ECONOMICS OF MEAT PRODUCTION FROM THE SPRINGBUCK IN THE EASTERN CAPE KAROO

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ECONOMICS OF MEAT PRODUCTION FROM THE SPRINGBUCK IN THE EASTERN CAPE KAROO

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The feasibility of springbuck based meat production in the EC Karoo was analysed through a stochastic budgeting model, while overtly taking cost and price risk into consideration. Monte Carlo simulation of a springbuck based meat production enterprise was used to quantify the risks that would be faced by springbuck ranchers. Springbuck ranching has been proven a viable alternative in the production of highly nutritious and healthy meat (venison) that is on high demand in European markets and more recently with a promising and growing local demand as well. The results indicate that in the Eastern Cape Karoo, springbuck ranching for meat production is a viable business. As the call for more environmentally friendlier rangelands utilisation economic systems intensifies, rangelands owners in the EC Karoo have a practicable option. At the very least, an alternative to broaden their incomes with springbuck based meat production exists.

Keywords: Game ranching, Springbuck ranching, meat production, economic feasibility, Monte Carlo simulation

1. Introduction

Game ranching literature suggests several potential benefits of wild animals on the environment. Firstly, wild animals are associated with an ability to improve ecological diversity, more especially if they are natural capital or keystone species in an area. Secondly, they can facilitate the continuance of certain basic ecological functions. Thirdly, game animals have a natural ability to survive under harsh arid environments and thus are pertinent repositories of biodiversity and finally; they are more efficient users of local vegetation. Moreover, wild animals also possess other consumptive and non-consumptive benefits such as meat production and ecotourism, respectively (Gibson, 2009; Rosenzweig, 2003; Milton *et al*., 2003; Joubert *et al*., 2007). It is assumed that the re-introduction of game in fragile rangelands would aid in their recovery particularly if they (game) are keystone species or natural capital (Milton *et al*., 2003). Other potential benefits of the re-introduction of natural capital in an area include gain in biodiversity, increased species (flora and fauna) composition and the holistic re-introduction of essential ecological processes (Perrings and Walker, 1997).

The realisation of such benefits and the need to tap into them from a sustainable agriculture point of view has led to an inherent decrease in the numbers of domestic livestock in the Eastern Cape Province Karoo (EC Karoo), as rangelands owners continue to seek practicable ways to correct the effects of two centuries of commercial livestock production on the environment (Esler *et al*., 2006). Particularly, the degradation of rangelands is a cause for concern in South Africa (Vetter, 2005; Vetter, 2009; Hahn *et al*.,

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2005; Archer, 2004). Over 200 years of domestic livestock farming has left visible scars on the environment in terms of land degradation in the EC Karoo. Government has passed various laws and policies in response to the need to stimulate the sustainable use of rangelands and what should be done to achieve it. The South African LandCare Programme forms the blue print policy on the rehabilitation of degraded rangelands (NDA, 1998). Yet regardless of the government's investment in considerable research, policy and action plans, Karoo rangelands continue to linger under a cloud of controversy on whether the current livestock farming systems are the best means through which ecological sustainability and ecosystem's health can be realised (Vetter, 2009). One way to achieve ecological diversity in rangelands is through the production of wildlife or keystone species (Barnes, 1998; Kreuter and Workman, 1996; Milton *et al*., 2003; Joubert *et al*., 2007; Tomlinson *et al*., 2002).

Against this background, Prins and Grootenhuis (2000: 3) caution that the holistic conservation of biodiversity in rangelands can happen "only if there are financial attractions for the landholder" to maintain and manage the environment through wildlife conservation. Indeed, conservation initiatives are persistently failing to arrest the loss of biodiversity in rangelands because of their inability to match current economic benefits derived from the use of rangelands for traditional farming purposes like grazing by domestic livestock, notwithstanding the negative effects they (domestic livestock) have on the environment (Hodgson *et al*., 2005: 263). This failure emanates from the fact that livestock farmers and rangeland owners respectively, are mainly interested in investing in rangelands utilisation economic systems that will yield superior returns than already existing conventional uses.

Thus, the main aim of this paper is to assess the economic feasibility of springbuck based meat production in the EC Karoo, with the aim of promoting rangelands reclamation and conservation through springbuck ranching.

2. Springbuck Ranching and the Conservation of Rangelands

Interest in game ranching in South Africa has increased noticeably over the past 15 years (Tomlinson *et al*., 2002). Since 1996, meat production from wild animals and hunting have each experienced a significant increase in the number of farms that have either converted into game ranching or incorporated wildlife ranching (ABSA Economic Research, 2003; Grove *et al*., 2007; Cloete *et al*., 2007; Carruthers, 2008; Carruthers, 2009; Childs, 2009; Tomlinson *et al*., 2002; Du Toit, 2007). In the Eastern Cape Province, for example, springbuck based meat production has risen from 20 000 animals in 1996 to over 60 000 animals per year in 2009, as shown in Table 1. This has also seen the number of exclusive commercial springbuck abattoirs increasing from one in the mid-1990s to three in 2009. Further, the National Department of Agriculture (NDA) reports that the conversion rate from commercial livestock farming to game ranching in the Eastern Cape Province (ECP) alone is between 25 to 30 percent (NDA, 2009).

Table 1. Number of Springbucks Cropped for Meat Production in Graaff-Reinet

Year	Quantity (animal units)	Average Dressed weight (Kg)	Price /Kilo (Yearly average)(R)
1996	20 975	19.20	8.00
2001	31 563	15.50	11.00
2009	24 814	14.60	20.00

It has been argued that the production of wild animals, which are keystone species or natural capital in an area, could promote environmental management in rangelands (Barnes, 1998; Kreuter and Workman, 1997; Milton *et al*., 2003; Joubert *et al*., 2007). Rosenzweig (2003: 201) has termed this "reconciliation ecology" and argues that it "discovers how to modify and diversify anthropogenic habitats so that they harbour a wide variety of wild species … [and further] seeks techniques to give many species back their geographical ranges without taking away ours." Consequently, it has been shown that for an ecosystem to function properly, it should comprise a minimum number of viable keystone species to aid in seed dispersion, control of woody plant encroachment and in the maintenance of other ecological processes (Rebelo, 1997: 582). For example, Gibson (2009: 13) identifies wild herbivores as "beneficial, adaptive, or even critical", cites a range of them as keystone species for many rangelands ecosystems, and hence classifies them as "pertinent repositories of biodiversity" (Gibson, 2009: 15).

Thus, the dominance of the springbuck in the EC Karoo presents the rare opportunity to rangeland owners to incorporate conservation practices whilst getting some income through meat production. The presence of an abattoir with access to international markets makes the prospect of springbuck based meat production a viable business in the EC Karoo. Not only is the springbuck a naturally occurring gazelle - like antelope in the EC Karoo, it also pre-dates the arrival of early European farmers (Roche, 2008: 157) thus has been argued to have co-evolved with both the environment and climate (Skinner, 1970). It is believed that the over-exploitation of the springbuck for meat purposes through hunting and to free land for agriculture (essentially sheep farming) by early farmers in the Karoo, eventually lead to their extirpation (Roche, 2008; Beinart, 2003) and as such is largely to blame for the environmental discrepancies of the Karoo (Dean *et al*., 1995; Milton *et al*., 2003; Archer, 2005; Hahn *et al*., 2005). Interestingly, the re-introduction of the springbuck in many farms around Graaff-Reinet comes as a result of rangeland owners attempting to improve the profitability of their farms.

Thus in a quest to achieve sustainable agricultural practices, that will promote nature conservation and help in the reclamation of degraded lands, whilst producing food for both the local and non local communities as per the dictates of agriculture, the springbuck in the EC Karoo becomes the obvious choice.

3. Procedures

Much research has been done to evaluate the profitability of game ranching in Southern Africa and in South Africa (see for example, Grove *et al*., 2007; Cloete *et al*., 2007; Kreuter and Workman 1997). Whilst most of these studies aimed at showing that game ranching is to a certain extent a viable option to beef-cattle farming from an income diversification point of view (Grove *et al*., 2007; Cloete *et al*., 2007; Kreuter and Workman, 1997), none of these researchers looked at the economic feasibility or cost of springbuck based meat production. Further, except Skinner *et al*. (1986), none of the studies reviewed actually analysed the economic feasibility of switching from the production of one livestock species to one game species. In a study by Skinner *et al*. (1986), an attempt was made to analyse the profitability of springbuck based meat production by comparing it to the profitability of merino sheep production. Skinner *et al*. (1986) reported that the springbuck had less management costs (31.3 % of gross margin) compared to the Merino sheep (51.1 % of gross margins), and thus were overall more profitable than the Merino sheep. However, Skinner *et al*. (1986) assumed constant prices and did not consider cost and price risk. Further, they also did not look into the long-term viability of springbuck based meat production when compared to the Merino sheep.

3.1 Monte Carlo Simulation for Springbuck Based Meat Production Feasibility Analysis

One important aspect of agricultural projects is that they require "a greater attention to risk than … [any other] projects because of the large measure of unpredictability inherent in many parameters" (Simpson et al., 1977: 306). Consequently, Richardson *et al*., (2007a) identify the incorporation of both price and cost risk as a key important step in economic feasibility studies. This is beneficial in that it presents the researcher with two basic results: 1) probability of economic success; and 2) the probability of positive annual cash flow. Using these two measures, the economic feasibility of a proposed investment or business can then be analysed (Richardson *et al*., 2007a; Richardson *et al*., 2007b; Richardson *et al*., 2006). The inclusion of price and cost risk in the feasibility analysis to identify the future values because of a wide variety of potential outcomes beckons the use of Monte Carlo Simulation (Richardson *et al*., 2007a; Richardson *et al*., 2007b; Richardson, 2006; Simpson *et al*., 1977). In essence, Monte Carlo Simulation is defined as a procedure that converts uncertainties in input variables of a model into probability distributions (Richardson *et al*., 2007a; Simpson *et al*., 1977). Drawing on Reutilinger (1970), Outlaw *et al*. (2007: 359) contend that to predict the probability distribution for an investment's net present value (NPV), a Monte Carlo financial statement model can be used. They argue that since the NPV represents "the present value of annual net returns and the change in net worth over the planning horizon, it is [consequently] a good variable for summarising the overall economic viability of a proposed new business" (Outlaw *et al.,* 2007: 359). Richardson *et al*. (2007a) have demonstrated the usefulness of Monte Carlo simulation for evaluating the economic viability of a proposed agribusiness.

3.1.1 Investment Feasibility Simulation Model

In order to conduct a Monte Carlo financial simulation, the first thing to do is to establish the objective of the model, which in this case is to determine the probability that the rate of return to investment is greater than 10 percent and that the business will be an economic success. Richardson *et al.* (2006) proposed four general steps that should be followed when developing a production-based investment feasibility simulation model. These are: 1) The definition, parameterisation, simulation, and validation of the probability distribution of all the risky variables. This can be done by following the procedure given by Rchardson, Klose and Gray (2000) to simulate the multivariate empirical (MVE) distribution. 2) Specification of accounting equations to compute the production, receipts, costs, cash flows, and balance sheet variables of the project based on the stochastic values obtained from the probability distributions. 3) The stochastic values are then used to perform repeated simulations using random variables for the risky variables. The simulated random variables are used to estimate the probability distribution of the unobserved key output variables (KOV) thus allowing the decision makers to evaluate the probability of success for a proposed project. 4) The information obtained from the stochastic simulation model is then used to "analyse the management scenarios and provides the results to decision makers in the form of probabilities and probabilistic forecasts for the KOVs" (Richardson *et al.*, 2007a: 117).

3.2 Simulation Model for Springbuck Based Meat Production

According to Richardson *et al.* (2007a) and Richardson *et al.* (2007b), the equations for the feasibility model are the accounting identities necessary to calculate an income statement, cash flow statement, and a balance sheet. For simplicity's sake, the model shall assume that the animals are harvested on an annual basis. Although the rancher can schedule his harvesting in such a way that it coincides with key hunting seasons, so that the skill of professional hunters can be used to harvest the animals, it suffices to assume a once-off hunting season in a year. In this particular study, the principal decision maker is interested in knowing whether it will be economically feasible to venture into a springbuck ranching for meat production enterprise, given an internal rate of return of 10%.

Currently, the farmer produces wool and mutton in a 5 000 ha farm. To convert into springbuck ranching, the principal decision maker would have to purchase breeding stock of 1 250 animals (with a male to female ratio of 1: 14 (Conroy, 2005: 215)). Whilst in reality most farms in Graaff-Reinet already have some springbuck populations in them, in this case the farm is assumed to have no population of springbuck at all. The farmer does not invest in substantial fencing, in so doing; he maintains the existing boundary fences for the 5 000 ha farm[3]. Harvesting and harvesting related costs (e.g. helicopter costs) are

[3] Although evidence suggests that the springbuck can do well in paddocks measuring at least 100 ha (See Conroy, 2005: 214 - 226), the farmer does not maintain the existing fences on the paddocks. The idea is to enable a free

the responsibility of the meat processor. During harvesting, the professional harvesters are assumed not to kill breeding stock (pregnant and lactating ewes), instead, once harvesting commences, only rams (with visible horns and a mean shoulder height of about 0.75 m) and other adult ewes (with visible horns and a mean shoulder height of about 0.70 m) are harvested (Conroy, 2005). Whilst in reality income in springbuck ranching can come from two sources: hunting and meat production, for the purpose of this analysis, the primary source of income for the springbuck ranch will come from meat production.

Historical data (1996 – 2009) for defining the probability distribution affecting the springbuck enterprise shall come from the principal decision maker, Camdeboo meat processors and Statistics South Africa (2009).

3.2.1 Stochastic Variables

In a simulation model, the decision maker is always faced with the challenge of having to make predictions about the outcome of certain variables. Because the decision maker is devoid of enough information to make predictions on these variables with certainty, in a Monte Carlo simulation model, such variables are known as stochastic variables and they have two components: one deterministic and the other stochastic (Richardson *et al.*, 2007a; Outlaw *et al.*, 2007; Richardson *et al.*, 2007b). The deterministic component is the part that can be predicted with certainty whereas the stochastic component comprise the part that cannot be predicted with certainty. The first thing to do before conducting a forecast for a stochastic variable is to know the deterministic component as shown in the equation below (Richardson, 2007a: 118):

$$\tilde{Y} = \hat{Y} + \tilde{e} \qquad (1)$$

where $\hat{Y}$ is the deterministic component and $\tilde{e}$ the stochastic component and can be forecasted by simulating a probability distribution, based on historical data. After this, the critical variables that are expected to influence success or failure of the investment are identified. Essentially, Richardson and Mapp (1976: 20) argue "probability distributions thought to be stochastic must be developed."

Stochastic variables in the springbuck meat production model used in this study included annual average prices for springbuck meat, interest rates, and inflation rates for production costs, annual animal yield (output), average bodyweight, average dressed weight of the springbucks and the mean rainfall amount for Graaff-Reinet. To simulate the stochastic variables, the procedure developed by Richardson *et al.* (2000) to estimate multivariate empirical (MVE) probability distributions was followed to account for correlation among the variables (Richardson *et al.*, 2007b). The idea of using an MVE distribution was to guarantee that the random variables are correlated the same way as they were in the past. Historical output data (both at national and farm level), meat prices, interest rates, mean average weight, output yield

movement of the animals over the long run, so as to move closer to a natural animal movement as possible within the 5 000 ha farm.

data and average annual rainfall data for 1999 to 2009 were used to estimate the parameters for the MVE distribution. Parameters for the MVE distribution were estimated by detrending the data and expressing the residuals as fractions of the trend (S_i) and cumulative probabilities ($F(S_i)$). This was then followed by the simulation of the model using Simetar ® (Richardson, Schumann and Feldman, 2008) add in for Excel ©.

3.3 Economic Feasibility Model

The first step to do in the specification of a Monte Carlo simulation model is to identify the equations necessary for the deterministic economic feasibility spreadsheet model (Richardson and Mapp, 1976). This involves the identification of the variables to be used in the *pro forma* financial statements (income statement, cash flow and balance sheet). The variables in equations A1 to A29 in the appendix were used as exogenous variables in the *pro forma* financial statement equation to capture risk into the model.

Meat production and subsequently output is dependent on the number of animals cropped and the size of the rangeland. A 5 000 ha farm can carry a maximum population of 2 250 animals, all other things constant. This figure varies with the amount of rainfall in a year. Higher rainfall amounts may lead to an increase in total biomass, and stimulate an equivalent increase in the population size of the springbuck and *vice versa*. Meat (A6) produced from springbuck is the product of the average dressed weight and the total number of springbuck culled in a given time. Hence, meat receipts (A11) are the product of the stochastic meat price and the quantity of springbuck culled.

The costs of ranching springbuck are relatively small. In other studies (see for example Skinner *et al.*, 1986) they were quantified to be about 33.1 percent of the total gross margins. However, in this model, the only expenses incorporated included the costs of fuel (diesel and petrol) for moving around the farm, insurances, legalities and other basic ranch related expenses. The lack of published data on springbuck ranching costs per hectare made the opinion and experience of springbuck ranchers in the case study area extremely important[4].

Projected prices, interest rates and rates of inflation were used for the 2010 – 2025 analysis. The prices further constituted the mean prices for the stochastic variables in the model. To project the mean annual price for springbuck meat, linear trend regression was used. This was in turn used to calculate the average price for springbuck meat. However, to project mean annual rates of inflation and interest rates, simple trend least squares regression was used. As a general rule, Richardson *et al.* (2008) and Richardson (2004) advise that, before working on the probability distribution, it should first be ascertained that the random variables are stationary. A linear trend is often sufficient. However, if a linear trend is not enough, a non-

[4] For example, in the interviews had with various farmers, questions related to the production cost structure in springbuck ranching were asked. Although such would differ significantly in a 100% springbuck based ranching enterprise, farmers highlighted the importance of fence and artificial watering points' maintenance, fuel costs and labour costs. Other costs included veterinary costs, which were, however cited more of a government (state veterinary services) than an individual farmers concern.

linear trend can be used or a structural model. Once the stochastic variables are stationary, the residuals from the trend (or residuals from the structural model) are used as the stochastic component to simulate the random variable. The model to simulate the multivariate empirical (MVE) probability distribution contained 7 variables. Using simple statistics, the data were checked for stationarity and used to perform the analysis. The analysis was carried out on Microsoft Excel© using Simetar®.

Economic feasibility or success of a project is, according to Richardson and Mapp (1976), best analysed by using the Net Present Value (NPV), which was calculated using equation (A27) in the appendix. A positive NPV means that the rate of return of the project is greater than its discount rate and therefore is an economic success (Gill *et al*., 2003; Richardson *et al*, 2007b; Richardson and Mapp, 1976). The return on investment (ROI) can also be used to determine the ability of the proposed investment to give returns, which are greater than the opportunity cost of the investor's capital. To calculate the ROI, the sum of net returns and cost of interest over the initial investment in the farm were used as shown in equation (29) in the appendix. The rancher's minimum expected ROI is 10% hence the proposed project is compared against its ability to give a greater ROI than the rancher's minimum 10% requirement. Similarly, the present value of the net worth (PVENW) was also calculated by diving the proposed enterprise's net worth on the last year of simulation ($Networth_{15}$) by the discount rate of 10% as shown in as shown in equation 28 on the appendix. The NPV, ROI and PVENW comprised the key output variables (KOVs) for the model. The simulation model for the proposed springbuck based meat production enterprise was programmed in Excel® using the equation and accounting identities given in the appendix. Using Simetar© (Richardson *et al*., 2008) the deterministic model was made stochastic and then simulated using a Monte Carlo sampling procedure for simulating pseudo-random numbers.

4. Results

The Monte Carlo simulation model for the proposed springbuck based meat production game ranch in the Eastern Cape Karoo (Graaff-Reinet) was simulated for 15 years, 2010 – 2025. The analysis was conducted by converting an existing sheep farm into a hypothetical springbuck based meat production ranching enterprise. Hence, the principal decision maker in the actual farm was assumed to sell by auction all his livestock and livestock related assets in order to raise capital for financing the springbuck enterprise. These included 2000 sheep (1150 ewes, 750 lambs, 100 rams), 500 goats, a tractor and shearing equipment. Income for the ranch comes from meat sales

The values for the KOV's and simple statistics are presented in Table 2. The results of the assumed scenario to compute the risks intrinsic in springbuck based meat production in Graaff–Reinet are presented in detail. According to Richardson and Mapp (1976: 22), an investment's decision may further be affected by the "distribution of annual net returns or cash flows over the life of the project." To further probe the variability of net cash inflow (NCI) and ending cash balance (ECB) of the project: first the stochastic NCI and ECB are simulated then using their probability distributions and fan graphs, their probabilistic analysis are done and presented as shown in Table 2 and in Figures 1 and 2, respectively. Figure 3 shows the probabilistic analysis of the ROI being less than the principal decision-maker's expected 10 percent rate of return.

The NPV of the springbuck based meat production game ranch averages R4.519 million and ranges from R4.021 million to R4.845 million.

Table 2. Results of a Monte Carlo Simulation for a 5000 ha Springbuck Based Meat production Game Ranch in Graaff-Reinet

	NPV (R'000)	ROI (%)	PV NW (R'000)					
Mean	4 519.90	10.61%	5 786.83					
StDev	162.32	2.18%	552.14					
CV	3.59	20.51	9.54	**P(NPV<O)**	0%			
Min	4 021.27	3.00%	4 061.06	**P(ROI<10)**	35%			
Max	4 845.33	14.97%	6 769.49	**P(PV NW<0)**	0%			
	NCI 1 (R'000)	**NCI 3 (R'000)**	**NCI 5 (R'000)**	**NCI 7 (R'000)**	**NCI 9 (R'000)**	**NCI 11 (R'000)**	**NCI 13 (R'000)**	**NCI 15 (R'000)**
Mean	398.24	405.72	410.60	423.20	403.88	394.09	375.24	345.76
StDev	185.76	204.15	200.28	204.94	184.03	174.18	182.92	160.90
CV	46.64	50.32	48.78	48.43	45.57	44.20	48.75	46.54
Min	-74.68	-137.32	-136.16	-90.96	-83.27	-83.98	-137.39	-138.67
Max	709.06	731.79	707.19	768.72	628.84	602.26	582.63	543.95
P(NCI<0)	7.21%	8.02%	7.21%	7.41%	7.41%	7.41%	7.62%	6.41%
	ECB 1 (R'000)	**ECB 3 (R'000)**	**ECB 5 (R'000)**	**ECB 7 (R'000)**	**ECB 9 (R'000)**	**ECB 11 (R'000)**	**ECB 13 (R'000)**	**ECB 15 (R'000)**
Mean	390.81	1 036.52	1 874.75	2 967.03	4 372.48	6 184.98	8 498.98	11 465.72
StDev	135.55	391.93	559.09	754.76	1 014.13	1 345.86	1 773.94	2 306.41
CV	34.69	37.81	29.82	25.44	23.19	21.76	20.87	20.12
Min	5.53	-216.95	-183.24	347.02	1 010.80	1 841.27	2 886.76	4 256.78
Max	560.26	1 585.66	2 748.32	4 263.01	6 133.07	8 509.42	11 588.63	15 570.54
P(ECB<0)	0%	7.21%	0.60%	0%	0%	0%	0%	0%

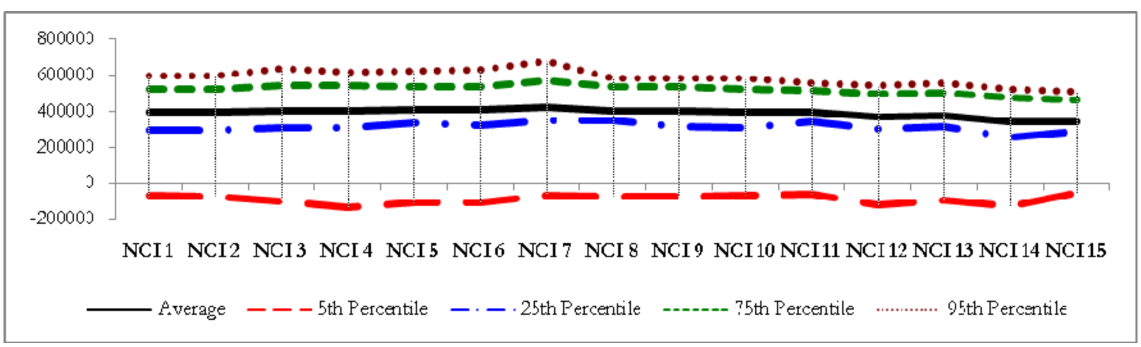

Figure 1. Fan Graph for Net Cash Inflow for a Springbuck Based Meat Production Game Ranch (R')

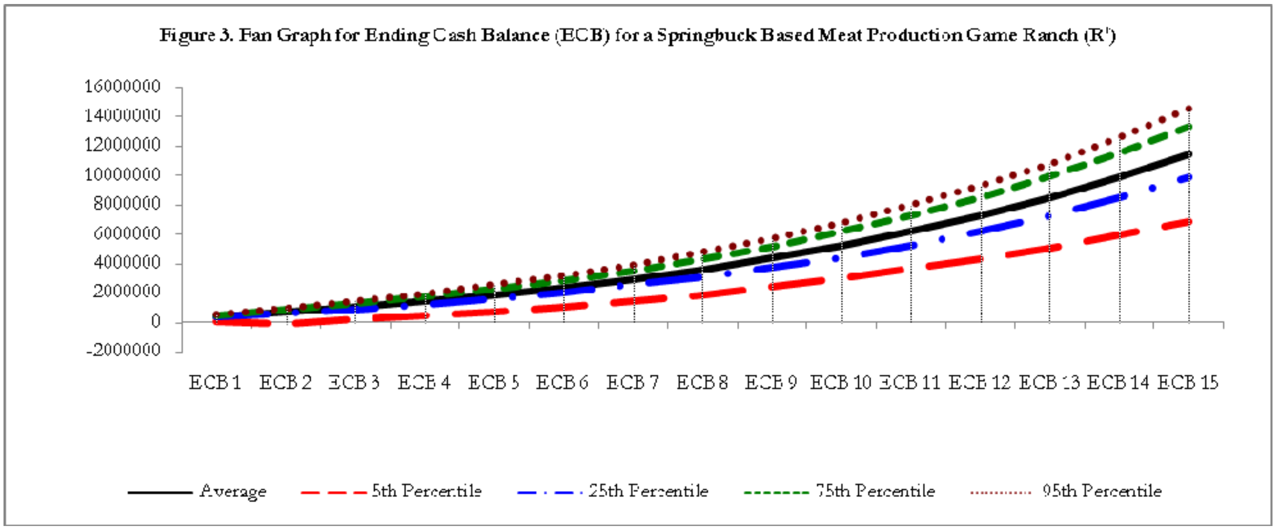

Figure 3. Fan Graph for Ending Cash Balance for a Springbuck Based Meat Production Game Ranch (R')

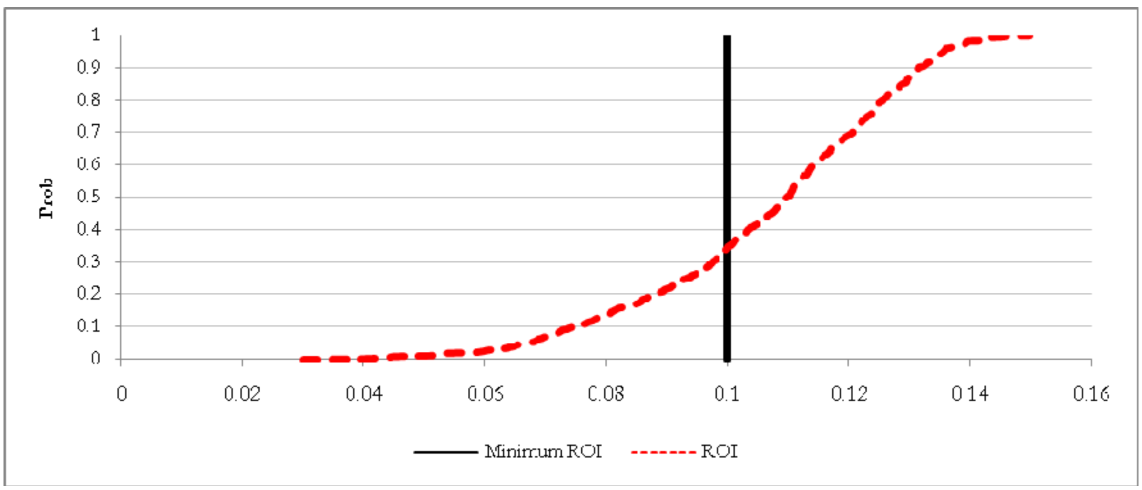

Figure 4. Cumulative Distribution Function of ROI Showing the Minimum ROI

There is a zero percent probability that the NPV will be below zero or negative at the end of the planning period. The average ROI is 10.61 percent and the probability that the average ROI over the planning period will be less than the principal decision-maker's minimum value of 10 percent is 35 percent, as shown in Figure 3. The middle column of Table 2 further shows that the average net cash income (NCI) from springbuck based production increases from R398 thousand in 2010 to R423 thousand in 2017, before declining to R345 thousand in 2025. Moreover, looking at the variability around the average net cash income, it is evident that the net cash income shows constant variability throughout the planning horizon. This is further shown by the coefficient of variability (CV) which starts from 46.64 percent in 2010 and constantly rises to 50.3 percent in 2013 before gradually decreasing to 46.54 percent in 2025, as further demonstrated on Figure 1.

Figure 1 displays the variability of net cash income for each year of the planning horizon. The bottom line represents the 5-percentile line whereas the upper-most line represents 95-percentile line. The line in the middle depicts the average net cash income over the planning horizon whilst the lines second from the bottom and topmost represent the 25 and 75 percentile, respectively. The bottom and topmost lines show the 90 percent confidence interval, whereas the second from the bottom and top lines respectively denote the 50 percent confidence interval for the annual net cash income. The fan graph shows a constant trend in net cash income for the springbuck based meat production enterprise. It further shows a minimal change in the overall net cash income variability over the 15-year planning period. The probability that the net cash income would be less than zero is between 8.02 in 2013 and 6.41 percent in 2025. Similarly, the minimum net cash income ranges between –R74 thousand in 2010 to –R138 thousand in 2025.

The mean ending cash balance (ECB) for the 5 000 ha springbuck based meat production game ranch is positive throughout the planning period. It starts from R390 thousand in 2010 and rises up to R11.465 million in 2025. The fan graph for the ending cash balance further demonstrates that the variability around the mean ending cash balance is relatively low. The CV for the ending cash balance is between 37.81 percent in 2013 and 20.12 percent in 2025. The minimum ending cash balance ranges from –R217 thousand with a 7.21 percent probability of obtaining it to –R183 thousand with a 0.6 percent probability of occurrence.

The probability of the present value net worth (PV Net Worth) and net present value (NPV) being less than zero is 0 %. According to Richardson and Mapp (1976), economic success is realised when a business yields a superior return than the discount rate. This means that any proposed business with an NPV greater than zero can be seen as an economic success. Hence, springbuck based meat production in Graaff-Reinet under the assumptions made for this analysis; depict a very high probability of being an economic success, all other things constant.

5 Conclusions

Issues of environmental sustainability and ecosystem health continue to be the centre focus of rangeland-based agricultural farming systems from both an ecological and economic sustainability point of views (Jouven and Baumont, 2002). Rangelands owners in the Eastern Cape Karoo are under increasing pressure to employ and produce using sustainable rangelands utilisation systems (Milton *et al*., 2003), following intense rangeland degradation as a result of over 2 centuries of domestic livestock farming. One way of achieving environmental sustainability and ecosystem health is through biodiversity restoration in rangelands (Milton *et al*., 2003; Fleischner, 1994; Hodgson *et al*., 2005; Smet and Ward, 2005). Particularly in the EC Karoo, biodiversity restoration can be achieved through springbuck ranching for meat production. However, as has been reported by amongst others, Milton *et al.* (2003) and more recently by Hodgson *et al.* (2005) biodiversity and ecosystem health is hindered by economic factors like the lack of economic incentives to employ more environmentally friendlier methods of rangelands utilisation.

Particularly, uncertainty about the prospect of making more money with springbuck ranching and fears of more degradation due to the feeding regime of the springbuck are some of the factors that have been cited as the reason why farmers and rangelands owners are not so keen in converting their rangelands into springbuck ranches for meat production in the EC Karoo.

This paper set out to quantify the risks and economic prospects that may influence the economic feasibility of springbuck based meat production in the EC Karoo. This was done through the identification of risks that could influence the incomes obtainable from probable springbuck based meat production game ranches.

This study followed the procedures developed by Richardson (2006) of conducting an economic feasibility assessment using Monte Carlo simulation model, to assess the economic viability of a springbuck based meat production game ranch. This was done by using a 5 000 ha merino sheep farm and converting it into a hypothetical springbuck ranch. The simulation was done for a period of 15 years, by considering both the cost and price risk associated with a springbuck based meat production enterprise in Graaff-Reinet, EC Karoo. The result evince that under the assumptions of this study, springbuck based meat production in a 5 000 ha rangeland would be an economic success, with an average NPV of R4.519 million and an average ROI of 10.61 percent. The study also showed a 100 percent chance that the NPV would be positive (greater than zero). The risk associated with springbuck based meat production in the case study farm was inherently small (3.57 percent) suggesting that springbuck based meat production is not that risky in Graaff-Reinet, hence perhaps the reason why a huge inclination towards springbuck ranching (although not on a full scale basis like domestic livestock farming) amongst rangelands owners in the area exists.

Based on the results of this study, it can be concluded that springbuck based meat production in the EC Karoo can be an economic success under the assumptions of this study. Put differently, springbuck based meat production in Graaff-Reinet possess a high potential of being a profitable and economically feasible investment more especially if the rangeland belongs to the rancher, or has at least been bought using own funds. Although this study did not consider any tax concessions or policy instruments to encourage the uptake of sustainable rangeland utilisation economic systems in semi-arid to arid areas of South Africa as a means towards combating wide spread environmental degradation, springbuck based meat production showed huge chances of being an economic success in Graaff-Reinet, nonetheless. Indeed, the study also did not take into consideration trophy hunting and the income that comes with it, which when factored in can further improve the profitability and viability of springbuck based meat production in the EC Karoo, under the prevailing conditions.

Data on game related production in South Africa is rather scanty and even where it is available it is hard to obtain. Due to this, the study employed a comparatively short time series of data (11 years) in developing the MVE distributions to conduct the analysis. Hence, uncertainty on the extent at which the distributions quantified depicted the true distribution of the outcomes exists, however, as Richardson *et al.* (2000) show, it is sufficient to use a short time series, as long as the data are correlated the same way in the future, as they were in the past. Thus, the findings for this study have implications for the on-going rangeland degradation discussion in the EC Karoo. Given the natural occurrence of the springbuck in the EC Karoo, and the wide benefits that are associated with keystone (natural capital) species in an area, rangelands utilisation through springbuck ranching is a practicable option to commercial domestic livestock farming in the EC Karoo, given the deleterious effects of domestic livestock on the environment. The springbuck presents greater prospects of arresting continuing imbalances in rangelands degradation and ecosystem health in the EC Karoo, whilst producing food for both the local and non-local communities.

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References

Amalgamated Banks of South Africa (ABSA) (2003). *Game ranch profitability in South Africa*. ABSA Group Economic Research. Rivonia. South Africa.

Archer, E.R.M., 2004. Beyond the 'climate versus grazing impasse'. *Journal of Arid Environments* 57: 381 – 408.

Beinart, W. (2003). *The Rise of Conservation in South Africa*. Oxford University Press Inc., New York.

Carruthers, J. (2008). "Wilding the farm or farming the wild"? The evolution of scientific game ranching in South Africa from the 1960s to the present. *Transactions of the Royal Society of South Africa* 63(2): 160 – 181.

Carruthers, J. (2009). *National Parks in South Africa*. In: H., Suich and B., Child with A. Spenceley (eds) Evolution and Innovation in Wildlife Conservation: Parks and Game Ranches to Transfrontier Conservation Areas. Earthscan. London, pp 51 – 66.

Child, B. (2009). *Conservation in Transition*. In: H., Suich and B., Child with A. Spenceley (eds) Evolution and Innovation in Wildlife Conservation: Parks and Game Ranches to Transfrontier Conservation Areas. Earthscan. London, pp 3 – 18.

Cloete, P.C., Taljaard P.R. and Grové B. (2007). A comparative economic ease study switching from cattle farming to game ranching in the Northern Cape Province. *South African Journal of Wildlife Research*, 37(1): 71–78.

Conroy, A.M. (2005). *The Springbok*. In: J. Du P. Bothma and N. Van Rooyen (eds) Intensive Wildlife Production in Southern Africa. Van Schaik Publishers. Pretoria, pp 214 – 226.

Dean, W.R.J., Hoffman, M.T., Meadows, M.E., and Milton, S.J. (1995). Desertification in the semi-arid, South Africa: review and reassessment. *Journal of Arid Environments* 30: 247 – 264.

Du Toit, J.G. (2007). *Report: Role of the Private Sector in the Wildlife Industry*. Tshwane Wildlife Ranching. SA/Du Toit Wilddienste. 87 pp.

Esler, K.J., Milton, S.J. and Dean, W.R. (2006). *Karoo Veld: Ecology and Management*. Briza Publications, Pretoria.

Gibson, D.J. (2009). *Grasses and Grassland Ecology*. Oxford University Press Inc. New York.

Gill, C.R., Richardson, J.W., Outlaw, J.L., and Anderson D.P. (2003). *An Analysis of Ethanol Production in Texas Using Three Ethanol Facility Sizes and Their Relative Optimal Subsidy Levels*. Presented Paper, Southern Agricultural Economics Association 35th Annual Meeting, Mobile, Alabama, February 1–5, 2003. Available on: http://purl.umn.edu/35003 [*accessed 12 February 2010*].

Grové, B., Taljaard, P.R. and Cloete, P.C. (2007). A Stochastic Budgeting Analysis of Three Alternative Scenarios to Convert from Beef-Cattle Farming to Game Ranching. *Agrekon*, 46(4): 514 – 531.

Hahn, B.D., Richardson, F.D., Hoffman, M.T., Roberts, R., Todd, S.W., and Carrick, P.J. (2005). A simulation model of long-term climate, livestock and vegetation interactions on communal rangelands in the semi-arid Succulent Karoo, Namaqualand, South Africa. *Ecological Modelling* 183: 211 – 230.

Hodgson, J.G., Monserrat-Martı`, G., Talowin, J., Thompson, K., Dı`az, S., Cabido, M., Grime, J.P., Wilson, P.J., Band, S.R., Bogard, A., Cabido, R., Ca`ceres, D., Castro-Dı`ez, P., Ferrer, C., Maestro-Martı`nez, M., Pe´rez-Rontome´, M.C., Charles, M., Cornelissen, J.H.C., Dabbert, S., Pe´rez-Harguindeguy, N., Krimly, T., Sijtsma, F.J., Strijker, D., Vendramini, F., Guerrero-Campo, J., Hynd, A., Jones, G., Romo-Dı`ez, A., de Torres Espuny, L., Villar-Salvador, P., Zak, M.R., (2005). How Much Will it Cost to Save Grassland Diversity? *Biological Conservation* 122: 263–273.

Joubert, J.W., Luhandjula M.K., Ncube, O., le Roux, G., and de Wet, F. (2007). An Optimisation Model for the Management of a South African Game Ranch. *Agricultural Systems* 92: 223 – 239.

Jouven, M., and Baumont, R. (2008). Simulating Grassland Utilisation in Beef Suckler Systems to Invetsigate the Trade-offs Between Production and Floristic Diversity. *Agricultural Systems* 96: 260 – 272.

Kreuter, U.P. and Workman, J.P. (1996). Cattle and Wildlife Ranching in Zimbabwe. *Rangelands* 18 (2): 44 - 47.

Millton, S.J., Dean, W.R.J., and Richardson, D.M. (2003). Economic Incentives for Restoring Natural Capital in Southern African Rangelands. *Frontiers in Ecology and the Environment* 1 (5): 247 – 254.

National Department of Agriculture (1998). Agricultural Policy in South Africa: A Discussion Document. Ministry of Agriculture and Land Affairs. Pretoria. Available on: http://www.nda.agric.za/docs/policy98.htm [accessed 07 February 2010]

National Department of Agriculture (2009). Commodity Profile: Willife Industry. Pretoria.

Outlaw, Joe L., Luis A. Ribera, James W. Richardson, Jorge Da Silva, Henry Bryant, and Steven Klose. (2007). Economics of Sugar-Based Ethanol Production and Related Policy Issues. *Journal of Agricultural and Applied Economics* 39 (2): 357 - 363.

Perrings, C. (1997). *Economics of Ecological Resources: selected essays*. Edward Elgar Publishing Limited. Cheltenham.

Perrings, C., and Walker, B. (1997). Biodiversity, resilience and the control of ecological-economic systems: the case of fire-driven rangelands. *Ecological Economics* 22: 73 – 83.

Prins, H.H., Grootenhuis, J.G. and Dolan, T.T. (2000). *Wildlife Conservation by Sustainable Use*. Kluwer Academic Publishers. Boston.

Reutlinger, S. (1970). Techniques for Project Appraisal Under Uncertainty. World Bank Staff Occasional Papers (10), International Bank for Reconstruction and Development, The John Hopkins University Press.

Richardson, J.W. (2006). Simulation for Applied Risk Management. Department of Agricultural Economics, Agricultural and Food Policy Center, Texas A&M University, College Station, Texas.

Richardson, J.W. and Mapp, H.P. Jr. (1976). Use of Probabilistic Cash Flows in Analyzing Investments Under Conditions of Risk and Uncertainty. Southern Journal of Agricultural Economics 8: 19 - 24.

Richardson, J.W., Herbst, B.K., Outlaw, J.L., and Gill, R.C. II. (2007a). Including Risk in Economic Feasibility Analysis: The Case of Ethanol Production in Texas. *Journal of Agribusiness* 25 (2): 115 – 132.

Richardson, J.W., Klose, S.L., and Gray., A.W. (2000). An Applied Procedure for Estimating and Simulating Multivariate Empirical (MVE) Probability Distributions in Farm-Level Risk Assessment and Policy Analysis. *Journal of Agricultural and Applied Economics*, 32(2): 299 - 315.

Richardson, J.W., Schumann, K., and Feldman., P. (2008). Simetar: Simulation for Excel to Analyze Risk. Department of Agricultural Economics, Texas A&M University, College Station, Texas.

Richardson, J.W., W.J. Lemmer, and J.L. Outlaw. (2007). Bio-ethanol Production from Wheat in the Winter Rainfall Region of South Africa: A Quantitative Risk Analysis. *International Food and Agribusiness Management Review* 10: 181 - 204.

Roche, C. (2008). 'The Fertile Brain and Inventive Power of Man': Anthropogenic Factors in the Cessation of Springbok Treks and the Disruption of the Karoo Ecosystem, 1865 – 1908. *Africa* 78 (2): 158 – 188.

Rosenzweig, M.L. (2003). Reconciliation ecology and the future of species diversity. *Oryx* 37 (2): 194 – 205.

Simpson, M.C., Gunawardena, A., and Wynne, A.J. (1977). Risk Analysis Applied to Rangeland Livestock Projections. *Agricultural Systems* 2: 305 - 315

Skinner, J.D. (1970). Game-Ranching in Africa as a Source of Meat for Local Consumption and Export. *Tropical Animal Health production* 2: 151 – 157.

Skinner, J.D., Davies, R.A.G. Conroy, A. M., and Dott, H. M. (1986). Productivity of Springbok (*Antidorcas Marsupialis*) and Merino Sheep (*Ovis Aries*) During a Karoo Drought. *Transactions of the Royal Society of South Africa* 46 (2): 149 - 164

Smet, M., and Ward, D. (2005). A Comparison of the Effects of different Rangeland management Systems on Plant Species Composition, Diversity and Vegetation Structure in a Semi-Arid Savanna. *African Journal of Range and Forage Science* 22 (1): 59 – 71.

South African Reserve Bank [Online] (2010). Statistical & Economic info. Quarterly Bulletin. Online download facility.

Statistics South Africa [Online] (2010). Main key indicators: Historical PPI indices; Historical CPI indices.

Tomlinson, K.W., Hearne, J.W. and Alexander, R.R. (2002). An approach to evaluate the effect of property size on land-use options in semi-arid rangelands. *Ecological Modelling* 149: 85 – 95.

Vetter, S. (2005). Rangelands at equilibrium and non-equilibrium: recent developments in the debate. *Journal of Arid Environments* 62: 321 – 341.

Vetter, S., (2009). Drought, change and resilience in South Africa's arid and semi-arid rangelands. *South African Journal of Science* 105: 29 – 33.

APPENDIX

The following equations were used to simulate the KOV's for the springbuck ranching enterprise. The variables which have been denoted in bold are all stochastic variables. those which are a function of stochastic variables become stochastic variables themselves are in turn denoted in bold.

Stochastic Variables

A1 **Trophy Price**$_t$ = **Mean price**$_t$ *[1 + MVE (Si , F(Si)],

A2 **Meat Price**$_t$ = **Mean price**$_t$ *[1 + MVE (Si , F(Si)],

A3 **Inflation Rate**$_t$ = Mean rate * [1 + MVE (Si, F(Si)],

A4 **OP Interest Rate**$_t$ = Mean rate * [1 + MVE (Si, F(Si)],

A5 **Trophy**$_t$ =Mean Crop* [1 + MVE (Si, F(Si)],

A6 **Meat**$_t$ =**Mean Trophy*** [1 + MVE (Si, F(Si)],

A7 **Average Dress Body Weight**$_t$ =**Mean Trophy body weight*** 0.56 [1 + MVE (Si, F(Si)],

A8 **Ave Live Weight**$_t$ = **Mean Trophy bdy weight*** [1 + MVE (Si, F(Si)],

A10 **Trophy**$_t$ = springbuck cropped

A11 **Meat Receipts**$_t$ = springbuck cropped***Average dressed weight**

A12 **Trophy Receipts**$_t$ = trophy* **Trophy Price**

A13 **Total Ranch Receipts**$_t$ = **Trophy Receipts**$_t$ + **Meat Receipts**$_t$

14 **Total Variable Cost**$_t$ = **ranching costs**$_t$ + fence maintenance costs$_t$ + Labour Costs$_t$ + Other Costs

Expenses

A15 **Total expenses**$_t$ = **Total Variable Costs**$_t$ + **Total Interest Expense**$_t$

A16 **Net Returns**$_t$ = **Total Receipts**$_t$ - **Total Expenses**$_t$

A17 **Net Cash Income**$_t$ = **Total Receipts**$_t$ - **Total Variable Costs**$_t$ - **Total Interest Expense**$_t$

Cash inflow

A18 **Interest Earned**$_t$ = **Positive Cash Reserves**$_{t-1}$ * **CD Interest Rate**$_t$

A19 **Cash Inflows**$_t$ = **Net Cash Income**$_t$ + **Positive cash Reserves**$_{t-1}$ + **Interest Earned**$_t$

Cash outflow

A20 **Family Cash Widrawals** = Maximum [0.0, **Net Returns**$_t$ * 0.25]

A21 **Income Taxes**$_t$ = **Positive Net Cash Income** * Income tax rate

A22 **Cash Outflows**$_t$ =Principal Payment$_t$ + **Repay Cashflow Deficit**$_{t-1}$ + Capital Replacement$_t$ + **Family Cash widrawals**$_t$ + **Income Taxes**$_t$

A23 **Ending Cash$_t$** = **Cash Inflows$_t$** - **Cash Outflows$_t$**

Balance sheet

A24 **Assets$_t$** = Land Value + Book Value of Ranch$_t$ + **Positive Ending Cash$_t$**

A25 Liabilities$_t$ =Plant Debt$_{t-1}$ - Principal Payments + **Negative Ending Cash$_t$**

A26 **Net Worth$_t$** =**Assets$_t$** - **Liabilities$_t$**

Financial Ratios and KOV's

A27 **NPV** = -Beginning Net Worth + $\sum$ (**family cash widrawals$_i$ + ΔNet Worth$_i$**) / (1 + 0.10)^*i*

A28 **PVENW** = **Net Worth$_{15}$** / (1+ 0.10) ^ 15

A29 **ROI$_t$** =(**Net Returns$_t$ + Total Interest Costs$_t$**)/Initial Ranch Cost