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PROFITABILITY ANALYSIS OF ABALONE FARMING IN PORT NOLLOTH, IN THE NORTHERN CAPE PROVINCE, SOUTH AFRICA.

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ABSTRACT

The abalone industry in South Africa is known as one of the largest in the world. The country produced 1000 tons in 2008 (DEAT, 2008). Most of the abalone farms are located in the Western Cape Province due to the suitable environmental conditions and established infrastructure. The growth of abalone aquaculture is expected to continue. However, access to suitable coastal land and the dependence on wild harvest of seaweed may restrict further development around main nodes of abalone farming. The government has proposed the development of the Namaqualand Mariculture Park (NMP) in the Northern Cape province of South Africa. The NMP concept involves the development of complementary marine aquaculture activities sharing common infrastructure, where access to coastal land and good quality seawater is guaranteed. The running costs of the Mariculture Park will be met by charging the tenant aquaculture operations a monthly rent. The NMP could support a diverse number of mariculture operations but for the short term only an abalone land-based grow-out farm would be established. The current project evaluated the feasibility of abalone farming as the first aquaculture venture to be established in the NMP. In order to do this, a 120 ton production model was developed and the results used as input for the profitability model. The results from the production model estimated that 70.000 spat needs to be purchased monthly to sustain the 120 tonne annual production of the farm. The main result from the profitability model, the Net Present Value (NPV) for the two cash flow series was negative R 37 million and negative R 30 million, respectively. The Internal Rate of Return was less than the Marginal Attractive Rate assumed for the current project, indicating that abalone farming with the current assumptions is not a profitable venture. Sensitivity analysis indicated that the abalone farm is most sensitive to variations in the sales price and the quantity of abalone sold. This is important as revenue earned must cover the cost incurred by production. Relating this to the assumptions used for the current project, dried abalone requires larger animals than those usually grown on the majority of abalone farms producing live animals. Abalone farming is capital intensive and the longer production period for the current study leads to even higher production costs. High production costs have been cited as one of the main reasons for the poor economic performance of abalone aquaculture. The models can now be used to explore alternative production strategies taking into account variables that have a noticeable effect on profitability of abalone farming.

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1 INTRODUCTION

The abalone industry in South Africa is known as one of the largest in the world. The country produced 1000 tonnes in 2008 (DEAT, 2008). Most of the abalone farms are located in the Western Cape Province due to the suitable environmental conditions and established infrastructure (DEAT, 2008; Hinrichson, 2007). The growth of abalone aquaculture is expected to continue. However, access to suitable coastal land and the dependence on wild harvest of seaweed/kelp may restrict further development around main nodes of abalone farming (Troell *et al.*, 2006).

The Northern Cape Province has potential for marine aquaculture. Nevertheless, the industry is still poorly developed and only two species (abalone and oysters) were cultured in the province during the year 2008. The establishment of Marine Aquaculture Development Zones has been promoted by government in order to support and stimulate growth in the marine aquaculture sector. This lead to the concept of the Namaqualand Mariculture Park (NMP) in the Northern Cape province of South Africa. The NMP concept involves the development of complementary marine aquaculture activities sharing common infrastructure, where access to coastal land and good quality seawater is guaranteed. The NMP will offer mariculture businesses a prepared site within the complex to develop for their operational needs (Oellermann, 2005). The running costs of the Mariculture Park will be met by charging the tenant aquaculture operations a monthly rent, a tariff per unit volume of seawater used by the operations, as well as *ad hoc* fees for services (Oellermann, 2005). This will result in lower individual operational costs by using shared resources.

The NMP could support a diverse number of mariculture operations especially the culture of species that prefer temperate waters (Oellermann, 2005). Businesses proposed to operate out of the Park include an abalone hatchery, abalone land based farming, abalone ranching (at sea culture), oyster long-lining and a fin-fish (turbot) on-growing farm.

All these operations would not be established simultaneously, and for the short term an abalone land- based grow-out farm would be established in the NMP. Local environmental conditions are favourable for abalone farming, and it is estimated that the kelp bed habitat could support 1000 tonnes of abalone production per year (DEAT, 2006; De Waal *et al.*, 2003).

1.1 Objectives

- Develop a production model in Excel, for abalone land based grow-out farming in Port Nolloth, Northern Cape Province of South Africa
- Develop a profitablity model based on the assumption that an abalone grow-out operation of 120 tonnes (economy of scale) is going to be established
- Use profitability measures such as Net Present Value (NPV) and Internal Rate of Return (IRR) to determine profitability over a planning period of 15 years
- Carry out Risk Assessment on uncertainty factors

This study will proceed by giving background information on aquaculture in South Africa, highlighting the importance of marine aquaculture, specifically abalone aquaculture. Challenges relating to expansion of the marine aquaculture industry are discussed as well as strategies from the government to mitigate these challenges. Governmental strategies important for the current study include the development of Marine Aquaculture Development Zones (MADZ). The NMP, as one of the MADZ, in the Northern Cape province of South Africa is reviewed and the way forward discussed. Abalone land-based grow-out farming as the first venture to be established in the NMP for the short term is discussed. Abalone aquaculture, biology and the market are discussed. The methodology of the current study is related to profitability assessment techniques and simulation by using models. Production cost inputs are determined by using a biological production model. Main results from the profitability assessment are discussed, and recommendations are made.

2 AQUACULTURE IN SOUTH AFRICA

The total aquaculture production in South Africa in 2008 was approximately 3.000 tonnes (DEAT, 2008). Aquaculture in South Africa can be divided into freshwater and marine aquaculture, contributing 40% and 60% to total aquaculture production respectively.
Freshwater aquaculture species include trout, tilapia, African catfish, common carp, mullet, largemouth bass, marron crayfish, Koi Carp and aquarium species. However, freshwater fish culture is severely limited by the supply of suitable water (Hinrichson, 2007).

The total value of the marine aquaculture industry in 2008 was estimated to be R 300 million rand (44 million U$ dollars) (DEAT, 2008). Commercial marine aquaculture in South Africa began in the 1980s with the establishment of oyster, mussel and prawn farming (DEAT, 2006). Current marine aquaculture species include abalone (integrated with seaweed culture), oyster, mussel, finfish, prawn and ornamental fish (Figure 1) (DEAT, 2008).

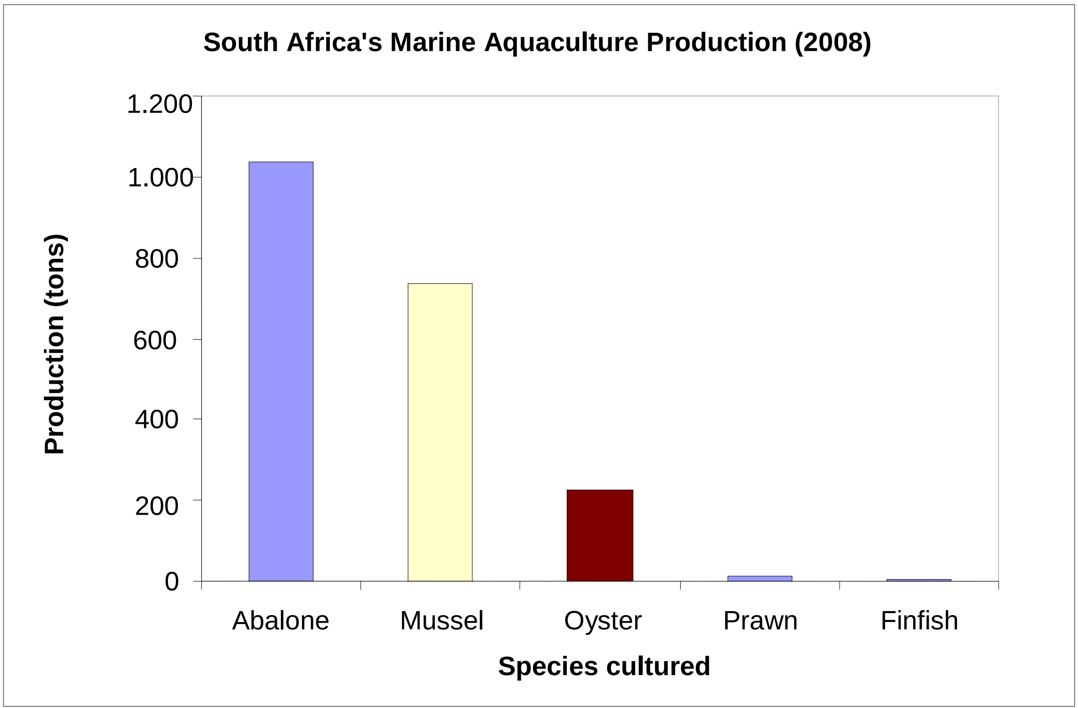

Figure 1: South African marine aquiculture production by species in 2008 (DEAT,

In terms of volume and value of production, abalone represents the largest sub-sector, contributing 94% to the total value of marine aquaculture in South Africa. Marine aquaculture is based on intensive production technologies with high input costs; therefore this sector will focus on the production of high-value products (DEAT, 2006). Despite the currently small size of the South African marine aquaculture sector, the industry is well served by the country’s established infrastructure and aquaculture support services (DEAT, 2006).

South Africa has well established fisheries. However, high value species fisheries such as abalone and prawns are over-exploited (DEAT, 2006). So although there are opportunities for aquaculture development, challenges cannot be excluded.

2.1 Challenges for marine aquaculture development in South Africa

The nature of the South African coastline limits opportunities for sea-based aquaculture to a small number of sheltered bays and estuaries. Hence, the majority of aquaculture operations are based on land (DEAT, 2006; 2007). Land-based, pump ashore operations have been successfully developed for abalone and seaweed farming. Although South Africa possesses favourable environmental conditions for aquaculture, coastal land is highly sought after and aquaculture operations have to compete with other industries including tourism and real estate (DEAT, 2006; 2007). High entry costs, an unsupportive regulatory environment and limited human resource, also pose problems. The combination of these factors has lead to the perception that marine aquaculture is a high-risk business (DEAT, 2006). The governmental policy on marine aquaculture aims to increase production in South Africa by implementing strategies to tackle some of these challenges. (DEAT, 2007). It was therefore proposed that government secure suitable sites for aquaculture in regions with a high potential for such an industry (DEAT, 2006).

2.2 The Namaqualand Mariculture Park Concept, Northern Cape Province

The Northern Cape province (Figure 2) is situated in northwest South Africa. It is the largest and most sparsely populated of the provinces. The climate is arid to semi arid. The primary land use within the province is stock and game farming and the coastal environment is unique in that mining, particularly diamond mining, is virtually the sole economic activity (DEAT, 2006). Few employment alternatives exist for the labour force (DEAT, 2006; Oellermann, 2005).

Port Nolloth, the proposed site of the NMP is situated along the West Coast of this province. The west coast of South Africa is affected by the cold water of the Benguela current (Oellermann, 2005). Most of the coast near Port Nolloth has a water temperature range of 13 to 17 °C (Oellermann, 2005). Variations of inshore temperatures in the Benguela region are relatively small; a 10-year mean shows a difference of 2°C during the coldest months and 4 °C during the warmest months (De Waal *et al*., 2003).

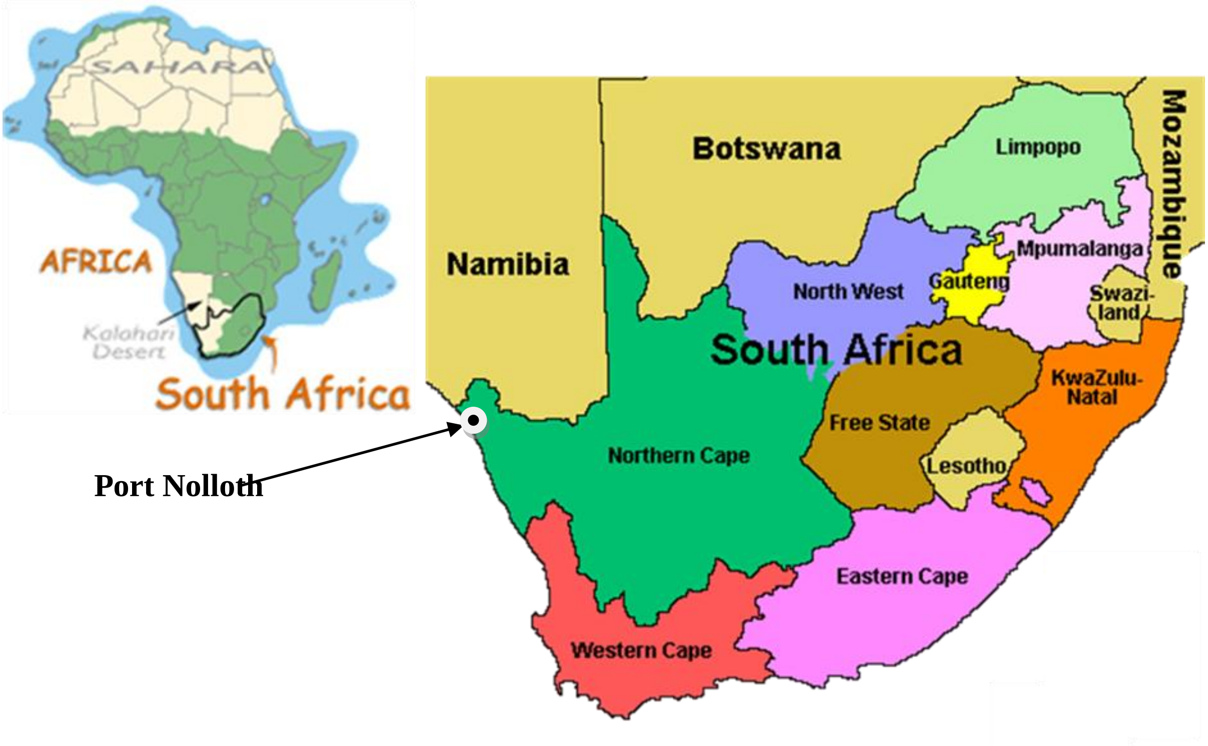

Figure 2: Map of South Africa, indicating the Northern Cape Province

Although mariculture has been identified by many sources as potentially highly beneficial to the Northern Cape Province's economy, it is a relatively undeveloped industry sector in South Africa. However, by developing a Mariculture Park in the Northern Cape, many of the problems associated with setting up a mariculture business will be mitigated. In order to create this enabling environment, the NMP will consist of basic infrastructure including seawater pumps and reticulation, seawater storage ponds, a wetland for effluent water treatment, an office and laboratory complex, paved access roads, site related services (power, municipal water and refuse) and security (Figure 3) (Oellermann, 2005).

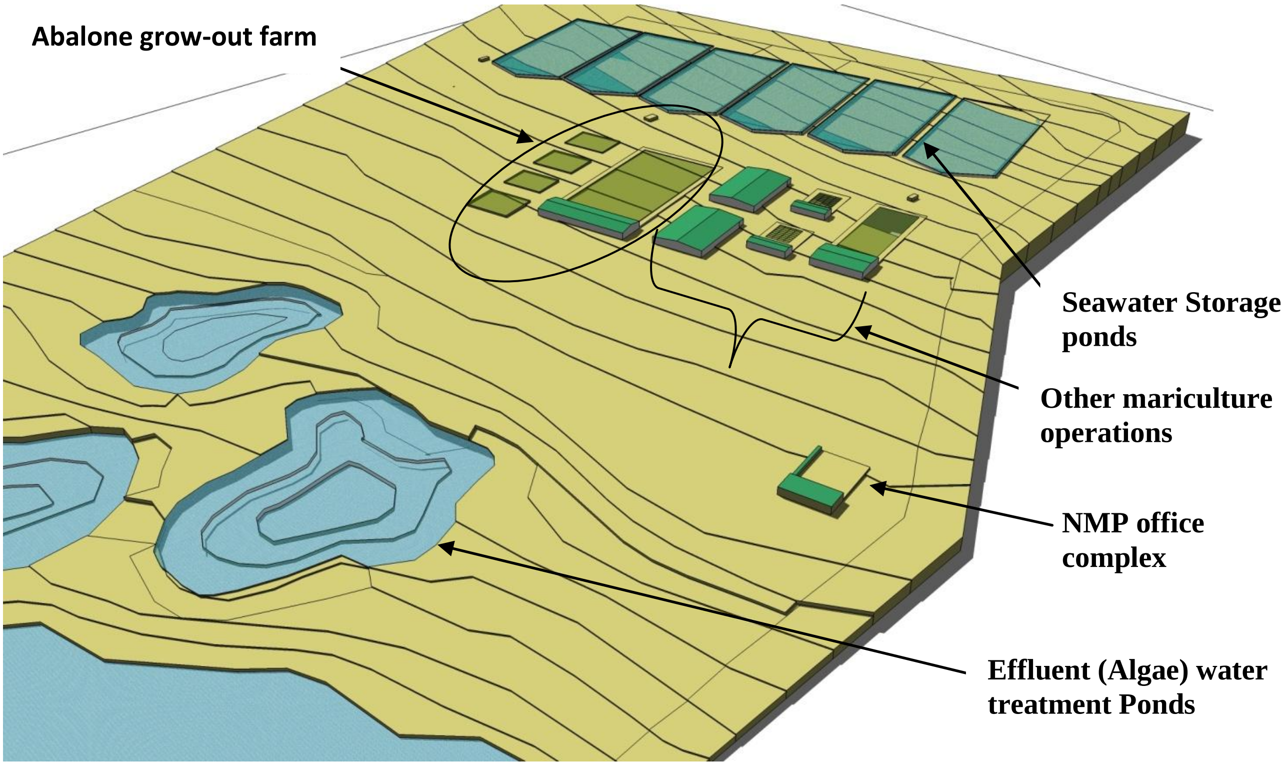

Figure 3: Concept of the Namaqualand Mariculture Park (adapted from Oellermann (2005).

Water will be pumped from the sea and flow into the (two-hectare) storage ponds, while the rest will flow directly to the mariculture operations, via a large reservoir (Oellermann, 2005). The two ha ponds will be used as solar heating ponds, as well as oyster culture ponds. The storage ponds serve as operational security for the NMP in case of complete pump failure (Oellermann, 2005).

At the concept stage of a project the complexities of the interactions cannot be fully predicted as is the case between tenant operations and the NMP Operating Company.

2.3 Challenges related to Mariculture Park

Port Nolloth (Figure 2) in the Northern Cape Province, is a logistically remote region in regards to distance from airports, and other aquaculture services including processing facilities.

3 ABALONE FARMING

3.1 The South African abalone, *Haliotis midae:* description and distribution

The abalone is a marine gastropod mollusc of the genus *Haliotis*, which inhabits rocky substrates in shallow waters along the coast (Figure 4) (Oellermann, 2005).

Figure 4: South African abalone, *Haliotis midae* (Oellermann 2005).

They can be found from the low tide mark to a depth of about 30 m. Their maximum population density occurs at 10 metres where the seaweed on which they live grows abundantly (Troell *et al.*, 2006). Although six abalone species are found in South Africa, only *H. midae* (perlemoen) is farmed commercially (Oellermann 2005). *H. midae* is distributed along much of the South African coast, ranging from the cold waters of the Benguela upwelling system in the west, to the warmer east coast which is influenced by the south flowing Agulhas current (Oellermann 2005; Britz *et al.*, 1997). Mean monthly sea temperatures range from a minimum of 12–13° C in the west, to a maximum of 21° C in the east (Britz *et al*., 1997). Abalone no longer naturally occur off the Northern Cape Coast, although the fossil record shows the presence of abalone in the region some 30 000 years ago (Oellermann 2005).

3.2 Abalone physiology and water quality

Maximisation of growth is an important factor for successful commercial aquaculture. A variety of factors such as food quality, stocking density, and water quality are known to influence the growth of abalone. Environmental temperature directly determines rates of gonad development, larval development, feed consumption, ammonia excretion, oxygen consumption, growth rate, and survival. Studies have shown that between 12 and 20° C growth rate and food consumption increases and the food conversion ratio did not differ significantly (Britz *et al*., 1997). Food consumption in most cultured poikilotherms, including abalone, is primarily determined by temperature and body size (Britz *et al.*, 1997). Between 20 and 24° C, growth and food consumption decline sharply, and FCR deteriorated. In aquaculture where food is not limiting, temperature will be the primary environmental factor determining growth rate (Britz *et al*., 1997). Also, ammonia excretion and oxygen consumption rates in *H. midae* increased significantly above 20° C. The condition factor of abalone decreased with increasing temperature. So it is fair to say that temperatures between 12 and 20° C are physiologically optimal for *H. midae* (Britz *et al.,* 1997).
Abalone in the larger size-class are competitively superior, therefore, regular grading is needed to prevent grazing competition.

3.3 Abalone aquaculture

Abalone is one of the most prized seafood delicacies worldwide. Farming of abalone began in the late 1950s and early 1960s in Japan and China (Abalone Consultants 2010). Triggered by a decline in yields from wild fisheries, a rapid development of abalone cultivation took place in the 1990s, and cultivation is now widespread in many countries including USA, Mexico, South Africa, Chile, Australia, New Zealand, Japan, Korea, China and Taiwan (Brown *et al*., 2008; 2009; Oellerman 2005).

Over-exploitation of wild abalone stocks by poaching and high market prices have been the main drivers for the cultivation of abalone in South Africa (Troell *et al*. 2006). Access to relatively cheap labour, together with favourable environmental conditions and infrastructure, also facilitated the growth of the industry in South Africa (Figure 5) (Troell *et al*., 2006).

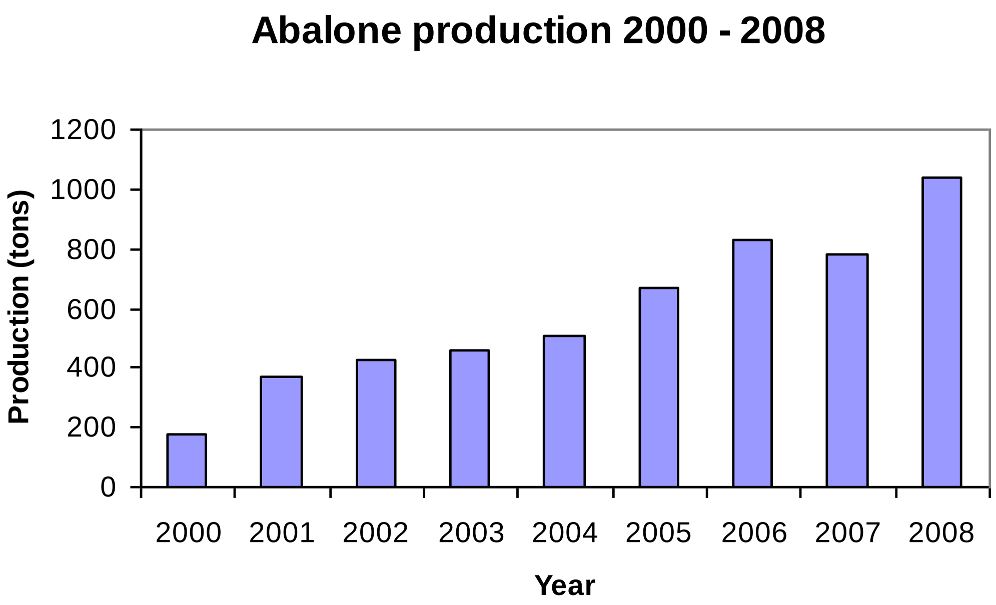

Figure 5: South African abalone production 2000-2008 (DEAT 2008).

The abalone aquaculture industry in South Africa in 2008 is comprised of 14 land based facilities, including 12 hatcheries, as well as an experimental abalone sea cage farm and a ranching operation (DEAT 2008). Most farms pump seawater into land based tanks that are operated in flow-through mode, though recirculation technology is also used (Britz, 1996). Some farms have both hatchery and grow-out facilities whilst others rely on purchasing juveniles from other hatcheries. Land-based abalone farming is associated with a high fixed capital investment (equipment and buildings) ranging between R 1.6 million and R 30 million for a 15 and 120 ton farm respectively (Troell 2006). Usually labour and feed costs account for the majority of operating expenses (De Ionno 2006, Abalone Consultants 2010).

Feeds used in the farming of abalone include artificial (formulated) feed and their natural food seaweed/kelp. The use of kelp or other seaweeds versus artificial feed on an abalone farm is related to a number of possibly conflicting aspects such as price of feed, availability and accessibility of fresh seaweed, food conversion ratio (FCR), cost of handling and storage and final quality of abalone and culture environment (Troell *et al*., 2006). The Feed Conversion Ratio (FCR) range for formulated feed is 5–9, whereas that of kelp is 12–17 (Troell *et al*., 2006). In general, abalone grow faster on formulated feed due to the higher protein content than kelp until they reach about 50 mm shell length at two years of age. Most farms use such feed in the early stages. This is because juveniles of *H. midae* have size-specific requirements for a higher protein diet (Britz and Hecht 1997). After 50 mm shell length, farmers tend to prefer kelp or a combination of formulated feed and kelp for two reasons: first, formulated feed promotes a higher incidence of sabellid infestation (shell boring worm) and second, shell growth rates tend to be higher on kelp (Troell *et al.*, 2006).

Maximum production capacity is not reached within the first 5 years of abalone growth and farms will have fewer employees per tonne once full production capacity is reached. The number of employees per tonne of abalone produced ranges from 0.46–1.62 (Troell *et al.*, 2006). In the start-up phase of a mariculture facility more part-time and more skilled workers are required than when the facility is well established. Skilled personnel include engineers, administrators, financial service providers, researchers and managers. The unskilled work is mainly maintenance, harvesting, processing and security (Troell *et al*., 2006).

3.4 The abalone market

The main market for abalone is Asia; specifically China, Japan and Taiwan (Brown *et al.*, 2008; Oellerman 2005). An important additional market for abalone is the United States mostly because of the large Chinese population (Brown *et al*., 2008). The demand for abalone is still increasing, while the world-wide production of the wild abalone fisheries is declining. The market differentiates abalone based on quality, but it is complex and often difficult to understand. Products tend to be differentiated by brand names, species, and according to the country of origin (Brown *et al*., 2008; Oellermann 2005).

The most sought-after abalone species is the Japanese Enzo (*Haliotis discus hannai*), but South Africa, the Middle East and Australia are perceived as producing high quality abalone as well (Brown 2008; Oellermann 2005; Zuniga 2009). South African abalone is well received on the markets of Japan, Hong Kong and Singapore and producers have been making experimental forays into the Chinese market (Oellermann 2005).

The different product forms of abalone on the market include live, canned, dried and frozen and different quality criteria may apply to each (Brown *et al*. ,2008; Oellermann 2005). Japan is the largest consumer of live, fresh and frozen abalone and China has a preference for canned abalone (Brown *et al*., 2008). South African producers have focused on the production of high quality live abalone (80–90 mm shell length) and lower quality specimens are either sold frozen or canned. It takes about four years to grow an abalone from seed to market size (approximately 80 mm shell length) (DEAT 2008).

Under normal market conditions, live animals are usually sold for a premium price.However, the risks associated with delivering live product to the market are significant. During standard freight procedures, there is a mortality rate of about 5% and drip-loss (dehydration due to stress) can result in a decrease in live weight by as much as 15% during transport to the markets in the Far East (Oellermann 2005). The costs of processing and handling live animals combined with high airfreight costs and mortalities can make alternative marketing strategies attractive.

Many of the Asian traditional recipes call for dried abalone as the traditional preparations began years before refrigeration (Abalone consultants, 2010). This sector requires larger animals (100 mm shell length) than are usually grown on the farms which means a longer grow-out period (increased risk) and a greater capital investment per kilogram of product (more tanks are required). The rewards include a 20–30% savings on production costs (mainly transport costs) and the dried product can be stored during unfavourable market conditions (Oellermann 2005). The preparation process for drying abalone is highly labour intensive and should not be confused with the sun dried product that sells for lower prices.

Currently abalone prices are driven by a few of the Asian nations, guided by their historical and changing customs, preparations, populations and economies. An additional influence is that of Asian populations living elsewhere in the world. Short term price variations are expected as the economies of the Asian buyer countries grow and shrink.

Regardless of the form in which abalone is sold–dried, fresh, frozen, etc.—the abalone price in shell in the same worldwide (Abalone Consultants 2010). The price for live abalone in 2005 was approximately 34.00 USD per kilogram. Frozen (USD 45.00/kg) and canned (US$ 25 per 425 g tin) abalone fetch good prices, and in some instances even higher than live abalone prices (Oellermann 2005). However, losses in weight associated with shucking and evisceration, as well as processing costs, result in a lower price than live abalone per unit. There are advantages and disadvantages related to different abalone product forms.

4 METHODOLOGY

4.1 The Concept of Modelling

A model can be referred to as a simplified representation of reality for the purpose of experimenting with alternative strategies (Leung 1986). In most cases it costs less to derive knowledge from the model than the real world, because the model may represent a system which does not yet exists, as is the case with the abalone mariculture in South Africa.
Identifying important variables and their relationships by creating formulas, forms the basis for modelling. Simulation models have only recently been used to evaluate the economic feasibility of aquaculture ventures (Zuniga, 2009).

Aquaculture models are used with different applications in mind including economic feasibility and optimisation of system design and operations (Leung, 1986). Different software approaches have been used to attain specific objectives, in the current study Microsoft Excel was used.

For the current study the abalone production model is important as the output from the production model becomes the input for the profitability model. The profitability analysis model can be defined as a simulation model of an initial investment and subsequent operations over a specified time.

4.2 Data collection for the abalone production model

The collection of data for the production model is based on the assumption that a 120 tonne abalone grow-out farm is going to be established. The main assumptions for the abalone production model will be based on information from the Namaqualand Mariculture Park Business Plan (Oellermann 2005). The information from the Namaqualand Mariculture Business Plan will be supplemented by a review of publications on common production practices for South African abalone and compulsory return statistics from South African Abalone farmers to the National Department of Environmental Affairs (DEAT).
The DEAT monthly reporting system was developed to provide the department with reliable information so that there is a better understanding of the ongoing operations and needs of the abalone industry (DEAT 2008).

The production model was created in Excel, based on a production model previously done for *Haliotis rufescens* (California red abalone) but revised, by adapting appropriate assumptions, for *H. midae* (Steinarsson, *pers. comm*).

4.3 Data Collection for the profitability model

The abalone prices and production costs (derived from the abalone production model) will be used to calculate the profitability of abalone aquaculture in the Northern Cape Province (Lee *et al*., 2003). The Namaqualand mariculture park business plan and a cost and profitability survey conducted in 2008 for the South African Mariculture Industry by DEAT, will be the main sources of information for the investment costs related to the abalone grow-out facility (DEAT, 2008).

All cost inputs related to the current study are based on prices at the end of 2009. An important adjustment from the Namaqualand Mariculture Business Plan that was written in 2005 is the price corrections for the investment costs. This was done by adding South African inflation for the respective years from 2005 to the end of 2009. For the sake of consistency, inflation was used throughout this study to adjust input costs to the end of 2009. All financial data represented in this study is recorded in South African Rand. The South African Rand/US Dollar exchange rate is R7.5.

4.4 Abalone Farming Assumptions

The production concept for land-based abalone grow-out farming is adapted from the NMP concept (Figure 3).

Water will be pumped from the ocean to a seawater storage pond. The cost of pumping seawater and related electricity usage will be included in the monthly rent paid to the NMP. From the storage pond water will be passed through a mechanical drum filter to remove sediment and particulate matter. Water from the pond is gravity fed to the grow-out tanks. Effluent water from the tanks will be returned to the sea, via a water treatment wetland system.

To produce 120 tons of abalone per annum, 887 tanks (5 m long x 2 m wide x 1.1 m deep) will be constructed within a designated site in the NMP. Approximately 20 abalone holding baskets (1 m^2) will be suspended in each tank. Each basket will contain plates which will provide the substrate for the abalone to attach themselves.

A monthly purchase of 70 000 abalone spat (approximately 10 mm in size) from an abalone hatchery will be placed in holding baskets. The abalone will be fed a rotational diet consisting of formulated feed up to 50 mm (two years), and kelp up to the harvest size of 100 mm shell length.

Approximately 120 tons of live abalone will be produced per annum, harvested at 100 mm shell length. The abalone will be sold to a local buyer to be processed and dried for the Asian market. The anticipated value of product is approximately R 242 (price adjusted by inflation).

Abalone should grow approximately 1.6–1.8 mm per month at an average water temperature between 16–18 °C (Oellermann, 2005). Abalone achieves market size (100 mm shell length) in approximately 53 months.

Operating costs are divided into fixed and variable costs (Appendix 2 b). The fixed operating costs remain the same throughout most of the planning period. Variable operating costs change with the size of the abalone production.
Abalone farming is labour intensive and in the current study the abalone farm employs 123 people over the entire production period. Variable labour costs are mostly unskilled labourers. The fixed labour costs are skilled employees and semi-skilled employees.

The highest production cost incurred by land based abalone farming in the scope of the current study is equipment (tanks and abalone holding baskets) in terms of fixed capital and labour and feed related to ongoing production (Appendix 2 b).

4.5 Profitability analysis techniques

4.5.1 Investment and financing

Before starting an aquaculture venture, a fish farmer needs access to money for investment. Investment costs can be categorized into buildings, equipment and other investment (engineering and other construction costs).

Added to the investment costs are the working capital, and this accounts for the total capital need of the project. Working capital is the amount of money needed to take care of operations and debts until the first sales of abalone. The Northern Cape Government will fund the shared infrastructure of the NMP (Table 1), this will lower the total capital need of the project. The abalone operation would pay a predetermined yearly rent (R2.5 million rand) for the prepared site.

Table 1: Infrastructure provided by NMP.

Shared initial infrastructure provided by Government	**Cost for whole Mariculture Park**
Seawater Source	**R 13, 6 million**
Seawater Outlet	**R 1, 1 million**
General Engineering (Landscaping and freshwater to site)	**R 1, 6 million**
Power Supply and backup system	**R 5,0 million**
Storage ponds	**R 6,0 million**
Access and general infrastructure (Entrance)	**R 3, 7 million**
EIA	**R 0,1 million**

For the purposes of the current project a planning period of 15 years is deemed a satisfactory period to evaluate the profitability of abalone farming. It is common to assume a 10 year planning period for aquaculture farms as it is unlikely that an aquaculture enterprise would be an attractive investment opportunity if it were not profitable after ten years (De Ionno *et al*., 2006). The reason for the 15 year planning period is that abalone is a slow growing species and the first sales will only be possible after a period of five years. For the financing of the abalone operation, a loan will be supplemented by investment through equity (Oellermann 2005). In 2005 the Industrial Development Corporation of South Africa (IDC) has offered a loan of up to 49% of the total investment required, at 11% interest rate, to be paid back over 15 years. Repayment of the loan will start in the first year of income (Oellermann 2005). The interest rate offered by the IDC is related to the South African prime rate, adjusted up or down, based on the risk attached to the project and the development impact, as well as some other factors. The interest rate of South Africa in 2009 (11%) is reasonable to use for the current study.

4.5.2 Cash Flow

The cash flow series is of particular interest for the profitability assessment, as this is widely recognised as the preferred technique for analysing long term, high risk investments of this type (De Ionno 2006). A cash flow statement is a summary of cash flow over a period of time; it tells us how the business has generated cash and where the cash has gone (De Ionno 2006). It can be divided into three well defined areas: operating flows, investment flows and financing flows (Massino 2006). Investment flows are related to the purchases and sales of fixed assets and business interests and the financing flows result from debt and equity financing transactions (Massino 2006). The operating flows are cash movements from the sale and production of abalone. The operating statement has the purpose of calculating the Revenue and Costs year by year, the income tax and the appropriation of profit. When subtracting the Total Production Costs from the revenue, an Operating Surplus is the result, which forms the basis for the cash flow statement.

Calculation of depreciation is important mainly for getting accurate estimates of income tax (Jensson, *pers.comm*). In South Africa, depreciation is calculated using the straight-line method (equal depreciation costs per annum over the asset’s life). Buildings are depreciated by 2% each year, equipment by 15% and other investment by 20% (Semoli, *pers. comm.)*. The income tax for companies in South Africa is 28% (Lowtax network 2010).

4.5.3 Profitability measures

As investment in aquaculture involves big sums of money, therefore it is important to have appropriate methods of evaluating the investment (Massino 2006). For the current study two measures of profitability are important: Net Present Value (NPV) and Internal Rate of Return (IRR). NPV and IRR are calculated for two cash flow series.The first is Total Capital invested and Cash Flow after taxes. The second cash flow series for which the NPV and IRR are calculated is the Equity and net cash flow (cash flow after tax less loan principal and interest).

Description of profitability measures important for the current study:

1. <u>The Net Present Value (NPV)</u>
   The net present value of an investment is the sum of the present values for each year’s net cash flow less the initial cost of investment. This method considers the time value of money as it acknowledges that money received today (present value) is worth more than the same amount to be received in the future (De Ionno 2006). An NPV of zero signifies that the cash flow is exactly sufficient to repay the total capital. A positive value indicates that a project is generating enough money to pay for its debtwith some residual money (De Ionno 2006; Massino 2006). A minimum Marginal Attractive Rate (MARR) of 15% was used for the current project. MARR is a preset minimum used to evaluate the rate of return on capital (Okechi 2005). If the IRR exceeds the MARR then it attracts investor confidence and the venture is profitable to operate.

2. <u>Internal Rate of return (IRR)</u>
   The IRR is the interest rate at which the NPV of an investment is equal to zero (De Ionno 2006). This is the maximum rate of interest that the farmer can afford to pay for the resources used and still recover the original investment and its operating costs (Massino 2006). If the IRR exceeds the financing costs of the project, a surplus

remains after paying back the capital and this surplus goes to the fish farmer as profit (Okechi 2005).

4.5.4 Sensitivity Analysis (Analysis of key variables affecting Profitability)

All businesses operate in an environment loaded with risk, thus it is of the utmost importance to evaluate the risks associated with a business before investing in it. Risk is associated with the natural variation in factors affecting profitability over time, such as annual production, prices and interest rates (Okechi 2005). In South Africa aquaculture is considered a high risk business, as it involves high start up costs, and in the case of abalone farming, does not show returns on investment until ten or more years into the venture. In order to compare the effects of different variables on profitability, sensitivity analysis was used in the current study. If we did not use sensitivity analysis, the model would only predict one possible outcome, which is not a realistic result.

For the current study Impact Analysis was used to compare the effects of different variables on profitability. Impact analysis deals with only one uncertain item at the time. All the parameters used in sensitivity analysis were varied by an increase and decrease of 50% from the base case assumptions used in the profitability model. Parameters used in sensitivity analysis include sales price, sales quantity, fixed and variable operating costs**.**

5 BUSINESS MODEL FOR ABALONE FARMING

5.1 Abalone (*H. midae*) Production model

Based on the assumptions in Table 2, a 120 tonne/annum abalone production model was developed (Appendix 1).

The production model monitors one monthly cycle of spat input over the entire production period of 53 months. The standing biomass at the end of this period, as a function of growth (FCR and monthly growth rate), mortalities and drip-loss will be the basis for determining the amount of monthly spat input to sustain the anticipated annual production of the abalone farm. Monthly additions of 70 000 abalone spat (10 mm in size) are suitable to produce 120 tonnes of abalone annually. The total biomass at a chosen time is the number of abalone multiplied by the individual weight (Zuniga 2009). The biomass turnover for the current study is 80%, meaning that a biomass of 150 tonnes is needed to sustain a 120 tonne production per year. A long grow-out time results in a low biomass turnover as is the case for the current study. The length/weight conversion formula used in the production model is based on a condition factor (CF) for *H.midae* and is equal to 5575 *(weight [g]/length [mm]$^{2.99}$ (Britz and Hecht, 1997).

The abalone is fed a rotational diet consisting of formulated feed up to a size of 50 mm shell length (after two years), and kelp up to the harvest size of 100 mm (Troell *et al*., 2006). The FCR for both formulated feed (5) and kelp (15) was derived from previous studies (Troell *et al*., 2006). The amount of abalone feed needed per month is a function of the biomass at a specific time and the FCR. A growth rate of 1.7 mm per month was assumed (Oellermann 2005). The specific growth rate formula used in the model is: Growth rate = (100 X [Ln final weight - Ln initial weight]/experimental period in days) (Britz *et al.*,1997).

The stocking density per basket (density factor) allowed for the grading times to be determined, as well as the number of tanks needed at a specific time of the production.
The model allowed for the amount and costs of inputs to be determined at specific times of the production period.

Table 2: Assumptions for abalone production model

Assumption	**Value**
Size of Spat (mm)	10
Growth rate (mm/month)	1.7
FCR formulated feed (feed/growth)	5
FCR Kelp	15
Mortality (%/month)	0.2%
Drip loss (%)	5%

Table 3: Production costs derived from the abalone production model

	Quantity	**Price**	**Total Cost**
Number of spat per year	843 000 pa	R1,20	**R 1 million**
Amount of Formulated feed (ton/year)	59 tons/annum	R1.885/ton	**R 111 thousand**
Kelp (ton/year)	1716 tons/annum	R 1.212/ton	**R 2 million**
Number of abalone holding baskets	17 746	R269	**R 8 million**
Number of tank units	1526	R12.567/unit	**R 19 million**

5.2 Cash Flow Analysis Results

Cash Flow Analysis results for the land-based grow-out abalone farming over the planning period of 15 years are shown in Figure 6.

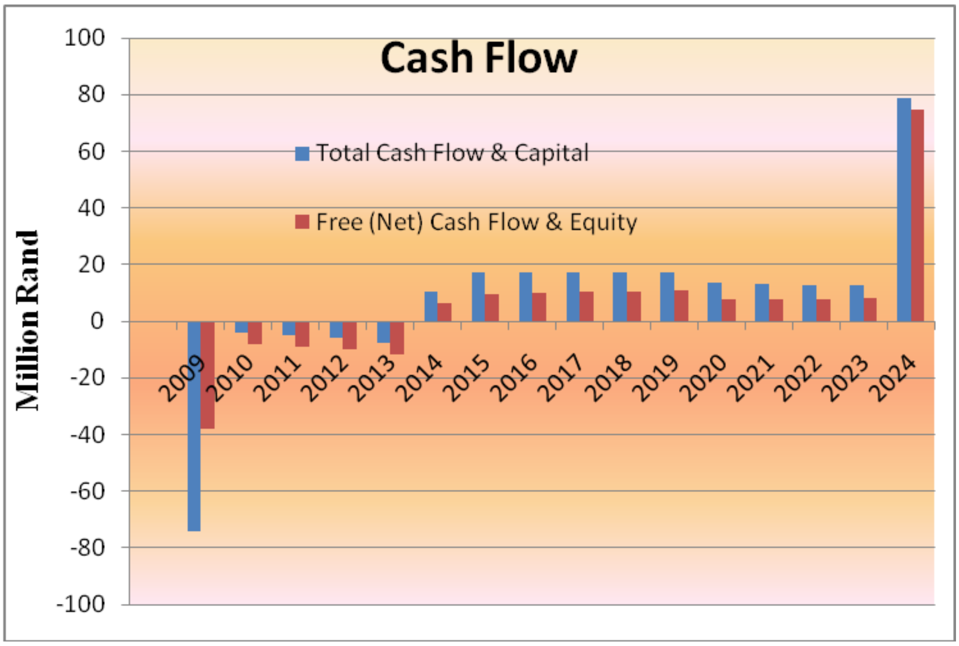

Figure 6: Cash flow from teh 120 tonne land based grow-out abalone farm simulated over the planning period of 15 years.

5.2.1 Total Cash Flow and Capital

The total fixed capital investment for the abalone farm is R 34 million, added to this is the working capital of R 40 million (Appendix 2 a). The total capital required for the abalone farm thus amounts to R 74 million as indicated in the year 2009 (Appendix 2 a). A breakdown of the investment and operational costs are shown in appendix 2 b. There are no sales of abalone for the first five years (2009–2013) (Appendix 2 a) implying no revenue to cover the operational costs of the operation, therefore the cash flow is negative during these years. From 2014 sale of abalone starts and cash flow becomes positive (Appendix 2 d). There is a decrease in the cash flow in 2018, as the company starts paying tax. The cash flow is R 17 million during the last years of the 15 year planning period. A salvage value of R 66 million was assumed at the end of the 15 year planning period.

5.2.2 Equity and net cash flow

In 2009, this cash flow series is the amount of equity, R 37 million, which is 50% of total financing for the abalone farm (Appendix 2 c). From 2010 the series is the Net Cash flow after payment of tax, financial cost (interest and loan management fee) and the loan repayment (Appendix-cash flow sheet). It is negative for the first five years because there are no revenues. The Net Cash Flow in 2024 during the last years of the 15 year planning period amounts to R 8 million. The Net Present Value (NPV) is negative, negative R 37 and negative R 30 million for Total Cash Flow and Net Cash Flow respectively, indicating that the abalone farm is not generating enough money to pay for its debt. Thus, the venture is not profitable under the current assumptions (Figure 7).

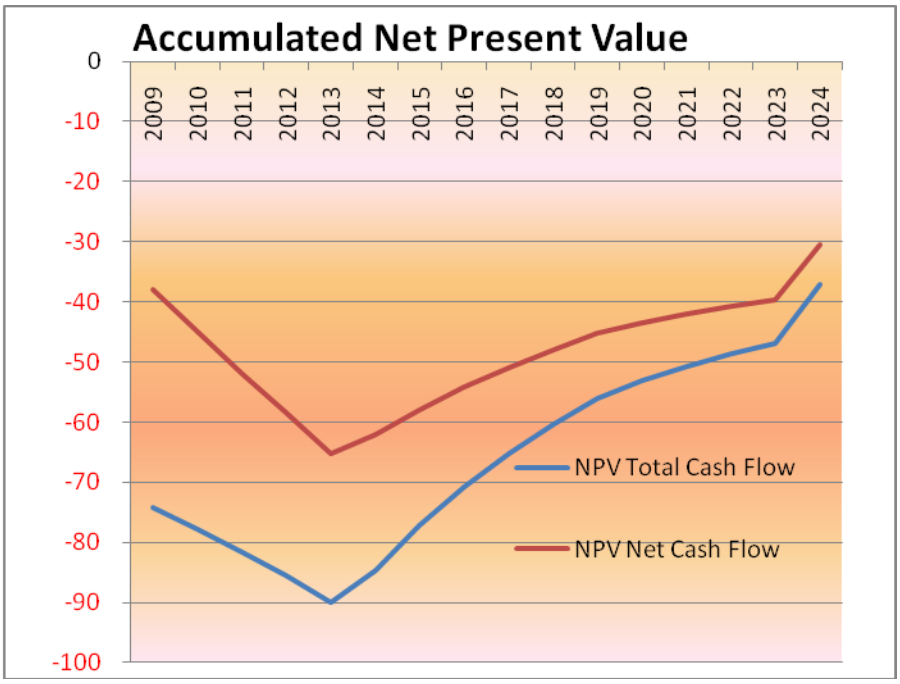

Figure 7: NPV of cash flow over the 15 year planning period.

The Internal Rate of Return (IRR) for both Total and Net Cash flow series are 9 and 8% respectively (Figure 8). The IRR is less than the 15% MARR for the current study, indicating that it is not an attractive investment opportunity.

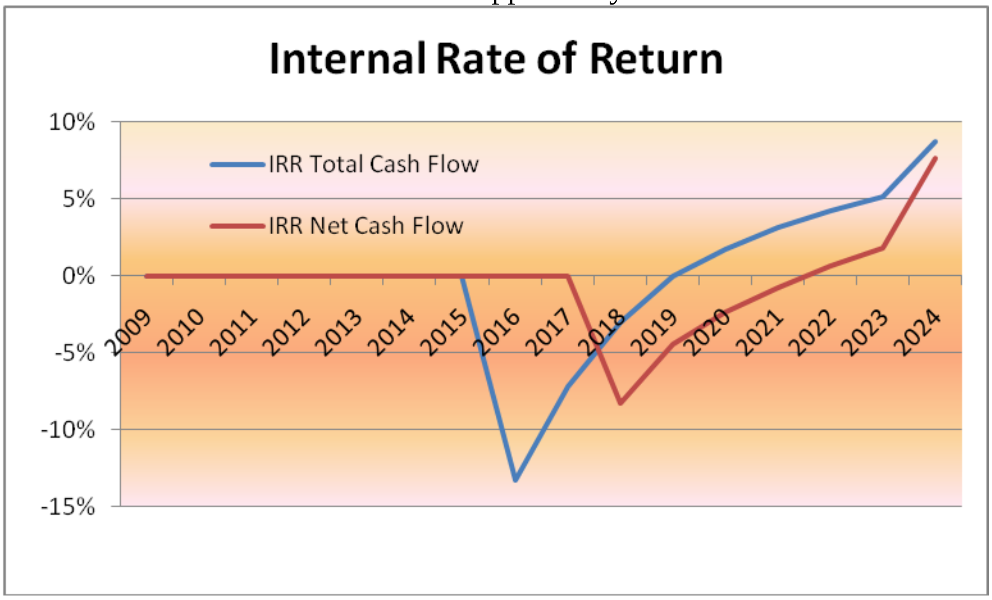

Figure 8: IRR of the abalone farm model.

5.3 Sensitivity Analysis

Sensitivity analysis was done with all major investment costs including sales price, and quantity of abalone sold. The parameters were varied by 50% (Table 4, Figure 9). The results of the impact analysis indicate that the abalone operation is most sensitive to the sales price of abalone. For example, if the sales prices of abalone are raised by about 35% the IRR is 15% which is an acceptable rate of return for the current project. The quantity of abalone sold also has a noticeable effect on profitability.

Variations in the cost of equipment and operational costs (fixed and variable), did not have a significant impact on the profitability of abalone farming. However, variations in variable costs had more influence on the IRR of equity than the cost of equipment and fixed costs.

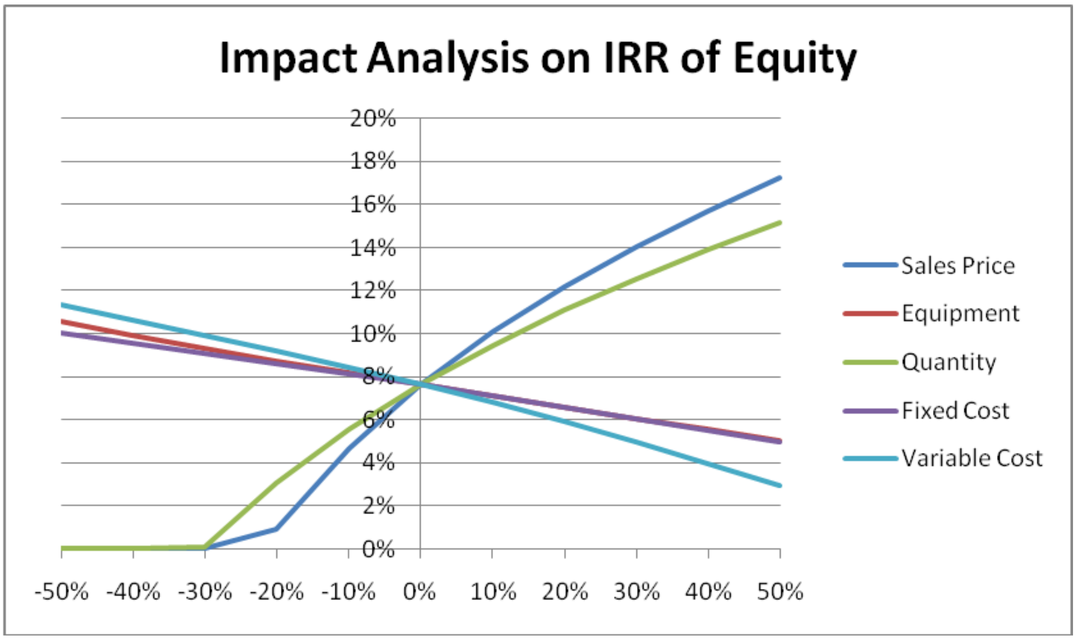

Figure 9: Sensitivity analysis of sales price, eqipment, sales volume, and fixed and variable operational costs.

Table 4: Sensitivity analysis of sales price, equipment, sales volume, and fixed and variable operational costs.

Deviations	Values	IRR Sales Price	IRR Equipment	IRR Sales Quantity	IRR Fixed Cost	IRR Variable Cost
-50%	50%	0%	11%	0%	10%	11%
-40%	60%	0%	10%	0%	10%	11%
-30%	70%	0%	9%	0%	9%	10%
-20%	80%	1%	9%	3%	9%	9%
-10%	90%	5%	8%	6%	8%	8%
0	**100%**	**8%**	**8%**	**8%**	**8%**	**8%**
10%	110%	10%	7%	9%	7%	7%
20%	120%	12%	7%	11%	7%	6%
30%	130%	14%	6%	13%	6%	5%
40%	140%	16%	6%	14%	6%	4%
50%	150%	17%	5%	15%	5%	3%

6 DISCUSSION

As abalone farming is the first venture anticipated to be established in the NMP, the current study evaluated the feasibility of abalone land-based farming in the Northern Cape province of South-Africa.

Using the collected data, projections for the facility were carried over a 15 year planning period. The planning period can be increased but investor attractiveness decreases with a longer waiting period. As shown in the profitability analysis, a considerable amount of total capital (R 74 million) is needed for abalone land-based farming. The high capital investment needed together with the long grow-out period prevents many entrepreneurs from starting a farm. Returns are not achieved for 5 years after initial setup, this underpins the notion that aquaculture is a high-risk venture (Troell *et al.*, 2006).

It is important that the operation is able to return the capital investment with profit (Okechi 2005). The profitability indicator, NPV, is negative indicating that abalone farming with the current assumptions is not profitable. The IRR is less than the Marginal Attractive Rate (MARR) of 15% for the current study. This implies that it is not an attractive investment opportunity.

There may be various reasons for the venture appearing to be unprofitable according to the assumptions used in the current study. Various assumptions are made when forecasting both in terms of biological and economic data that might be highly variable in reality. Some studies suggest excluding highly variable factors like tax, land value, and borrowings in order to focus on the profitability of the operation itself (De Ionno *et al.,* 2006). For example, the type of tax rates that are available depends on the structure of the operation (e.g. partnership, company, trust, etc.) and there are differing tax laws between countries and states. Interest rates on loans can also be highly variable. In some countries there are tax breaks for start-up companies, this was not considered in the current study (Steinarsson, *pers. comm*).

The cost of constructing an intensive land-based abalone system can vary depending on many factors including the site, size and preferred production strategy. A higher fixed capital investment is needed to establish larger farms in order to achieve economies of scale. There are noticeable advantages for facilities where economies of scale have been achieved and investor confidence is not apparent until that goal is achieved. Generally, economy of scale is not evident until facilities reach approximately 100 tonnes per annum (de Ionno *et al.,* 2006; Troell *et al.,* 2006). For the current study an annual production of 120 tonnes annual production was assumed.

In the current study, the capital investment was lowered, due to government funding infrastructure related to the NMP (Table 1). The abalone operation paid a yearly rent for the use of these infrastructure provided by the NMP. The amount of rent paid is calculated based on the volume of seawater used by the operation, as well as *Ad hoc* fees for services. The rent paid is assumed to be the same amount every year, and it is clear that in the start-up phase the operational needs would be less compared to when maximum production capacity is reached. This needs to be reviewed.

Different feeding strategies (formulated vs kelp), product form (live, frozen, canned, dried), culture technology (flow-through and recirculation) and production strategy (grow-out, hatchery) have implications on the profitability of aquaculture ventures. It does not imply that if one farm is profitable using a certain production strategy, all will be. Every situation is unique and site-dependant. Appropriate management strategies maximise comparative advantage to increase benefits and profits.

The highest production costs for the current study were equipment (number of tanks and abalone holding baskets), labour and feed. Generally these are the highest costs related to intensive land based aquaculture (Zuniga 2009; De Ionno 2006). These costs increase with time.

For the current study, abalone is sold to a processor to be dried for the Asian markets.
Dried abalone is harvested at a larger size (100 mm shell length) than usually grown on farms selling live abalone. This implies a higher capital investment (tanks) due to a longer grow-out period. Significant production costs, such as electricity due to pumping of water, feed and labour costs, will be even higher because of the longer grow-out period. High production costs have been cited as one of the main reasons for the poor economic performance of abalone culture in Chile (Zuniga 2009). As shown in the sensitivity analysis, variation in abalone prices has the most significant effect on profitability. This is because the revenue earned from selling abalone must cover the production and other operating costs in order for the operation to be profitable. This highlights the importance of an effective production strategy.

The majority of existing abalone farms in South Africa focus on the production of live (80-90 mm shell length) abalone. Live abalone is harvested at a smaller size than dried abalone, reducing labour and feed costs. Also, under normal circumstances live abalone receive a premium price. Usually there are risks (mortalities and drip-loss) associated with delivering live abalone to the market in the Far East. Existing abalone farms are located in urban areas (in proximity to airports and aquaculture services), thus they have comparative advantage, compared to logistically remote regions.

The current study only evaluated the effect of varying economic variables on the profitability of abalone farming (Figure 9, Table 4). Biological variables are very important and further studies of the effect of growth rate and mortalities are necessary. A low growth rate or a decrease in growth rate means a longer production period and an increase in production costs. It has been suggested that biological variables are more relevant than economic variables on the economic performance of aquaculture ventures (Zuniga 2009).

The NMP proves to be a good concept as access to sites both on land and water is the biggest constraint to aquaculture development in South Africa. There are added benefits like job creation and attracting business to the Northern Cape Province. The principal challenges that the South African government seeks to address are poverty and unemployment (DEAT, 2007), and a future challenge for aquaculture development will be to integrate social, environmental and economic goals.

The current study does not take into account all the uncertainties associated with abalone farming. The model can be used to explore different alternative strategies, taking into account variables having a noticeable effect on profitability.

7 CONCLUSION

The purpose of this study was to become familiar with profitability assessment techniques and to use the knowledge in the future as a tool to assess the feasibility of new aquaculture ventures. As aquaculture is a relatively new economic sector in South Africa, and government aims to increase aquaculture production, profitability assessment techniques can be a valuable tool. Aquaculture requires high capital investment and major financial institutions and investors require a business plan indicating important profitability indicators.

Existing abalone farms in South Africa are profitable commercial ventures. These farms maximise their comparative advantage ascribed to their proximity to airports and aquaculture services by selling the abalone in live product form. Usually live abalone receives a premium price compared to other products. Sensitivity analysis indicated that sales price have the most significant influence on profitability. The key is to find an effective production strategy, maximising profits gained from aquaculture ventures.

8 RECOMMENDATION/FUTURE RESEARCH

For the short term government can adapt the NMP infrastructure for abalone farming only, without compromising the greater concept. In this way government would reduce the risk involved with establishing infrastructure meant to serve an industrial sized operation without the guarantee of returns in the short to medium term. It can be gradually built up to full capacity, as additional aquaculture ventures are established.

As the NMP concept is not designed for abalone farming alone, it will utilise a larger space than typically required for only abalone farming. The seawater storage ponds (2.0 ha) described serve as operational security for the entire NMP, for a time period up to 48 hours after complete pump failure. Without establishing any additional infrastructure, in the short term, there is also the possibility to maximise the comparative advantage of having more space by combining complementary aquaculture activities, like oyster culture, with the abalone farmed in the seawater storage ponds. It is suggested that one storage pond can support 20 oyster long-lines (Oellermann 2005). Oyster culture technology is proven in South Africa and oysters are good aquaculture candidates as they are sedentary, require no feeding, and can withstand a broad range of environmental conditions. Oysters are marketed locally and can compensate for the long grow-out period of abalone, by earning revenue in the short term.

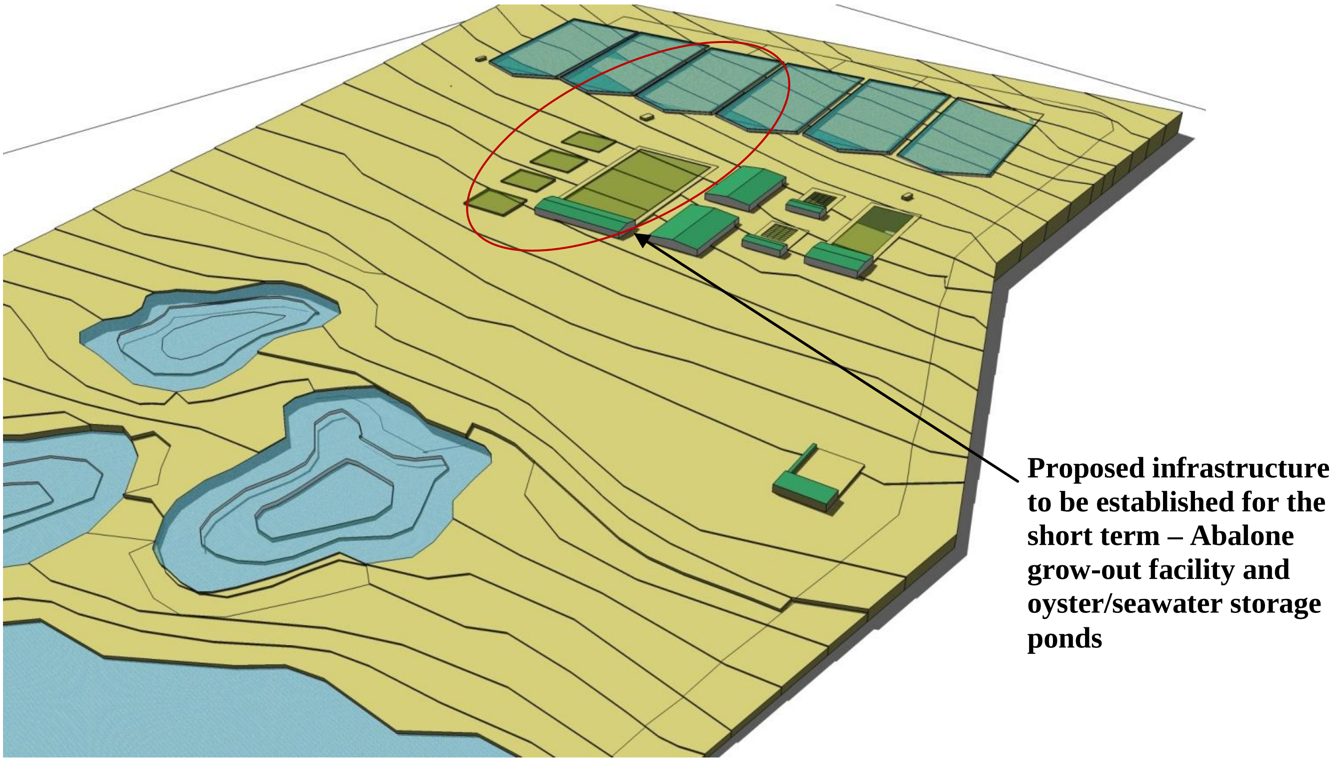

Figure 10: Proposed production strategy for hte NMP in the short term.

8.1 Infrastructure adaptation for the short term

When designing an industrial sized facility certain responsibilities become more evident like environmental awareness. Typical land-based abalone production systems do not incorporate wetland systems for effluent water treatment as abalones are known to discharge low levels of nutrients (Troell, *et al*., 2006). The seawater effluent treatment ponds can be reduced or omitted for the short term.

Infrastructure established in the short term would include the pumpstation, seawater storage /oyster ponds and the abalone production facility (Figure 10). The number of oyster ponds can be reduced, depending on the anticipated oyster production per year. Further studies and technical consultations must be undertaken to determine the feasibility of such an operation.

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Appendix 1: Abalone production model

PRODUCTION MODEL

Model made by Agnar Steinarsson, Marine Research Institute of Iceland.

ABALONE FARMING (Haliotis midae)

Size of spat (mm)	10	Production (tons/year)	120.3
Spat per month	69,500	Hatch to market (years)	4.9
Growth (mm/month)	**1.7**	Biomass turnover (%)	85%
FCR formulated (feed/growth)	5.0	Biomass (tons)	**141.5**
FCR kelp (feed/growth)	15	Growth rate (%/day)	0.43%
Density factor (%)	**100%**	Water flow (m3/hour)	2,037
Seawater (l/sec/ton)	4.0	Formulated feed (tons/year)	59
Mortality (%/month)	0.2%	Kelp (tons/year)	1,716
Basket (m2)	1.0	Number (spat/year)	834,000
Baskets/tank	20	Number of baskets	30,512
Drain loss (%)	5%	Number of tanks	1,526

Time Months	Diameter mm	Weight g	Number /month	Biomass tons	Growth %/day	Density kg/basket	Tanks number	Feed kg/month	Seawater m3/hr
0	10.0	0.2	69,500	0.01	1.75%	0.9	1	0.8	0.2
1	11.7	0.3	69,361	0.02	1.54%	1.0	1	1.2	0.3
2	13.4	0.4	69,222	0.03	1.33%	1.2	1	1.6	0.4
3	15.1	0.6	69,084	0.04	1.17%	1.3	2	2.0	0.6
4	16.8	0.8	68,946	0.06	1.05%	1.4	2	2.5	0.8
5	18.5	1.1	68,808	0.07	0.94%	1.6	2	3.0	1.1
6	20.2	1.4	68,670	0.10	0.86%	1.7	3	3.6	1.4
7	21.9	1.8	68,533	0.12	0.79%	1.9	3	4.3	1.8
8	23.6	2.2	68,396	0.15	0.73%	2.0	4	5.0	2.2
9	25.3	2.8	68,259	0.19	0.68%	2.2	4	5.8	2.7
10	27.0	3.4	68,122	0.23	0.64%	2.3	5	6.6	3.3
11	28.7	4.0	67,986	0.27	0.60%	2.4	6	7.4	3.9
12	30.4	4.8	67,850	0.32	0.56%	2.6	6	8.3	4.7
13	32.1	5.6	67,715	0.38	0.53%	2.7	7	9.3	5.5
14	33.8	6.6	67,579	0.44	0.51%	2.9	8	10.3	6.4
15	35.5	7.6	67,444	0.51	0.48%	3.0	8	11.3	7.4
16	37.2	8.7	67,309	0.59	0.46%	3.2	9	12.4	8.5
17	38.9	10.0	67,174	0.67	0.44%	3.3	10	13.6	9.7
18	40.6	11.4	67,040	0.76	0.42%	3.4	11	14.8	11.0
19	42.3	12.8	66,906	0.86	0.40%	3.6	12	16.0	12.4
20	44.0	14.5	66,772	0.96	0.39%	3.7	13	17.3	13.9
21	45.7	16.2	66,639	1.1	0.37%	3.9	14	18.6	15.5
22	47.4	18.1	66,505	1.2	0.36%	4.0	15	20.0	17.3
23	49.1	20.1	66,372	1.3	0.35%	4.2	16	21.4	19.2
24	50.8	22.2	66,240	1.5	0.33%	4.3	17	22.9	21.2
25	52.5	24.5	66,107	1.6	0.32%	4.4	18	73.2	23.3
26	54.2	27.0	65,975	1.8	0.31%	4.6	19	77.9	25.6
27	55.9	29.6	65,843	1.9	0.30%	4.7	21	82.7	28.0
28	57.6	32.3	65,711	2.1	0.29%	4.9	22	87.6	30.6
29	59.3	35.3	65,580	2.3	0.29%	5.0	23	92.7	33.3
30	61.0	38.4	65,449	2.5	0.28%	5.2	24	97.8	36.2
31	62.7	41.7	65,318	2.7	0.27%	5.3	26	103.1	39.2
32	64.4	45.1	65,187	2.9	0.26%	5.4	27	108.6	42.4
33	66.1	48.8	65,057	3.2	0.26%	5.6	28	114.1	45.7
34	67.8	52.6	64,927	3.4	0.25%	5.7	30	119.8	49.2
35	69.5	56.7	64,797	3.7	0.24%	5.9	31	125.6	52.9
36	71.2	60.9	64,667	3.9	0.24%	6.0	33	131.5	56.8
37	72.9	65.4	64,538	4.2	0.23%	6.2	34	137.5	60.8
38	74.6	70.1	64,409	4.5	0.23%	6.3	36	143.7	65.0
39	76.3	74.9	64,280	4.8	0.22%	6.4	37	149.9	69.4
40	78.0	80.1	64,151	5.1	0.22%	6.6	39	156.3	73.9
41	79.7	85.4	64,023	5.5	0.21%	6.7	41	162.8	78.7
42	81.4	90.9	63,895	5.8	0.21%	6.9	42	169.4	83.7
43	83.1	96.7	63,767	6.2	0.20%	7.0	44	176.1	88.8
44	84.8	102.8	63,640	6.5	0.20%	7.1	46	182.9	94.2
45	86.5	109.1	63,512	6.9	0.19%	7.3	48	189.9	99.7
46	88.2	115.6	63,385	7.3	0.19%	7.4	49	196.9	105.5
47	89.9	122.4	63,259	7.7	0.19%	7.6	51	204.1	111.5
48	91.6	129.4	63,132	8.2	0.18%	7.7	53	211.3	117.7
49	93.3	136.8	63,006	8.6	0.18%	7.9	55	218.7	124.1
50	95.0	144.3	62,880	9.1	0.18%	8.0	57	226.1	130.7
51	96.7	152.2	62,754	9.6	0.17%	8.1	59	233.7	137.5
52	98.4	160.3	62,629	10.0	0.17%	8.3	61	241.4	144.6
53	100.1	168.8	62,503	10.5	0.17%	8.4	63	249.1	151.9
Juvenile phase (1-10 g)			**10%**	11.9	0.66%	65.9	180	240	171
Grow-out phase (10-80 g)				152.8	0.23%	136.9	1,116	4,464	2,201
Total:		Mortalities:	6,997	164.7	0.43%	127.0	1,297	4,704	2,372

Appendix 2 (a): Summary of main assumptions and results

Assumptions and Results

		2009	
Investment:		MRAND	
Buildings		**2.5**	
Equipment	100%	**31.7**	
Other		**0.0**	
Total		**34.2**	
Financing:			
Working Capital		**40**	
Total Financing		**74**	
Equity	100%	**50%**	
Loan Repayments		**10**	years
Loan Interest	100%	**11%**	

Discounting Rate	**15%**	**(MARR)**
Planning Horizon		**years**

	Total Cap.	Equity
NPV of Cash Flow	**-37**	**-30**
Internal Rate	**9%**	**8%**

Capital/Equity after 10 years	
Minimum Cash Account	0

Operations:		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	
Sales Quantity	100%		0	0	0	0	0	120	120	120	120	120	120	120	120	120	120	**Ton/annum**
Sales Price	100%						0	242,000	242,000	242,000	242,000	242,000	242,000	242,000	242,000	242,000	242,000	**Rand/ton**
Variable Cost	100%	**64**	Rand/kg															
Fixed Cost	100%	**4**	MRAND/year															
Inventory Build-up			**0**															

Debtors (accounts recei	**25%**	of turnover
Creditors (accounts paya	**15%**	of variable cost
Dividend	**30%**	of profit
Depreciation Buildings	**2%**	
Depreciation Equipm.	**15%**	
Depreciation Other	**20%**	
Loan Managem. Fees	**2%**	
Income Tax	**28%**	

Appendix 2 (b): Breakdown of main investment costs

Breakdown of Main Assumptions

Investment Cost:		
Buildings:		
Site Preparation	953,386	Rand
Admin Buildings	471,300	"
Workshops, stores and ablutions	224,928	"
Splitting and packaging rooms	56,232	"
Concrete Effluent channels	484,800	"
Mixing Station reservoir	40,392	
Contingency ca 10%	223,104	"
Total Buildings	**2,454,142**	**Rand**
Equipment		Rand
Primary water source reticulation	115,117	"
Growout tanks	19,177,242	"
Baskets	8,207,728	"
Air Blowers	430,848	"
Industrial Lights	89,034	"
Abalone handling equipment	40,392	"
Oxygen flow monitor & alarm system	30,374	
Office equipment	71,359	"
Mechanical Drum Filter	340,393	"
Dispatching/Packaging equipment	75,946	"
Miscellaneous equipment	284,764	"
Contingency ca 10%	2,886,319	"
Total Equipment	**31,749,516**	**Rand**
Other Investment (Provided by NMP)		Rand
Seawater intake source		"
Seawater outlet		"
General Engineering		"
Power Supply and backup system		"
Storage pond		"
Access & general infrastructure		
EIA		
Contingency ca 10%		
Total 'other investment'	**0**	

Operating Costs:		
Variable Costs:		
Purchase of spat	8.3	R/kg/year
Feed (kelp)	17.3	"
Feed (formulated feed)	0.9	"
Labour expenditure	23.0	"
Transport	0.8	"
Electricity	3.8	
Repair and Maintenance	2.5	"
Consumables	2.1	"
Contingency ca 10%	5.7	**R/kg/year**
Total Variable Costs	**64**	
Fixed Costs:		R/year
Salaries	807,840	"
Administration costs	127,908	"
Site Rental	2,501,412	
Insurance	296,551	
Contingency 10%	373,371	
Total Fixed Costs	**4,107,082**	**R/year**

Appendix 2 (c): Investment and financing

Investment

		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Total
Investment and Financing			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Investment:																		
Buildings		2.5	2.4	2.4	2.3	2.3	2.2	2.2	2.1	2.1	2.0	2.0	1.9	1.9	1.8	1.8	1.7	
Equipment		31.7	27.0	22.2	17.5	12.7	7.9	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	
Other		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Booked Value		**34.2**	**29.4**	**24.6**	**19.8**	**15.0**	**10.1**	**5.3**	**5.3**	**5.2**	**5.2**	**5.1**	**5.1**	**5.0**	**5.0**	**4.9**	**4.9**	
Depreciation (Straight Line):																		
Depreciation Buildings	2%		0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	**0.7**
Depreciation Equipm.	15%		4.8	4.8	4.8	4.8	4.8	4.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**28.6**
Depreciation Other	20%		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
Total Depreciation			**4.8**	**4.8**	**4.8**	**4.8**	**4.8**	**4.8**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**29.2**
Financing:		**74.2**																
Equity	50%	37.1																
Loans	50%	37.1																
Loan 1																		
Repayment	10		0	0	0	0	0	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	**37.1**
Principal		37.1	37.1	37.1	37.1	37.1	37.1	33.4	29.7	26.0	22.3	18.6	14.8	11.1	7.4	3.7	0.0	
Interest	11%		4.1	4.1	4.1	4.1	4.1	4.1	3.7	3.3	2.9	2.4	2.0	1.6	1.2	0.8	0.4	**42.9**
Loan Managem. Fees	2%	0.7																

Appendix 2 (d): Operations sheet

Operations

Operations Statement		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024		Total	
Sales			0	0	0	0	120	120	120	120	120	120	120	120	120	120	120	Ton/ann	**1200**	
Price			0	0	0	0	242,000	242,000	242,000	242,000	242,000	242,000	242,000	242,000	242,000	242,000	242,000	Rand/ton		
Revenue			**0.0**	**0.0**	**0.0**	**0.0**	**29.0**	**29.0**	**29.0**	**29.0**	**29.0**	**29.0**	**29.0**	**29.0**	**29.0**	**29.0**	**29.0**		**319.4**	**MRAND**
Variable Cost	64		0.5	1.0	1.9	3.9	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7		**92.3**	
Net Profit Contribution			**-0.5**	**-1.0**	**-1.9**	**-3.9**	**21.3**	**21.3**	**21.3**	**21.3**	**21.3**	**21.3**	**21.3**	**21.3**	**21.3**	**21.3**	**21.3**		**227.2**	
Fixed Cost	4		3.8	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1		**61.3**	
Diverse Taxes																			**0.0**	
Operating Surplus (EBITDA)			**-4.3**	**-5.1**	**-6.0**	**-8.0**	**17.2**	**17.2**	**17.2**	**17.2**	**17.2**	**17.2**	**17.2**	**17.2**	**17.2**	**17.2**	**17.2**		**165.9**	
Earnings Bfore Interest, Taxes, Depreciation and Amortization																				
Inventory Movement			0.0																**0.0**	
Depreciation			4.8	4.8	4.8	4.8	4.8	4.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		**29.3**	
Operating Gain/Loss (EBIT)			**-9.1**	**-9.9**	**-10.9**	**-12.8**	**12.4**	**12.4**	**17.2**	**17.2**	**17.2**	**17.2**	**17.2**	**17.2**	**17.2**	**17.2**	**17.2**		**119.4**	
Financial Costs (Interest + LMF)		0.7	4.1	4.1	4.1	4.1	4.1	4.1	3.7	3.3	2.9	2.4	2.0	1.6	1.2	0.8	0.4		**43.6**	
Profit before Tax (EBT)		**-0.7**	**-13.2**	**-14.0**	**-14.9**	**-16.9**	**8.3**	**8.3**	**13.5**	**13.9**	**14.3**	**14.7**	**15.1**	**15.5**	**15.9**	**16.3**	**16.7**		**93.0**	
Loss Transfer	0	-0.7	-13.9	-27.9	-42.8	-59.7	-51.4	-43.1	-29.6	-15.7	-1.4	0.0	0.0	0.0	0.0	0.0	0.0			
Taxable Profit		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.3	15.1	15.5	15.9	16.3	16.7			
Income Tax	28%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.7	4.2	4.3	4.5	4.6	4.7		**26.0**	
Profit after Tax		**-0.7**	**-13.2**	**-14.0**	**-14.9**	**-16.9**	**8.3**	**8.3**	**13.5**	**13.9**	**14.3**	**11.0**	**10.9**	**11.2**	**11.5**	**11.8**	**12.1**		**66.9**	
Dividend	30%	0.0	0.0	0.0	0.0	0.0	2.5	2.5	4.0	4.2	4.3	3.3	3.3	3.4	3.4	3.5	3.6		**38.0**	
Net Profit/Loss		**-0.7**	**-13.2**	**-14.0**	**-14.9**	**-16.9**	**5.8**	**5.8**	**9.4**	**9.7**	**10.0**	**7.7**	**7.6**	**7.8**	**8.0**	**8.2**	**8.4**		**28.9**	

Appendix 2 (e)

Cash Flow

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Total
Cash Flow																	
Operating Surplus (EBITDA)	**0**	**-4.3**	**-5.07**	**-6.04**	**-7.97**	**17.2**	**17.2**	**17.2**	**17.2**	**17.2**	**17.2**	**17.2**	**17.2**	**17.2**	**17.2**	**17.2**	**149**
Debtor Changes		0.0	0	0	0	-7	0	0	0	0	0	0	0	0	0	0	**-7**
Creditor Changes		0.1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	**1**
Cash Flow before Tax	**0**	**-4.2**	**-5**	**-5.89**	**-7.68**	**10.5**	**17.2**	**17.2**	**17.2**	**17.2**	**17.2**	**17.2**	**17.2**	**17.2**	**17.2**	**17.2**	**143**
Paid Taxes		0.0	0	0	0	0	0	0	0	0	0	4	4	4	4	5	**21**
Cash Flow after Tax	**0**	**-4.2**	**-5**	**-5.89**	**-7.68**	**10.5**	**17.2**	**17.2**	**17.2**	**17.2**	**17.2**	**13.5**	**13**	**12.9**	**12.7**	**12.6**	**126**
Financial Costs (Interest + LMF)	1	4.1	4	4	4	4	4	4	3	3	2	2	2	1	1	0	**43**
Repayment	0	0.0	0	0	0	0	4	4	4	4	4	4	4	4	4	4	**37**
Free (Net) Cash Flow	**-1**	**-8.3**	**-9**	**-10**	**-12**	**6**	**9**	**10**	**10**	**11**	**11**	**8**	**8**	**8**	**8**	**9**	**58**
Paid Dividend		0.0	0	0	0	0	2	2	4	4	4	3	3	3	3	4	**31**
Financing - Expenditure (WCap)	40																**40**
Cash Movement	**39**	**-8.3**	**-9**	**-10**	**-12**	**6**	**7**	**7**	**6**	**6**	**7**	**4**	**4**	**5**	**5**	**5**	**58**

Appendix 2 (f): Profitability sheet

Profitability

Profitability Measurements

		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Total
NPV and IRR of Total Cash Flow																	66	
Cash Flow after Taxes		0	-4	-5	-6	-8	11	17	17	17	17	17	13	13	13	13	13	**138**
Loans		-37																**-37**
Equity		-37																**-37**
Total Cash Flow & Capital		**-74**	**-4**	**-5**	**-6**	**-8**	**11**	**17**	**17**	**17**	**17**	**17**	**13**	**13**	**13**	**13**	**79**	**130**
NPV Total Cash Flow	15%	**-74**	**-78**	**-82**	**-86**	**-90**	**-85**	**-77**	**-71**	**-65**	**-60**	**-56**	**-53**	**-51**	**-49**	**-47**	**-37**	
IRR Total Cash Flow		**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**-13%**	**-7%**	**-3%**	**0%**	**2%**	**3%**	**4%**	**5%**	**9%**	
NPV and IRR of Net Cash Flow																		
Free (Net) Cash Flow		-1	-8	-9	-10	-12	6	9	10	10	11	11	8	8	8	8	75	**124**
Equity		-37																**-37**
Free (Net) Cash Flow & Equity		**-38**	**-8**	**-9**	**-10**	**-12**	**6**	**9**	**10**	**10**	**11**	**11**	**8**	**8**	**8**	**8**	**75**	**87**
NPV Net Cash Flow	15%	**-38**	**-45**	**-52**	**-59**	**-65**	**-62**	**-58**	**-54**	**-51**	**-48**	**-45**	**-44**	**-42**	**-41**	**-40**	**-30**	
IRR Net Cash Flow		**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**-8%**	**-4%**	**-2%**	**-1%**	**1%**	**2%**	**8%**	