	178200	138200	138200	138200	138200	138200	138200	138200	138200	138200
Fixed overheads																				
Admin-stration	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000
Muni-cipality tax	6615	6615	6615	6615	6615	6615	6615	6615	6615	6615	6615	6615	6615	6615	6615	6615	6615	6615	6615	6615
Licences	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
Permitts	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
Other costs	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000

Insurance	100 000	100 000	100 000	100 000	100 000	100 000	100 000	100 000	100 000	100 000	100 000	100 000	100 000	100 000	100 000	100 000	100 000	100 000	100 000	100 000
labour costs	57600	5760 0	5760 0	5760 0	5760 0	5760 0	5760 0	5760 0	5760 0	5760 0	5760 0	5760 0	5760 0	5760 0	5760 0	5760 0	5760 0	5760 0	5760 0	5760 0
Total over-heads	179215	1792 15	1792 15	1792 15	1792 15	1792 15	1792 15	1792 15	1792 15	1792 15	1792 15	1792 15	1792 15	1792 15	1792 15	1792 15	1792 15	1792 15	1792 15	1792 15
Total costs	414915	4149 15	1792 15	1792 15	1792 15	1792 15	1792 15	1792 15	1792 15	1792 15	1792 15	1792 15	1792 15	1792 15	1792 15	1792 15	1792 15	1792 15	1792 15	1792 15
Capital invested+ assets replacement	293943 93.83	0	0	2493 54	1007 750	0	0	1000 0	0	1835 271	0	3182 54	0	0	8782 750	2593 54	0	0	0	0
Yearly total cash flow	-27 293 854.83	2 10 0 539	2 10 0 539	1 851 185	1 09 2 789	2 10 0 539	2 10 0 539	2 09 0 539	2 100 539	2 65 2 68	2 060 539	1 78 2 285	2 1005 39	2 100 539	- 6 68 2 211	1841 185	2 10 0 539	2 100 539	2 1005 39	3 1494 933

Internal rate of return 5.86%
Interest rates
Inflation rate 6%
Norminal interest rate 11%
Real rate 5.71%

Annexure C: Asset replacement for a sheep farming system

Asset Replacement																				
Years	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Buildings and installations																				
Offices	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Workshops and sheds	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Irrigation equipment	0	0	0	0	0	0		0	0	0	0	0	0	0	10 000	0	0	0	0	
Kraals and feeding places	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
House and cottages	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fencing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1 000 000	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1010000	0	0	0	0	0
Water supply																				
Engine pumps	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15 000	0	0	0	0	0
Vehicles, Machinery and Equipment																				
Truck 2.0 tonnes	0	0	0	0	280 000	0	0	0	0	280 000	0	0	0	0	280 000	0	0	0	0	280 000
Ripper	0	0	0	0	0	0	0	0	0	0	0	9 000	0	0	0	0	0	0	0	0
Mouldboard plough	0	0	0	0	0	0	0	0	0	0	0	7 490	0	0	0	0	0	0	0	0
67 KW Tractor	0	0	0	0	0	0	0	0	0	427 521	0	0	0	0	0	0	0	0	0	427 521
Trailer	0	0	0	0	0	0	0	0	0	68 900	0	0	0	0	0	0	0	0	0	68 900
Ford Ranger	0	0	0	0	280 000	0	0	0	0	280 000	0	0	0	0	280 000	0	0	0	0	280 000
Farm bike	0	0	0	0	13 900	0	0	0	0	13 900	0	0	0	0	13 900	0	0	0	0	13 900
Office furniture and equipment	0	0	0	0	0	0	0	0	0	17 000	0	0	0	0	0	0	0	0	0	17 000
Tools	0	0	0	0	0	0	0	0	0	120 000	0	0	0	0	0	0	0	0	0	120 000
Total machinery and equipment	0	0	0	0	0	0	0	0	0	1207321	0	16 490	0	0	573900	0	0	0	0	1207321
Total replacement value per year	0	0	0	0	573900	0	0	0	0	2414642	0	32 980	0	0	3182800	0	0	0	0	2414642

Asset replacement for a game farming system

Asset replacement																				
Buildings & installations	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
offices	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
workshop and sheds	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
water points	0	0	0	0	0	0	0	0	0	0	0	0	0	0	75 000	0	0	0	0	0
houses	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lodge and cottages	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fencing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7 500 000	0	0	0	0	0
Roads	0	0	0	0	0	0	0	0	0	90 000	0	0	0	0	0	0	0	0	0	90 000
Bomas	0	0	0	0	0	0	0	0	0	100 000	0	0	0	0	0	0	0	0	0	100 000
visitor facility	0	0	0	0	0	0	0	0	0	15 000	0	0	0	0	0	0	0	0	0	15 000
Dam	0	0	0	0	0	0	0	0	0	0	0	0	0	0	200 000	0	0	0	0	0
Amenity value	0	0	0	0	0	0	0	10 000	0	0	0	0	0	0	0	10 000	0	0	0	0
Slaughtering and packing facility	0	0	0	0	0	0	0	0	0	75 000	0	0	0	0	0	0	0	0	0	75 000
Springbok (rams & bulls)	0	0	0	84 000	0	0	0	84 000	0	0	0	84 000	0	0	0	84 000	0	0	0	84 000
Gemsboks (rams & bulls)	0	0	0	54 654	0	0	0	54 654	0	0	0	54 654	0	0	0	54 654	0	0	0	54 654
kudu(rams & bulls)	0	0	0	110 700	0	0	0	110 700	0	0	0	110 700	0	0	0	110 700	0	0	0	110 700
Total	0	0	0	249354	0	0	0	10000	0	280000	0	249354	0	0	7775000	259354	0	0	0	529354
Vehicles, Machinery and equipment																				
Amarok	0	0	0	0	220000	0	0	0	0	220000	0	0	0	0	220000	0	0	0	0	220000
Ford ranger	0	0	0	0	240000	0	0	0	0	240000	0	0	0	0	240000	0	0	0	0	240000
Land rover	0	0	0	0	519950	0	0	0	0	519950	0	0	0	0	519950	0	0	0	0	519950
farm bike	0	0	0	0	27800	0	0	0	0	27800	0	0	0	0	27800	0	0	0	0	27800
Tools	0	0	0	0	0	0	0	0	0	120000	0	0	0	0	0	0	0	0	0	120000
Tractor	0	0	0	0	0	0	0	0	0	427521	0	0	0	0	0	0	0	0	0	427521
Trailer	0	0	0	0	0	0	0	0	0	0	0	68900	0	0	0	0	0	0	0	0
Golf cart	0	0	0	0	0	0	0	0	0	0	0	0	0	0	60 000	0	0	0	0	0
Total	0	0	0	0	1007750	0	0	0	0	1555271	0	68900	0	0	1007750	0	0	0	0	1555271
Total Replacement of Assets	**0**	**0**	**0**	**249354**	**1007750**	**0**	**0**	**10000**	**0**	**1835271**	**0**	**318254**	**0**	**0**	**8782750**	**259354**	**0**	**0**	**0**	**2084625**