

# DOES NAMIBIA HAVE A COMPARATIVE ADVANTAGE IN BEEF PRODUCTION?

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**Abstract:** Namibia's beef industry is an economic paradox. The traditional view of economic development suggests that Namibia has a comparative advantage in the production of beef and, yet, the country's production and exportation of beef has enjoyed only modest growth since 2000. This is best illustrated by the underutilization of national export abattoirs and the failure to meet EU export quotas. Existing literature has only begun to study the reasons for this phenomenon. Some explanations suggest low producer prices are the source of the problem, while others point towards high feed costs and environmental factors. The purpose of this study is to provide an in-depth analysis of the Namibian meat export industry in order to discover the cause of this paradox.

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## INTRODUCTION

Namibia's beef industry is an economic paradox. The traditional view of economic development suggests that Namibia has a comparative advantage in the production of beef and, yet, the country's production and exportation of beef has enjoyed only modest growth since 2000. This is best illustrated by the underutilization of national export abattoirs and the failure to meet EU export quotas. Existing literature has only begun to study the reasons for this phenomenon. Some explanations suggest low producer prices are the source of the problem, while others point towards high feed costs and environmental factors. The purpose of this study is to provide an in-depth analysis of the Namibian meat export industry in order to discover the cause of this paradox.

The subject of this study is of absolute importance to the future well being of Namibia. The country's long-term development depends upon its ability to diversify its income generating activities beyond that of simple mineral exportation. Since the 1990's, exports have generated 50% of Namibia's annual GDP<sup>1</sup>. As of 1998, half of these exports were mining related<sup>2</sup>, which suggest that mineral exports generate a large percentage of Namibia's GDP. Indeed, 10% of the country's gross domestic product was generated by mineral exports in 2000<sup>3</sup>. If Namibia is to have a sustainable economy then it needs to continue diversifying its exports away from such a finite commodity. One feasible alternative is the exportation of beef. Approximately 70%<sup>4</sup> of Namibia is made up of savannah grasslands suitable for cattle grazing, while the country's arid climate is excellent for livestock rearing. Furthermore, Namibia's agricultural sector is the

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<sup>1</sup> <http://www.thedti.gov.za/econdb/raportt/namibiaOverview.html>

<sup>2</sup> <http://aonim.spaces.live.com/Blog/cns!962B969A34135612!737.entry>

<sup>3</sup> <http://www.thedti.gov.za/econdb/raportt/namibiaOverview.html>

<sup>4</sup> <http://www.namibia-travel.net/namibia/flora.htm>

number one source of employment in the country currently employing nearly 35,000<sup>5</sup> Namibians. Livestock production could therefore become an effective and sustainable addition to mineral exportation

### *Background*

As a part of the African Caribbean and Pacific group (ACP), Namibia has enjoyed preferential access to the European Union (EU) market since 1975 first under the [Lomé Convention](#) and now through the Cotonou Agreement signed in 2000. The Cotonou Agreement was negotiated between the ACP and the EU as a way to reduce poverty through sustainable development and integration into world markets. It granted Namibia a tariff-free quota of 13,000 metric tons of beef per year; a number that the country was never able to fulfill. The expiration of the preparatory phase of the Cotonou agreement at the end of 2007 gave way to an interim economic partnership agreement that is in the process of being modified and ratified in 2008 in order to reach a permanent agreement. This process has been difficult as South Africa and Namibia disagree with the EU on issues regarding the liberalization of services and investments. As it stands, the new treaty will grant Namibian beef exporters unrestricted tariff-free, quota-free access to the EU markets which allows them to sell Namibian meat at European prices. Entrance into the EU market also sets high quality standards for the Namibian cattle industry. The fulfillment of these standards could allow producers to access other demanding yet highly profitable international markets such as the United States. Up until today Namibia's beef sector has been unable to fully exploit this opportunity.

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<sup>5</sup> <http://www.winne.com/dninterview.php?interview=1799>

### *Rising Demand for Meat*

Current trends in the international meat market suggest that the global demand for meat is likely to rise in the near future. The steady growth of some emerging economies, such as China and India which are expected to double their income per capita in the next decades will add to the demand of beef. Given that beef is considered a superior good, the consumption of this good should grow as incomes grow. We would expect that the increasing demand on beef would put upward pressures on international beef prices.

### *Namibia's Comparative Advantage in Meat Production*

At first glance, Namibia seems to have a comparative advantage in beef production: It is sparsely populated; has large extents of pasture land; a large segment of the population is already involved in this activity; land is cheap and labor costs are low. However, there seems to be a series of factors which are diminishing Namibia's comparative advantage and, thus, causing the Namibian meat industry to remain underdeveloped. Research suggests that these factors include unattractive beef producer prices, high fodder costs<sup>6</sup>, and risk including environmental uncertainty. Lange, Barnes, and Motinga (1998) investigated land degradation and its negative impact on Namibia's beef industry. Additionally, Dyck and Nelson (2003) provide an overview of the structure of global meat markets and confirm Africa's comparative advantage in grazing land as well as a disadvantage in grain production. Sweet and Burque (2006) provided insight into the environmental conditions affecting livestock production in Namibia. Finally, Schutz (2007) shows that Namibia's commercial beef production has been recently declining due to such factors as bush encroachment and wildlife farming. Schutz also provides data suggesting

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<sup>6</sup> Fodder costs are foodstuff used to feed livestock.

that a large percentage of Namibia's young livestock are exported rather than being raised in Namibia. Most existing literature has, however, ignored the Namibian market structure in terms of meat prices and inputs and the impact of uncertainty upon Namibia's comparative advantage. It is the purpose of this study to shed more light on these issues. The underutilization of Namibian abattoirs may be a symptom of internal market distortions which are causing Namibia's meat export industry to be underproductive. For example, it might be possible that the prices paid to local meat producers by Namibian abattoirs may not be competitive with other international prices being paid for Namibian meat. As a result, local meat producers may be choosing to bypass the Namibian meat export industry by selling their livestock to foreign buyers in exchange for more lucrative prices. It is therefore important to determine whether or not Namibian abattoirs are creating a market distortion. Namibia also suffers from seasonal droughts which have deep negative affects on the natural vegetation essential to livestock rearing, which introduce uncertainty for commercial farmers. A recent study by the USDA determined that amounts of grazing land and feed availability are two of the most important factors in creating comparative advantage for beef production (Dyck). While Namibia has plenty of land, its arid climate and soil conditions are not sufficiently adequate for the production of substantial amounts of animal fodder. The climate and soil conditions create the need for feed imports which might raise the costs of beef production. Additionally, the maize price volatility could also be a source of risk for Namibia.

### *Economic Explanation*

The paradox of Namibia's meat export industry relates to existing economic theory on comparative advantage in uncertain environments. Jabara and Thompson (1980) show that in

both theory and empirical tests, Senegal's "comparative advantage in the production of peanuts and comparative disadvantage in the production of cereals is less clear-cut when international price risk is considered." Risk reduces the comparative advantage of a small country which cannot influence the world market price as is the case with Namibia. Hoff (1994) built a model showing that production uncertainty could also affect comparative advantages in Heckscher-Olin-Samuelson model. "If preferences exhibit decreasing absolute risk aversion, then a capital poor country tends to obtain lower revenues from its resources than the same resources would yield in capital-rich countries and a capital rich country would have comparative advantages on risky sector." Using this literature, we created a model which depicts how risk can affect the comparative advantage of Namibia's beef sector.

### *Outline*

In the following sections we will analyze each of the above factors. The first section includes an analysis of Namibian cattle prices and how they compare to the cattle prices of South Africa. The same section will also analyze the affects of fodder prices on Namibian cattle farmer decisions. The second section will investigate the impact of environmental risk upon the Namibian beef industry. The final section presents a model relating comparative advantage to risk in order to theoretically demonstrate how this relationship applies to the country's beef industry situation.

## I. Causal Relation Analysis

### A. Cattle Prices

Namibian cattle producers have many options in terms of which type of cattle they can produce and to whom they can sell. Some Namibian producers choose to raise weaners (cattle which are approximately 1 year of age) which they then sell to either Namibian auctioneers or to South African feedlots. Other farmers choose to raise Grade B and Grade C cattle (cattle which are approximately 3 years of age and 4.5 years of age, respectively) which they then sell to Namibian abattoirs. In recent years, an increasing number of Namibian cattle producers have opted to raise and export weaners to South Africa (See Figure 1.1). As a result, roughly 55% of all exported Namibian have been exported live to South Africa since 1985 (see Figure 1.2), causing Namibian abattoirs to become heavily underutilized. Indeed, in that same time period the annual number of cattle slaughtered by Namibia's largest abattoir, Meatco, has fallen by more than 75,000 head of cattle (Katswara), causing it to operate at approximately 70% capacity since 2004 (see Figure 1.3).

One reason that Namibian cattle producers may be choosing to export their cattle to South Africa could be that South African feedlots offer higher prices to producers than do abattoirs or auctioneers in Namibia. In order to determine whether this is true, a comparison of the historical beef prices offered to Namibian producers by Namibian abattoirs, Namibian auctioneers, and South African feedlots<sup>7</sup> was carried out (see Figure 1.4).

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<sup>7</sup> As can be seen in Figures 1.1-13, there is a dramatic decrease in the exportation of Namibian cattle to South Africa as well as a decrease in the utilization of Namibian abattoirs during the years 1997 and 1999. Since this implies that both Namibian abattoirs and South African feedlots both received less Namibian cattle during that time period, it

As can be seen in 1.4, Namibian abattoirs have often offered higher prices per kg for the slaughtered meat of full-grown cattle than have South African feedlots offered for live weaners. This suggests that there is no price incentive encouraging Namibians to produce weaners instead of full-grown cattle. However, the same data provided in Figure 1.4 also shows that South African feedlots offer higher prices for weaners than do Namibian auctioneers, with the average difference being approximately \$N.66 since 2001. This difference in price is due to the fact that Namibian feedlots and South African feedlots use different types of fodder in order to feed the weaners which they have purchased. Feedlots generate income by purchasing cattle from local cattle producers, increasing the weight of the cattle through intensive feeding practices, and then selling the fattened cattle to abattoirs for a higher price. Some feedlots, such as those found in South Africa, incorporate growth stimulants into their fodder in order to boost the rate and at which their cattle gain weight. Doing so allows them to increase the final weight of their cattle before they are sold off to abattoirs, increasing the prices abattoirs are willing to pay for each head of cattle. Unlike the feedlots in South Africa, Namibian feedlots do not include growth stimulants in their fodder. Most of the meat exported by Namibian abattoirs is destined for the EU, which sets high standards for the quality of its meat imports. One such standard is that imported meat must not contain any growth stimulants. Namibian feedlots therefore cannot use growth stimulants in their fodder if they intend to sell their fattened cattle to Namibian abattoirs. Consequently, Namibian feedlots are unable to fatten their cattle at the same rate as South African feedlots and so do not

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can only be assumed that the overall production of cattle by Namibian farmers dramatically decreased during these years. This is most likely due to a drought as droughts are the most common cause of cattle production decreases in Namibia.



receive the same high prices for each head of cattle they sell to abattoirs. Unable to generate the same level of income per head of cattle they purchase from Namibian farmers, Namibian feedlots cannot offer local farmers the same high prices for their weaners as does South Africa (South African Feedlot Association). Therefore, attractive weaner prices in South Africa may not explain why Namibian farmers are choosing to produce weaners. They may however partially explain why Namibian weaners are being exported to South Africa instead of being sold in Namibia.

## B. Feed Costs

Although producer prices do not seem to be the reason that Namibian farmers are choosing to produce weaners, profit-related incentives may still be the cause of this ongoing trend. For instance, it is possible that the production of weaners is more cost-efficient and, thus, more profitable than the production of full-grown cattle in Namibia. To determine whether this is true, the operational costs of cattle production were examined, revealing that the feeding of cattle is one of the most significant costs associated with cattle production. Historically, the feeding of cattle has not been a costly endeavor for Namibian farmers thanks to the country's sprawling grasslands. Bush encroachment and desertification, however, have taken their toll in recent years, slowly destroying the savannahs in Namibia. With the country's grasslands slowly shrinking, the most likely cattle food alternative available to Namibian farmers is cattle fodder, which can either be produced locally or imported from abroad. Unfortunately, the production and importation of cattle fodder are costly. As of 1997, only 1% of Namibia's land surface had the nutrients and the water-holding capacity necessary for rain-fed and

irrigated crop production (National Drought Task Force). Producing yellow maize, a crop which constitutes 50% of the ingredients found in cattle fodder (Olivier), is therefore a costly process in Namibia, resulting in high prices for local maize (see Figure 1.5). Furthermore, transport costs within Namibia are also very high (Swedish Trade Council), causing the price of maize imports to also be high for Namibian farmers.

To determine whether or not high fodder costs are the reason that Namibian farmers are choosing to sell weaners instead of full-grown cattle, the profits associated with selling each type of cattle when fodder expenses were taken into account were calculated and then compared. Due to data restrictions, the following analysis has been limited to the time period between 2001 and 2005.

To determine the profitability of selling each type of cattle, the costs of feeding each type of cattle needed to be subtracted from the revenues generated by their sale. The revenues Namibian farmers received for selling their weaners to South African feedlots and for selling their graded cattle to Namibian abattoirs were calculated. This was done by finding the approximate weights of each type of cattle at the time of sale as well as the price per kilogram at which they were sold between 2001 and 2005. Research suggests that South African feedlots normally purchase weaners which weigh approximately 230 kg (SAMIC). The average of grades B and C cattle in Namibia were also acquired from market statistics provided by the Meat Board of Namibia. Using price statistics provided by the Meat Board of Namibia, the average annual price Namibian farmers received for selling weaners to South African feedlots as well as the price they received for selling graded cattle to Namibian abattoirs was calculated. The average annual weight of each type of cattle prior to its sale was then multiplied by its average

annual price at the time of sale in order to calculate the average revenue Namibian farmers received by selling one unit of each type of cattle (See Table 1.1 and Figure 1.6).

After determining the revenues received by Namibian farmers for each type of cattle, the feeding costs associated with raising each type of cattle were calculated. First, the total amount of fodder consumed by each type of cattle prior to sale was determined by multiplying the monthly weight of each type of cattle prior to its sale by 3%<sup>8</sup>. The amount of fodder consumed by each type of cattle prior to sale was then multiplied by the weighted average price of maize<sup>9</sup> that period of time in order to determine the feeding costs of each type of cattle (See Table 1.2).

Having calculated the revenues received by farmers for selling their cattle and the feeding costs farmers incurred prior to sale, the latter was then subtracted from the former to determine the profit received by farmers when selling each type of cattle (See Table 1.3 and Figure 1.7).

As can be seen in Figure 1.7, selling mature cattle to Namibian abattoirs is more profitable than selling weaners to South African feedlots even when Namibia's high fodder costs are taken into account. Nevertheless, the converging lines in Figure 1.7 suggest that weaner sales are becoming relatively more profitable. Considering that the revenue curves in Figure 1.6 are not converging as well, changes in beef prices are not the reason why weaner sales are becoming more profitable. The cause of this convergence in profitability must therefore be Namibia's high fodder costs; a theory which is confirmed by the rising price of Namibian maize in Figure 1.5. Thus, although selling mature cattle to Namibian abattoirs has historically been more profitable than

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<sup>8</sup> Cattle generally consume 3% of their body weight every day (Ford)

<sup>9</sup> Maize prices were used in this equation because maize constitutes 50% of all fodder ingredients.

selling weaners to South African feedlots, high fodder costs in Namibia are causing weaner sales to become relatively more profitable, partially explaining why Namibian farmers are increasingly choosing to raise and sell weaners instead of full-grown cattle.

In summary, the results of the analyses conducted so far suggest that 1) high fodder costs may be one of the reasons why Namibian farmers have begun to raise and sell weaners instead of full-grown cattle and that 2) high South African weaner prices may be one of the reasons why they choose to export those weaners to South Africa.

Nevertheless, these results do not provide enough substantial evidence for us to conclude that high fodder costs and high South African weaner prices are the only reasons why Namibian farmers are choosing to raise and sell weaners to South African feedlots as opposed to raising and selling mature cattle to Namibian abattoirs. If profit and cost incentives do not fully explain why this trend is taking place, then perhaps risk aversion is to blame. For instance, if yellow maize prices are highly volatile then fodder costs are equally unpredictable, making cattle raising a risky practice for Namibian farmers.

Selling young weaners at an early age may therefore be an attempt by Namibian farmers to avoid the risk associated with unstable maize prices. To test this theory, we calculated the average and the standard deviation of yellow maize prices in Namibia and in South Africa, Namibia's main source of yellow maize produced abroad (See Table 1.4).

As can be seen in Table 1.4, the standard deviation of yellow maize prices has been significantly high in recent years, falling anywhere between 15% and 39% of average maize prices since 1997. Furthermore, standard deviation values have steadily increased in the past decade. Yellow maize prices are therefore not only unstable, but are also becoming increasingly volatile over time.

After confirming that yellow maize prices were indeed volatile we then attempted to determine whether or not there existed a positive correlation between the volatility of maize prices and the number of Namibian cattle exported to South Africa each year by conducting a regression of the two variables. The p-value of the regression proved to be greater than .05, suggesting that this correlation was not statistically significant (see Appendix 1 for more information). The presence of price volatility in the maize market is therefore not the reason why Namibian farmers are choosing to export their weaners to South Africa. Nevertheless, other forms of risk may be at work in Namibia which are causing farmers to sell weaners to South Africa rather than selling mature cattle to Namibian abattoirs.

#### I. Environmental Factors and Risk

The environment plays a predominant role in Namibia's beef cattle sector. The country is among the driest in Sub-Saharan Africa averaging approximately 270mm of rain each year (Sweet). Except for the Caprivi region and a few central-northern areas, growing periods are excessively short and the land is too dry for other agricultural activities other than livestock farming. Namibia also possesses large, sparsely populated tracts of land, has low labor costs and a climate with temperatures suitable for cattle. In fact this sector produces 75% of total agricultural output in Namibia (Sweet). However, the environment also poses a series of threats to this industry which lowers its productivity, limits its growth potential and increases the risks for investments.

A variety of environmental conditions in Namibia pose a series of threats to the country's livestock sector. The most serious of these threats are desertification, droughts, and global

warming. These issues are not isolated from one another. Consider for example that the intensity of recent droughts is believed to be a consequence of global warming and bush encroachment (NAPCOD). In turn, bush encroachment becomes worse in periods of drought followed by intense rainfall. All these factors reduce the productivity of the Namibian cattle sector by increasing animal mortality, hindering the production of healthy and heavier animals, raising costs, reducing profits and increasing the risks to investments.

A study of the commercial livestock sector from 1915-1995 by Lange, Barnes and Motinga analyzed the decline in cattle numbers that occurred during that period. Their conclusion was that the decline was not due to disease, farm infrastructure, veterinary or marketing facilities which have markedly improved in the country. Likewise, the decline wasn't due to a compensating increase in animal biomass as in fact, it has remained somewhat stable since 1955. According to the authors the reduction was due to responses to environmental conditions that forced commercial farms to reduce their cattle stocks due to the adverse conditions of the land in order to prevent its further deterioration (Lange). An increasing turnover rate due to improved farm management has kept beef production per hectare constant at around 150,000 tones, however there has only been modest to no growth in the sector up until 2007.

The focus of this section is to analyze each of the environmental conditions mentioned above to determine their impact on cattle production in Namibia. More specifically, the goal is to determine whether and to what extent these conditions influence the beef industry's profitability and viability as well as the risk-related decisions of its farmers.

## A. Desertification

Desertification is perhaps the most serious environmental challenge currently endangering Namibia and its beef industry. The country is already extremely arid, with few perennial rivers crossing its territory which makes it extremely difficult to perform agricultural activities. The few lands which are capable of sustaining livestock are fragile and prone to overgrazing, erosion and destruction. The Namibian government has named desertification as a major threat to the Namibian population and economy and has established the National Programme to Combat Desertification (NAPCOD) to oversee and coordinate a variety of initiatives carried out by various government entities, Nongovernment Organizations (NGOs) and with the support of the United Nations Convention to Combat Desertification. NAPCOD has identified a list of major causes of desertification which include the following:

- too many people and livestock in one place for too long, contributing to overgrazing and deforestation;
- inappropriate provision of artificial water points;
- absentee farm management
- inappropriate fencing in dry areas;
- rapidly increasing human population;
- low and variable rainfall

Desertification is therefore defined as a set of processes which lead to land degradation resulting from various factors including climatic variations and human activity. Among the indicators of desertification there are two that are clearly present in Namibia; loss of grasses and shrubs and bush encroachment. There is ample evidence for the existence of both phenomena and in the case of bush encroachment the economic impacts have been quantified and are widely felt throughout the country.

- *Bush Encroachment*

Bush encroachment is defined as the thickening of aggressive undesired woody species resulting in an imbalance of the grass to bush ratio and a decrease in carrying capacity of land. It is brought about by prolonged deterioration of land as a result of overgrazing and droughts followed by above average rainfall (NAPCOD). Examples of increased bush encroachment occurred during the 1960s, 1973 and the 1980s which were all periods of extremely variable weather. Other important catalysts of bush encroachment are the replacement of browsers and grazers which traditionally lived in the area by livestock, high stocking rates, poor range management policies and the suppression of high-intensity fires which were traditionally used to suppress bush. A study by the Namibian Meat Board has determined that bush encroachment is the single most important obstacle towards the development of the country's meat sector (Schutz).

Bush encroachment decreases the water-use efficiency of land and dries up water tables which induces desertification and creates bush induced artificial droughts. For example, the evapotranspiration rate of certain bush types is 32,500 liters per day for every 500 trees which is seven times higher than those of benign grassland used for feeding cattle (Donaldson).<sup>10</sup> Therefore bush encroached fields need 3-10 times more rain to produce the same amount of grass than a non encroached field. This can be seen in Table 2.1 which shows the effects of bush encroachment on the carrying capacity of land. The results obtained at Pontdrif, South Africa compare two very similar sites with different amounts of rainfall. The results show that bush encroachment is a problem during both rainy and dry seasons with its impacts felt more intensely in dry areas. The less bush per hectare, the higher the carrying capacity of land

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<sup>10</sup> Donaldson 1969, he compared this effect to two windmills pumping water out of the soil at a rate of more than 7,000 liters per hectare per hour for 8 hours a day.



measured in large stock unit/hectare with the effects of debushing get lower around 20%. The implications of these results are very serious for Namibia where the average amount of rainfall is 250mm per year. The carrying capacity of a field free of bush encroachment is almost 27 times higher than a field that is 100% infested. The loss of grassland and the incidence of bush-induced drought leads to a decline in the carrying capacity of land and thus makes livestock production more challenging and expensive.

Bush encroachment raises the operating costs of commercial farms and lowers their net income. The average commercial farm size in Namibia is around 8,800 hectares meaning that farmers spend 26,000 N\$ on de-bushing per year, representing 7% of an average farm's total costs (Karstveld Study Group). The above costs are confirmed by a study conducted by the Namibian Agricultural Union. This study determined that most debushing programs in Namibia are done manually as it is more cost-effective than the aerial application of chemicals or demolishing by bulldozing. According to this and other studies, effective de-bushing for an average commercial farm (8800 hectares) requires the hiring of 4 full-time workers, each capable of debushing an area of 47 hectares per year. Additionally, each worker would need to earn an average of N\$ 600 per month to make the salaries competitive, which adds to N\$ 28800 per year or N\$ 3.6 per hectare (NAU). This is just slightly higher than the figure provided by the Karstveld Study Group.

Most studies in the area of carrying capacity of land in Namibia have determined that a debushed hectare of land can produce an average of N\$ 50 more than one suffering from bush encroachment (NAPCOD). The rough estimate of the amount of commercial land that is severely bush encroached is 12 million hectares which means that N\$ 600 million of earnings is

forgone in this land. If combined with the N\$ 170 million per year that commercial farmers spend in de-bushing, the total loss for Namibia's commercial sector due to bush encroachment is roughly N\$ 770 million per year (US\$ 100 million) the equivalent to 1.5% of GDP (NAPCOD). This has a direct impact to 6,283 commercial farmers, 35,000 workers and around 140,000 dependants on this activity.

- *Loss of Grazing Grass*

The loss of grasslands is another important indicator of desertification and it is a situation that is clearly happening in Namibia. Most cattle in commercial farms is grass-fed due to poor soil conditions in Namibia, making feed hard to produce and expensive to import from South Africa. As was seen in the previous section, this has a significant impact on the decision making of Namibian beef producers and also reduces the productivity of the land.

According to several studies it is hard to determine if desertification is happening due to a (long term) reduction in grasslands because it is hard to isolate declining productivity from other environmental (yet short-term) effects (Sullivan). Fortunately, in the case of Namibia there is long-term data from a study done by Walter in 1939 which used a rainfall gradient. This allowed researchers to use it as a basis for comparison with current periods (Ward and Ngairorue). The reason it is important to use a rainfall gradient is that it allowed researchers to perform regression analysis to control for short-term differences in rainfall over time periods. The analysis was repeated by Ward and Ngairorue in 1997 with results obtained from 31 commercial farms randomly selected across Namibia.

The study concludes that the slope of the regression of herbage yield on mean annual rainfall in 1997 was 5.93 kg per hectare down from 10.34 kg per hectare obtained in Walter's

1939 study (Ward and Ngairorue). The main reason for this reduction is a combination of rainfall variability and overestimation of annual forage productivity. Mainly, given the high variability of rainfall in Namibia it is hard for farmers to determine how much grazing they can allow. As a consequence overgrazing is common and has a very slow long-term effect that is only felt after periods of 50-70 years. Although hard to quantify, the impacts of this trend are clearly felt in Namibia. The slow growth in the numbers of cattle in commercial areas, the export of live cattle down to South Africa and thus the underutilization of the export abattoir infrastructure can all be traced back to insufficient high quality grazing land and the high costs of importing feed.

## B. Drought

Drought is a natural phenomenon that has been a part of Namibia for centuries and has been a major obstacle for the growth of the beef sector. A drought can be defined as an extended period of time (months or years) of abnormal dryness due to below-average rainfall that causes a pronounced decrease in forage yield relative to what is expected in an average year. These events are associated with crop failures, livestock deaths and disruptions to human beings (Routhage). In Namibia drought is primarily caused by oceanic currents that alter rainfall patterns and especially by the El Niño and La Niña effects. Scientists however have determined that during the last two decades of the 20<sup>th</sup> century droughts became more pronounced and severe. The rate of climatic warming for the South African Development Community was .05 degrees centigrade per decade during the 20<sup>th</sup> century and only two out of the sixteen years up to 1996 had above average rainfall. In fact the period from 1985 to 1996 was the warmest and driest ten year period in the 20<sup>th</sup> century in Namibia (Sweet).

Drought affects all regions of the globe with different degrees of intensity. For instance, during 2003, farmers in Europe faced a 1.5 billion euro bill after the summer drought. Each livestock producer spent an average of 30,000 euro on feed. Maize production dropped 21% across Europe and as a consequence, maize has had to be imported from abroad at higher costs (Clarke). Farmers in Europe were able to request help from the EU's solidarity fund and obtained an advance payment of livestock subsidies. Namibian farmers, however, do not enjoy such benefits during times of drought. The 1992/1993 drought in Namibia had severe recessionary impact on commercial agriculture where enormous agricultural losses translated into a massive layoff of agricultural workers at 40% of all commercial farms. The reason for this enormous impact relates to livestock mortality and the costs of preventing it during a drought.

Drought can have extremely negative impacts for the beef industry economically. Drought weakens animals due to a lack of water, food and higher temperatures. During such periods, livestock are more vulnerable to diseases such as rinderpest, contagious bovine pleuropneumonia and pest de petit ruminant (FAO). As a result, the most immediate impact of drought is the death of livestock like during the 1992 Namibian drought where 2% of commercial livestock and 20% of communal livestock died. The reason for the higher mortality in the communal sector is that the commercial sector has a variety of ways to mitigate the impacts of drought. Commercial farmers usually have savings available to buy supplemental feed and water during a drought. They can also rent additional grazing land in adjacent farms or move cattle from one property they own to another. They usually maintain grazing at about 60% of the carrying capacity of land to save fodder for dry periods. During a drought this excess capacity can be used for the animals. However grazing below carrying capacity reduces the

year-round productivity of the land which would not happen in less drought-prone areas such as South and North America.

During a drought commercial farmers need to take two specific actions to prevent cattle mortality. First, they need to destock at emergency rates in order to prevent cattle from dying. The problem is that in Namibia abattoirs do not have enough capacity to process all cattle during a drought and as a consequence, cattle are sold to South Africa. This emergency destocking has a middle-term impact in that commercial farms take a few years to recover to normal numbers usually just in time to face a new period of drought. Hence it is difficult for the cattle sector to achieve a sustained period of growth. Additionally, in periods where both South Africa and Namibia are hit by drought at the same time, Namibian farmers do not have an escape valve through South Africa as that market is also flooded by domestic meat.

The second important action taken by commercial farmers is to prevent the death of the remaining live cattle by buying supplemental feed, water and renting additional grazing land. The 2% death rate during the 1992 severe drought demonstrates that these methods are fairly successful at preventing livestock death. However, they are also extremely expensive. During drought, cereal production in Namibia often suffers a collapse. For instance, during the 1996/97 drought, the cereal production decreased from 173,000 in 1995/96 to 33,000 tones. During that same year, the cereal demand in the country was 260,000 tones/year, which means that during a drought there is a severe cereal deficit. As a consequence feed needs to be imported from South Africa which entails high transportation costs (Sweet). The result is that farmers spend large sums of money buying feed and moving cattle to nearby grazing land which motivates farmers to take a risk-averse mindset. As will be seen in more detail later, risk adverse farmers sell large

amounts of live cattle to South Africa each year rather than to export abattoirs to sell to the European Union.

### C. Climate Change

Although perhaps a more long-term challenge, climate change will pose a significant threat to the Namibian beef industry in the not too distant future. Important studies done for the World Bank and the United Nations indicate that global warming will have effects on Namibia that could range from extreme economic impacts for the beef industry all the way to a complete destruction of it. The results of these studies present a disheartening picture for the future and growth of this industry especially with regards to the possibility of attracting significant investments from abroad. Likewise, climate change increases the element of risk for local producers, representing a major disincentive for investment and growth. Additionally, the more risk involved for the sector, the more likely it is that the export abattoirs will continue to be underutilized and that live cattle will be exported to South Africa with the consequence of less beef exported to Europe and lower profits for the Namibian beef industry at all levels.

A series of policy research papers for the World Bank makes predictions on the effects of climate change in Africa by using Ricardian approaches for farmland net revenue. Although the studies offer varying results in terms of specific economic impacts they do agree on a number of issues. First, Sub-Saharan Africa will be hit particularly hard by climate change because of the already high-temperatures, highly variable low amounts of rainfall, high dependence on agriculture and low levels of technology in place. A warming climate will only exacerbate the existing harsh climatic conditions and the insufficient levels of technology present in the country that can be used to deal with them appropriately. Second, within Sub-Saharan Africa, countries

that are located in drier areas to start out (Namibia being the driest country) will be the most impacted if global warming brings about a warmer/drier scenario. In Namibia with an already dramatic loss of grassland productivity and with the bush encroachment induced droughts, global warming would imply an additional impact on grassland which according to these studies would especially harm beef cattle. Third, all studies predict a significant fall of net income for farms that specialize in beef, although the quantity of this impact varies from one study to another and depending on different climate change scenarios. Finally, it is also interesting to see that small African farms (less than US\$ 630 worth in animals) would suffer less from climate change because it is easier for them to switch to alternative economic activities such as small-stock (especially goats which are more heat resistant) (Mendelsohn et al).

The exact quantity of the loss to the Sub-Saharan livestock sector induced by global warming differs from one study to another. This is due not only to different applications of the Ricardian model but also to different global warming scenarios used. One study calculates that the loss to beef operations will be an average of US\$ 379 per farm per each 1 degree Celsius increase in temperature (Mendelsohn et al). However larger farms could expect a greater impact as this figure was taken for African farms as a whole in the study's sample. A more detailed study that used various global warming scenarios predicts losses of 38% in expected net income with a warming of 2.5 degrees Celsius and losses of 70% of net income for a warming of 5 degrees Celsius (Mendelsohn and Seo). The study also predicts a reduction in the possibility of selecting beef cattle as an economic activity (see Figure 2.1 below for South Africa as an example) and thus a reduction in the possibility of growth and future investment in the sector. It is interesting from Figure 2.1 below that those regions in South Africa that are neighboring

Namibia and thus share some geographic characteristics in common are the ones that have the least probability of selecting beef cattle in the future.

A study by the United Nations Framework Convention on Climate Change determined that mean annual temperatures as well as monthly maximum and minimum temperatures in Namibia will rise between 2 to 6 degrees until 2100 (UNCCC). A series of Atmospheric Oceanic General Circulation Models (CCC, CCSR and PCM) make similar conclusions for Sub-Saharan Africa as a whole although with varying degrees of warming. All models however predict losses that could range from a 43% reduction in net income per farm under the more conservative models to a more than 77% reduction in net income under more pessimistic ones by 2100. In the short-term, these same models predict losses ranging from 13% of net income to 37% by 2020 (Mendelsohn and Seo). This means that if Namibian and foreign investors consider global warming as a serious threat, the prospects for investment and growth in this sector are limited and will depend on whether international beef prices remain attractive.

#### D. Discussion

The environment poses a serious challenge to the development of the Namibian beef industry. Desertification reduces the profitability and the productivity of commercial farms through bush encroachment and the loss of grasslands. Bush encroachment forces farmers to implement de-bushing mechanisms thus raising their operating costs and reducing their net income. Otherwise they risk the loss of the carrying capacity of their lands and the viability of their businesses. The loss of grasslands has a similar effect to bush encroachment. It is worth mentioning that desertification is a threat to the Namibian commercial beef sector mainly



because it raises costs and reduces productivity while it is not a threat in terms of risk. Given that it is a more long-term and constant effect, it is more predictable and allows farmers the opportunity to mitigate its effects through investment. Therefore desertification cannot be considered a risk factor in that it is not an unforeseen event.

The main environmental risk factor affecting the beef sector is drought. This seasonal event is not sufficiently predictable to allow farmers enough time to completely mitigate its effects. When a drought strikes Namibia it does so with enough force to cause major disruptions to commercial farmers. Fearing the death of their cattle and the significant costs of buying feed, farmers are with left no alternative but to destock. It can take some time for a commercial farm to recover to its original stock and to pay for debt incurred during such an event. Therefore the risk of a drought is sufficiently large that it creates a dissinsentive for investment and a major block for the growth of the sector.

Global warming is another risk factor that erodes Namibia's comparative advantage in beef. The risk of extreme reductions in the net incomes of commercial farms that may be caused by rising temperatures is another great deterrent for investment in this sector. Given that most models predict that such a scenario will take place in Namibia it is likely that investors both foreign and domestic will think twice before investing in beef operations in the future. In order to fully understand the effects that risk can have upon Namibia's comparative advantages in meat production we continue by providing a theoretical model to further illustrate this point.

#### IV. Conclusion

The Namibian beef industry has experienced sluggish growth for a number of years in spite of the fact that the country has a comparative advantage in this sector. Given that Namibia's

beef sector has enjoyed preferential access to the European Union market, conventional trade theory suggests that the country would have exported increasing quantities of beef to that destination. Nevertheless, this has not been the case. The purpose of this study was to find answers to this seemingly paradoxical situation. Our analysis has established four conclusions in this regard.

First, cattle prices do not play a determining role in the underutilization of Namibian abattoirs. In the past, many Namibian farmers have chosen to export their cattle to South African feedlots instead of selling them to Namibian abattoirs. As a result, Namibia has been unable to maximize its beef exports to the EU. Our analysis has concluded that Namibian abattoirs offer higher prices to Namibian cattle producers than do South African feedlots. High South African cattle prices are therefore not the reason that Namibian farmers are choosing to export their cattle to South Africa.

Second, high Namibian fodder prices play a small role in the underutilization of Namibian abattoirs. High fodder costs in Namibia cause the raising of cattle to be very expensive for Namibian farmers. As a result, selling weaners which require little fodder prior to their sale has become increasingly profitable relative to that of selling mature cattle which require large amounts of fodder prior to their sale. This may partially explain why many Namibian farmers are choosing to sell weaners to South African feedlots which offer the highest weaner prices. Nevertheless, selling mature cattle continues to be slightly more profitable compared to selling weaners and so high Namibian fodder prices only play a partial role in the underutilization of Namibian abattoirs.

Third, the environment has a significant impact on the beef sector by increasing production costs, reducing productivity, and heightening risk. More specifically, the dry climate

of Namibia makes it difficult to produce the grains necessary for the manufacturing of animal feed which creates the necessity for expensive South African imports. Additionally, most cattle are grass fed and depend upon the fragile, dry eco-system which is in constant danger due to several environmental factors. Among these, desertification threatens to reduce the availability of both the amount of land the quality of grasses necessary for raising animals. Droughts and the process of global warming create an environment that exposes commercial farmers to high degrees of risk. The detrimental effects of these natural phenomena are such that they act as negative incentives for investment in this sector. Our study shows that, even though Namibian farmers can obtain higher prices by selling their cattle to local abattoirs, they choose to sell a large percentage of their live weaners to South Africa. This is due to a large extent to the high risk to their investments in Namibia.

Finally, a mathematical model was introduced to show how the presence of risk can undermine the comparative advantage of a country. Individuals involved in industries with high levels of uncertainty require a risk premium which increases with the level of risk. The presence of risk therefore increases the cost of production for an industry. This seems to be the case in Namibia, where the comparative advantage in the production of cattle is undermined by the presence of high degrees of risk created by the environment and legal uncertainty.

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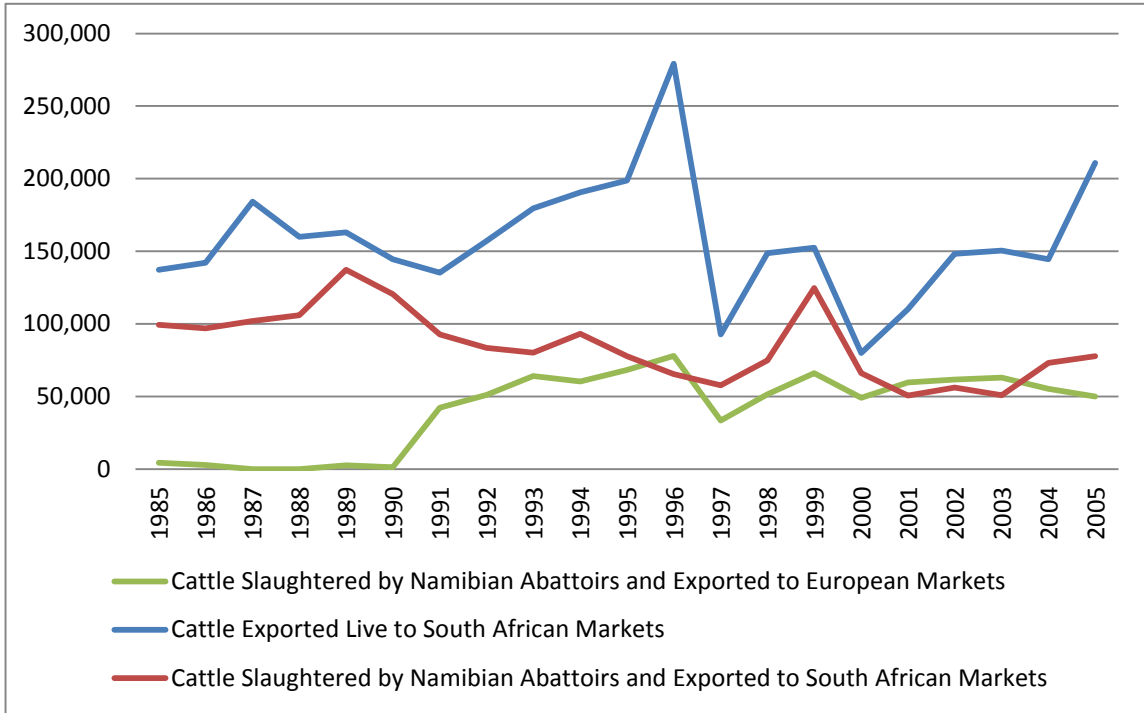
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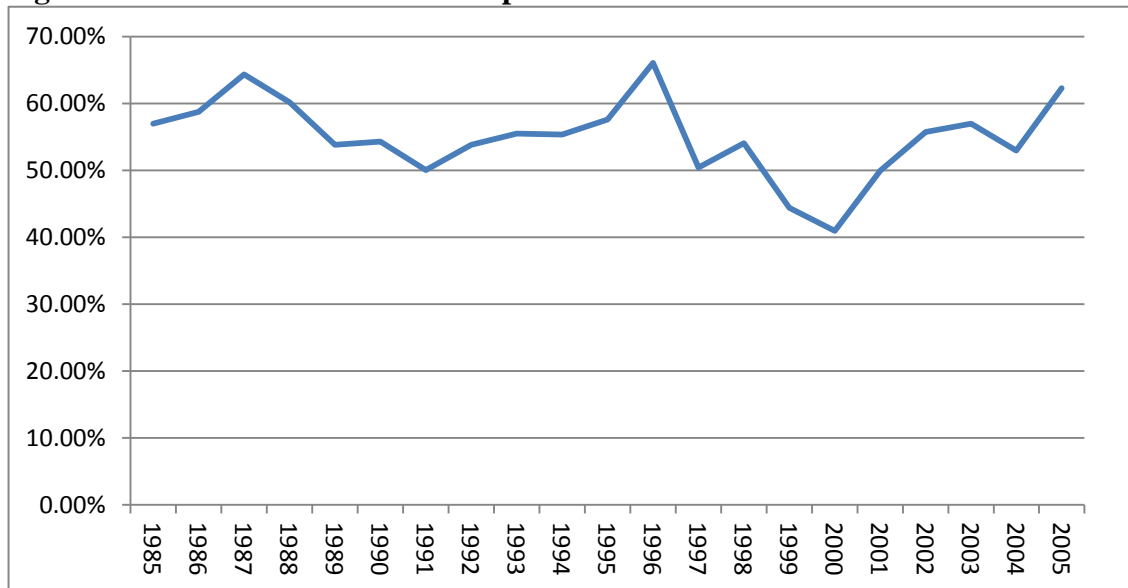
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**Figure 1.1: History of Namibian cattle exports (units)**



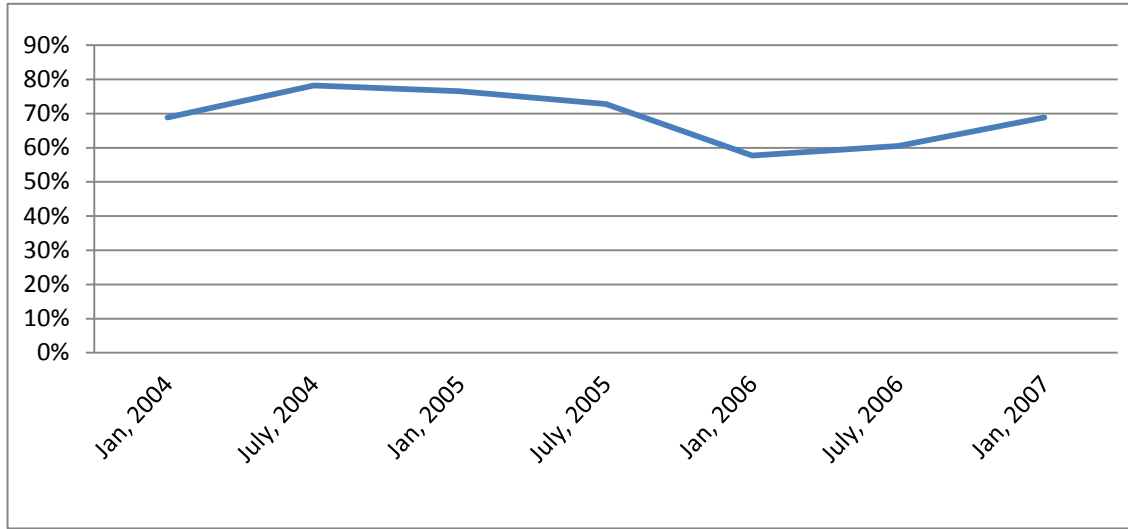
Note: Created using market statistics provided by the Meat Board of Namibia. Details in Appendix 1.

**Figure 1.2: % of Namibian cattle exports sent live to South Africa**



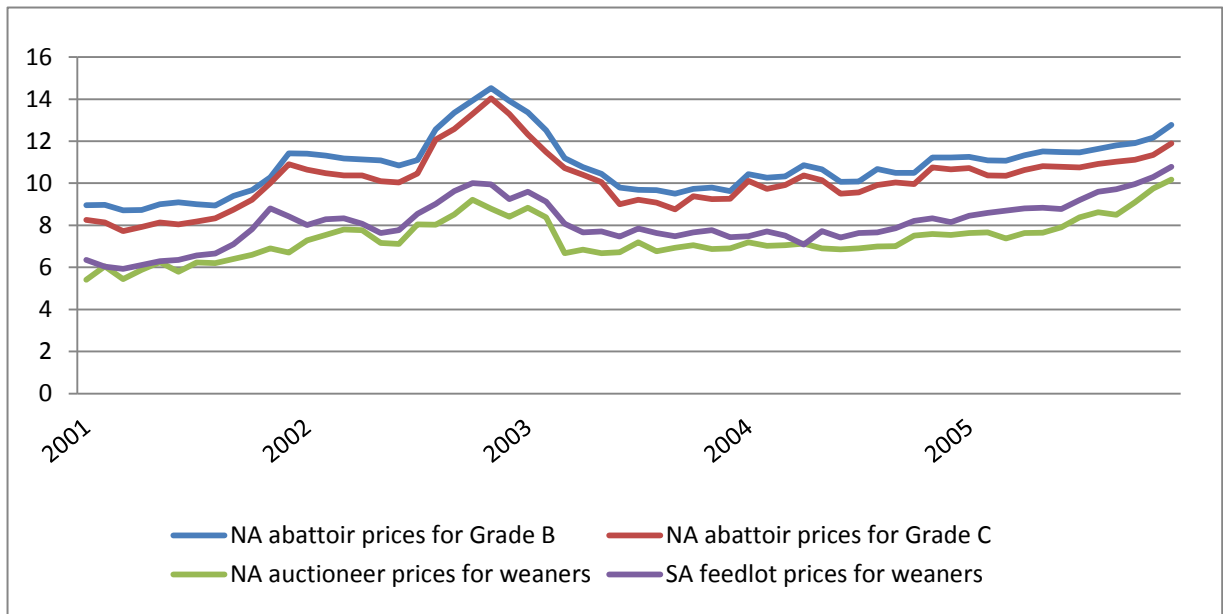
Note: Created using market statistics provided by the Meat Board of Namibia. Details pertaining in Appendix 1.

**Figure 1.3: Recent utilization of the slaughtering capacity of MeatCo abattoirs**



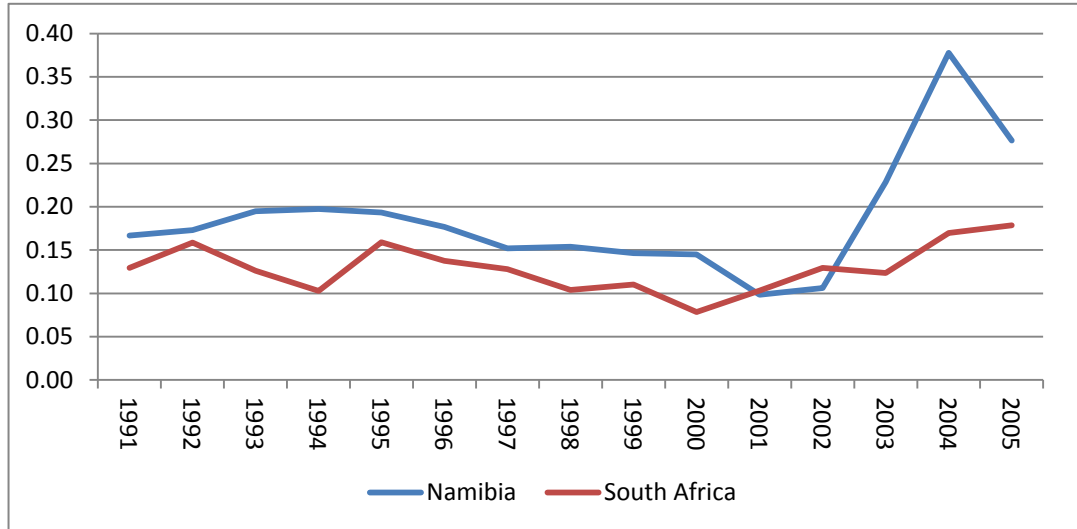
Note: Created using market statistics from a 2007 report “Cattle Review: Production and Marketing Trends” by the Meat Board of Namibia. See Appendix.

**Figure 1.4: Average prices offered to Namibian cattle producers (\$N/Kg)**



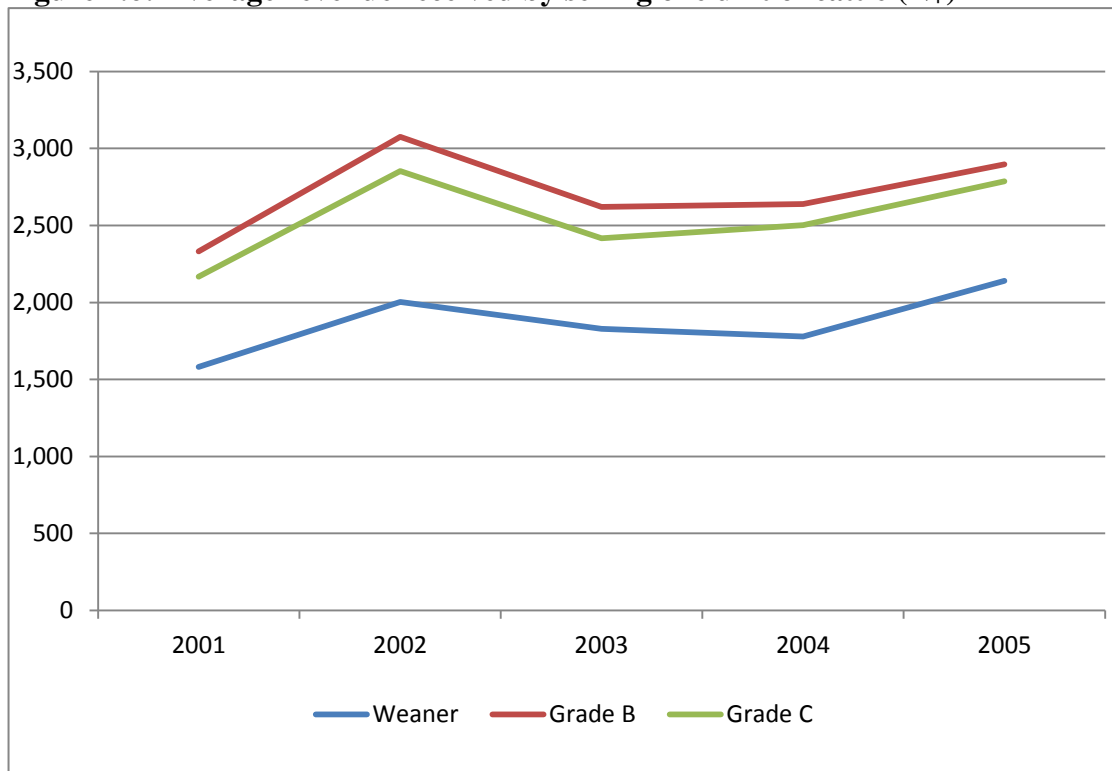
Note: This figure was created using market statistics provided by The Meat Board of Namibia. Details pertaining to the creation of this figure can be found in Appendix 1.

**Figure 1.5: Local producer prices for maize (US\$/Kg)**



Note: This figure was created using price statistics provided on the Food and Agricultural Organization of the United Nations website. Details pertaining to the creation of this figure can be found in Appendix 1.

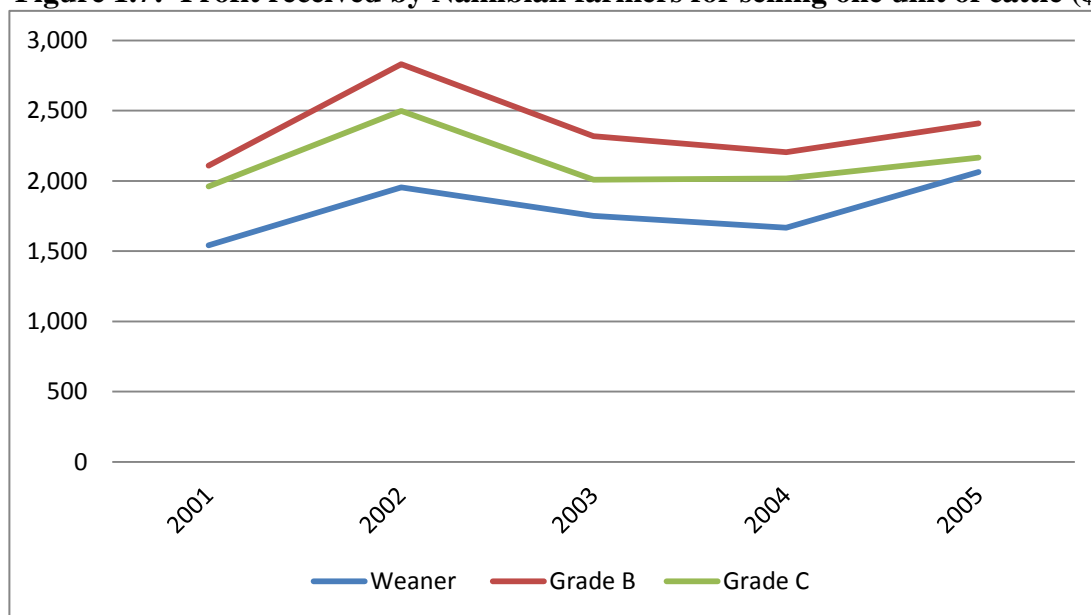
**Figure 1.6: Average revenue received by selling one unit of cattle (N\$)**



Note: Details pertaining to the creation of this figure can be found in Appendix



**Figure 1.7: Profit received by Namibian farmers for selling one unit of cattle (\$N)**



Note: Details pertaining to the creation of this figure can be found in Appendix 1

**Table 1.1: Revenue received by Namibian farmers for selling types of cattle (N\$)**

Year	Average Annual Weight of Cattle at Time of Sale (Kg)			Average Annual Price of Cattle at Time of Sale (N\$/Kg)			Revenue received by Farmers for Selling one unit of cattle (N\$)		
	Weaner	Grade B	Grade C	Weaner	Grade B	Grade C	Weaner	Grade B	Grade C
2001	230.00	249.31	251.25	6.87	9.35	8.63	1580.10	2331.31	2168.36
2002	230.00	252.13	248.62	8.71	12.20	11.48	2003.30	3075.08	2853.91
2003	230.00	249.39	243.81	7.95	10.51	9.91	1828.50	2621.31	2416.11
2004	230.00	249.81	248.91	7.73	10.57	10.06	1777.90	2640.24	2502.75
2005	230.00	249.26	255.70	9.31	11.63	10.90	2141.30	2897.60	2786.67

Note: Details pertaining to the creation of this figure can be found in Appendix 1.

**Table 1.2: Total costs of feeding cattle prior to sale**

Year	Total Amount of Feed Consumed by Cattle Prior to Sale (Kg)			Weighted Price of Maize while Cattle were Being fed by Farmers (N\$/Kg)			Total Costs of Feeding Cattle Prior to Sale (\$N)		
	Weaner	Grade B	Grade C	Weaner	Grade B	Grade C	Weaner	Grade B	Grade C
2001	44.86	242.76	383.34	0.85	0.92	0.54	38.13	223.34	207.00
2002	44.86	245.55	379.37	1.13	1.00	0.94	50.69	245.55	356.61
2003	44.86	242.76	371.93	1.76	1.25	1.10	78.95	303.45	409.13
2004	44.86	243.16	350.11	2.49	1.79	1.39	111.70	435.26	486.65
2005	44.86	242.75	390.27	1.77	2.01	1.59	79.40	487.93	620.53

Note: Details pertaining to the creation of this figure can be found in Appendix

**Table 1.3: Profit farmers received by raising and selling cattle**

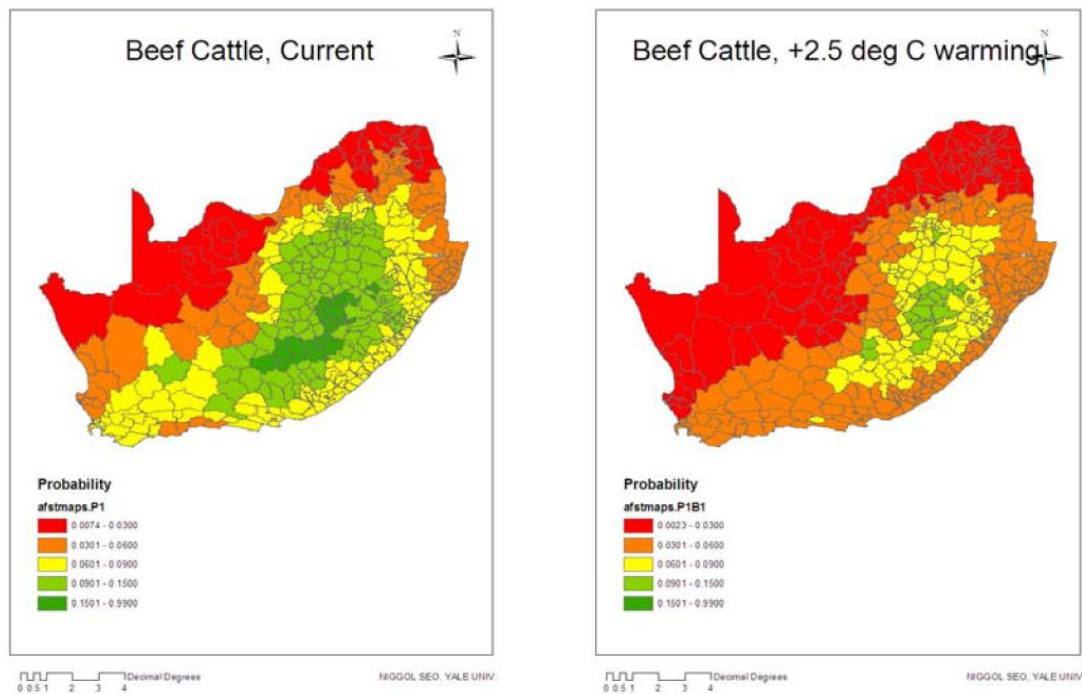
Year	Revenue Farmers Receive by Selling Cattle			Costs Farmers Incur by Raising Cattle			Profit Farmers Receive by Raising and Selling Cattle		
	Weaner	Grade B	Grade C	Weaner	Grade B	Grade C	Weaner	Grade B	Grade C
2001	1,580	2,331	2,168	38.13	223.34	207.00	1541.97	2107.97	1961.36
2002	2,003	3,075	2,854	50.69	245.55	356.61	1952.61	2829.53	2497.31
2003	1,829	2,621	2,416	78.95	303.45	409.13	1749.55	2317.86	2006.99
2004	1,778	2,640	2,503	111.70	435.26	486.65	1666.20	2204.98	2016.09
2005	2,141	2,898	2,787	79.40	487.93	620.53	2061.90	2409.66	2166.14

**Table 1.4: Average and standard deviations of Yellow Maize prices in South Africa (R\$/Kg)**

<b>Time Period</b>	<b>Average Price of Maize in South Africa</b>	<b>Standard Deviation of Maize Price in South Africa</b>	<b>Standard Deviation as Percentage of Average Price</b>
1997-1999	0.68	0.10	15.41%
1998-2000	0.69	0.11	15.92%
1999-2001	0.80	0.18	22.24%
2000-2002	1.02	0.35	34.33%
2001-2003	1.12	0.27	24.22%
2002-2004	1.16	0.25	21.31%
2003-2005	0.91	0.21	23.20%
2004-2006	0.98	0.26	27.09%
2005-2007	1.22	0.47	38.84%

Note: This table was created using price statistics from the South African Futures Exchange website. Details pertaining to the creation of this figure can be found in Appendix 1

**Figure 2.1 Probability of Selecting Beef Cattle**



Source: Mendelsohn,, Seo, Yale University

**Table 2.1 The Effect of Bush Encroachment on Carrying Capacity**

Site	Treatment (bushes Left) per hectare	Hectare per large stock unit
<b>Pontdrif (1991/92) 214mm</b>	0%	9.9
	20%	29.4
	50%	128.9
	100%	267.4
<b>Pontdrif (1991/92) 440mm</b>	0%	9.4
	20%	12.3
	50%	25.5
	100%	81.7

Source: Recreated from Bush Encroachment in Namibia Report

## Appendix 1

### Figure 1.1

- Source of Data:
  - The data used to create Figure 1.1 was found in an excel file entitled “Export of cattle and beef carcasses, cuts, and tinned meat” provided by Willie Schutz at the Meat Board of Namibia.
- Characteristics of Data:
  - The data includes annual statistics of Namibian cattle exports to the RSA Markets (live and slaughtered) and Overseas Markets (slaughtered).
- How the Data was used:
  - The annual statistics were inputted into an excel file and a chart was created. The data for “Overseas Markets” was re-labeled “European Markets” because the EU is the primary customer of Namibian beef exported by Namibian abattoirs.

### Figure 1.2

- Source of Data:
  - The data used to create Figure 1.2 was found in an excel file entitled “Export of cattle and beef carcasses, cuts, and tinned meat” provided by Willie Schutz at the Meat Board of Namibia.
- Characteristics of Data:
  - The data includes annual statistics of live Namibian cattle exports to the RSA Markets.
- How the Data was used:
  - The annual statistics were inputted into an excel sheet and a chart was created.

### Figure 1.3

- Source of Data:
  - The data used to create Figure 1.3 was found in Figure 3 of a report entitled “2007 Cattle Review: Production and Marketing Trends” provided on the Meat Board of Namibia website at <http://www.nammic.com.na/stats.php>.
- Characteristics of Data:
  - The data includes monthly statistics of the utilization of the slaughtering capacity of Namibian abattoirs between 2004 and 2007.
- How the Data was used:
  - An average of the monthly statistics for each 6-month period was calculated. The 6-month averages were then inputted into an excel worksheet and a chart was created.

### Figure 1.4

- Source of Data:

Data	Source
Price data for Grade B and C cattle between 2001 and 2004	An excel file named “Average producer price of beef carcasses at export abattoirs” provided in the 2001-2004 market statics on the Meat Board of Namibia website.
Price data for Grade B and C cattle during 2005	An excel file named “Average producer price of beef carcasses at export abattoirs” which was provided by Willie Schutz at the Meat Board of Namibia.
Price data for weaners sold to Namibian abattoirs between 2001 and 2004	An excel file named "Auctions" provided in the 2001-2004 market statistics provided on the Meat Board of Namibia website.
Price data for weaners sold to Namibian abattoirs during 2005	An excel file named “Auctions” provided by Willie Schutz at the Meat Board of Namibia.
Price data for weaners sold to South Africa between 2001 and 2005.	An excel file named “Copy of Pryse voerkraal vs meat Worksheet” which was provided by Willie Schutz at the Meat Board of Namibia.

- Characteristics of Data:
  - The data included monthly statistics of the prices offered by Namibian abattoirs for Grade B and C cattle as well as monthly statistics of the prices offered by South Africa and Namibian auctioneers for weaners.
- How the data was used:
  - The monthly statistics were inputted into an excel file and a chart was created.

**Figure 1.5**

- Source of Data:
  - The data used to create Figure 1.5 was found on the Food and Agricultural Organization of the United Nations website at <http://faostat.fao.org/site/570/default.aspx>.
- Characteristics of Data:
  - The data included annual statistics of the producer prices of maize in Namibia and in South Africa.
- How the data was used:
  - The annual statistics were inputted into an excel file and a chart was created.

**Table 1.1**

- Source of Data:

- The price data sources used in Figure 1.4 were also used in Table 1.1.

<b>Data</b>	<b>Source</b>
Weight data for Grade B and C cattle between 2001 and 2004	An excel file named "Average Beef Carcass Mass at Export Abattoirs" provided in the 2001-2004 market statics on the Meat Board of Namibia website.
Weight data for Grade B and C cattle during 2005	An excel file named "Average Beef Carcass Mass at Export Abattoirs" which was provided by Willie Schutz at the Meat Board of Namibia.
Weight data for weaners between 2001 and 2005	The South African Meat Industry Company website at <a href="http://www.samic.co.za/SAMIC/Introduction.htm">http://www.samic.co.za/SAMIC/Introduction.htm</a> .

- Characteristics of Data:
  - The data for Grade B and C cattle included monthly statics of the weight of pre-slaughtered and post-slaughtered cattle.
  - The data for weaners was acquired from a statement made on the SAMIC website.
- How the data was used:
  - Monthly weight statistics of Grade B0, B2, and B5 cattle were used to find average annual weights for Grade B cattle. Monthly weight statistics of Grade C0, C2, and C5 cattle were used to find average annual weights for Grade C cattle. The statistics of other Grade B and C cattle categories were not used due to find the average annual weights of Grade B and C cattle due to data constraints.
  - No weight statistics other than the single statistic provided by SAMIC could be found to calculate the average annual weight of weaners. The single statistic was therefore used for every year between 2001 and 2005.
  - The pre-slaughter weight statistics of weaners were used in Table 1.1 because South African feedlots purchase weaners from Namibian producers before the cattle are slaughtered. In contrast, the slaughtered weight of Grade B and C cattle were used in Table 1.1 because Namibian abattoirs purchase meat from Namibian producers only after the cattle have been slaughtered.

### Figure 1.6

- Source of Data:
  - The data sources used to create Table 1.1 were also used to create Figure 1.6.
- Characteristics of Data:

- The same as the data used to create Table 1.1.
- How the data was used:
  - The revenue values calculated in Table 1.1 were inputted into a spreadsheet and a chart was created.

**Table 1.2**

- Source of Data:
  - The weight data sources used to create Table 1.1 were also used to calculate the average annual weight statistics found in Table 1.1.

<b>Data</b>	<b>Source</b>
Average age of different types of cattle	The website of the Department of Animal and Range Sciences at South Dakota State University found at <a href="http://ars.sdstate.edu/AnimalEval/Beef/beefgrade.htm">http://ars.sdstate.edu/AnimalEval/Beef/beefgrade.htm</a>
Foreign exchange rates of US\$ to N\$	FX History website at <a href="http://www.oanda.com/convert/fxhistory">http://www.oanda.com/convert/fxhistory</a>
Producer price data of Maize in Namibia (US\$)	The Food and Agricultural Organization of the United Nations at <a href="http://faostat.fao.org">http://faostat.fao.org</a>

- Characteristics of Data:
  - The producer price data of maize were annual statistics.
  - The foreign exchange rates were daily statistics.
- How the data was used:
  - Since cattle generally tend to consume a daily amount equal to 3% of their body mass at the time, it was necessary to calculate the pre-slaughter weight of Grade B and C cattle in order to determine the quantity of fodder they consume prior to sale.
  - First, the pre-slaughter weight statistics of Grade B and C cattle at the time of sale were calculated by dividing the monthly post-slaughter weight statistics used to create Table 1.1 by .57 because the post-slaughter weight of cattle generally tends to be 57% the of its pre-slaughter weight (F. Potgieter).
  - Second, the maximum and minimum ages of the age range for each type of cattle were added together and divided by two in order to find the average age each type of cattle in months.
  - Third, the pre-slaughter weight of each type of cattle at the time of sale was divided by the average number of months the cattle was expected to have been alive in order to calculate the monthly weight of each type of cattle prior to its sale.



- Fourth, the monthly pre-slaughter weight of each type of cattle prior to sale was multiplied by .03 in order to determine its monthly consumption of fodder because cattle generally tend to consume an amount equal to 3% of their body weight at the time of consumption.
- Fifth, the monthly amounts of fodder consumed by each type of cattle prior to their sale were then added together to determine the total amount of fodder consumed by each type of cattle prior to sale.
- In order to determine the cost of feeding each type of cattle prior to its sale, the total amount of fodder consumed by the cattle prior to their sale needed to be multiplied by the weighted average price of maize during the period which they were being fed by the farmers. The weighted average price of maize prior to the sale of each type of cattle therefore needed to be calculated.
- First, the average annual foreign exchange rate of US\$ to N\$ was calculated using daily FX data found on the FX exchange website.
- Second, the average annual foreign exchange rate from of US\$ to N\$ was multiplied by the annual price of maize offered to producers in Namibia found on the FAO website in order to convert the annual price of maize from US\$ to N\$.
- Third, a weighted average of the price of maize prior to each type of cattle's sale was determined by multiplying the annual price of maize for each year prior to the cattle's sale by the percentage of that year the cattle was fed by the owner and then adding together the results of each year. Take for instance a Grade B cattle sold in 2001. Since Grade B cattle have lived an average of 36 months, it can be assumed that owners must feed Grade B cattle for 36 months before they are sold. If the cattle are sold at the end of 2001, then the farmer must therefore feed the cattle during the years of 1999, 2000, and 2001. The weighted price of maize during this time can be calculated by multiplying the maize price of each of these years by the number of months the cattle is fed by the farmer during that particular year and then adding together the results of years 1999-2001. In other words, the weighted price for Grade B cattle sold in 2001 would be  $(1999 \text{ maize price} * 12/12) + (2000 \text{ maize price} * 12/12) + (2001 \text{ maize price} * 12/12)$ .
- Fourth, the total amount of fodder consumed by the cattle prior to their sale needed to be multiplied by the weighted average price of maize during the period which they were being fed by the farmers in order to determine the cost of feeding each type of cattle prior to its sale.

### Table 1.3

- Source of Data:
  - The revenue calculations made in Table 1.1 and the cost calculations made in Table 1.2 were used to create this table.
- Characteristics of Data:
  - The data used in Table 1.3 included annual statistics.
- How the data was used:

- The costs statistics created in Table 1.2 were subtracted from the revenue statistics created in Table 1.1 to find the profits Namibian farmers received by raising and selling each type of cattle.

**Figure 1.7**

- Source of Data:
  - The data sources used to create Figure 1.7 were also used to create Table 1.3.
- Characteristics of Data:
  - The same as the data used to create Table 1.3.
- How the data was used:
  - The profit statistics calculated in Table 1.3 were inputted into an excel file and then a chart was created.