

Research Report

**Profitability aspects of biofuel manufacturers
in the Republic of South Africa, 2006**

by

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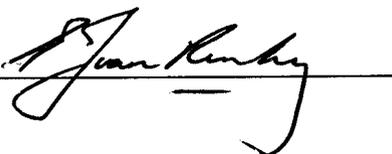
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Definition of terms and abbreviations

Term or abbreviation	Definition
Additive	Traces of a substance added to a fuel in order to improve the fuel's attributes, such as its performance and storage capabilities.
B10, B100	Diesel containing the stated percentage of biodiesel.
Bbl	Barrel, the standard measure unit of oil, which is 158.98 litres or 42 United States of America gallons.
Biodiesel	Biofuel used as diesel in its pure form or as a blend in petroleum diesel, normally manufactured from sunflowers, soybeans or <i>jatropha curcas</i> . It conforms to SANS 1935. As a blend in petroleum, diesel must conform to SANS 342.
Bio-ethanol	Biofuel used as a blend in petrol, normally manufactured from maize or wheat. The scientific notation is C ₂ H ₅ OH. It conforms to SANS 1598.
Biofuel	Fuel manufactured from biomass.
Biomass	Renewable organic resources.
CTL	Coal to liquid technology for the production of fuel from coal.
E10, E85	Petrol containing the indicated percentage of bio-ethanol.
Feedstock	Raw materials that are used in the process of manufacturing biofuel.
Fuel	Substance with combustion properties that can be used in internal combustion engines.
GTL	Gas to liquid technology for the production of fuel from natural gas.
Oil	Blend of organic compounds. It consists primarily of hydrogen, carbon and oxygen.
OPEC	Organisation of the Petroleum Exporting Countries.
Petroleum	Latin for "rock oil", refers to fossil oil or crude oil.
Petroleum fuel	Fuel manufactured from petroleum.
RON	Research octane number.
SAFEX	South African Futures Exchange.
SANS	South African National Standard issued by Standards South Africa, a division of the South African Bureau of Standards (SABS).
SWOT analysis	Analysis of the enterprise's resource and management strengths and weaknesses, opportunities and threats.
Value chain	Entities in the industry or activities performed by enterprises that add value to the product.

EXECUTIVE SUMMARY

Research report

Profitability aspects of biofuel manufacturers in the Republic of South Africa, 2006

by Evert Janse van Rensburg

Introduction and problem statement

Biofuel is manufactured from biological, renewable resources and has beneficial attributes similar to those of petroleum fuel. It is therefore primarily used to propel internal combustion engines, *inter alia*, in trucks, tractors, heavy duty equipment, motor vehicles and electricity generators. Biofuel in this report refers to bio-ethanol manufactured from grains such as maize and wheat, and biodiesel manufactured from oil seeds, such as sunflowers, soybeans, and *jatropha curcas*.

Manufacture biofuel locally holds at least three advantages for South Africa. Firstly, savings on expensive fuel imports and foreign currency will improve the balance of payments. Secondly, the additional production of feedstocks utilise the carbon dioxide that is produced from the burning of fuel. The net effect from the use of biofuels will therefore not contribute significantly to global warming, as petroleum fuels currently do. Thirdly, agriculture, which is an important sector of the economy, will benefit from the new markets created for crops used as feedstocks in biofuel manufacturing. Local manufacture of biofuel is therefore in the interests of the national economy and society.

The commercial production and utilisation of biofuel is a relatively new development in the South African fuel industry. Increases in the international price of fuel are one of the reasons why existing and potential new enterprises would consider manufacturing biofuel. The main objective of an enterprise is to generate the required profitability on its investment in the long run. A profitability analysis is therefore an important requirement for decision-making. However, only limited information is available on certain aspects of the profitability of biofuel manufacturing in South Africa. This study endeavours to identify, describe and quantify aspects that have an impact on biofuel manufacturers' profitability. These aspects are grouped in this report under five headings namely an introduction to biofuel in South Africa, biofuel manufacturing value chain activities, competition in the biofuel industry, the macro-

environmental forces on biofuel manufacturers, and related matters that influence biofuel manufacturers' profitability. The findings of this study are discussed briefly below.

Summary of research findings

Part 1: Introduction to biofuel in South Africa

The value of biofuel and the necessity of manufacturing biofuel locally have been discussed above. Various biofuel manufacturing processes have been developed for different feedstocks. Bio-ethanol is generally manufactured from the fermentation of feedstocks with high starch content such as maize and wheat. Biodiesel is manufactured from the esterification of oil seeds such as sunflowers, soybeans and *jatropha curcas*. The choice of feedstock therefore greatly influences the total capital investment of a biofuel manufacturer. A biodiesel plant with a capacity of 1 000 litres per day may require a total capital investment of ±R1.518 million or R1 518 per capacity litre. A total capital investment of ±R2.846 million may provide a biodiesel plant producing 4 000 litres per day or R712 per capacity litre. The economies of scale are clearly shown by these figures.

Part 2: Biofuel manufacturing value chain activities

The value chain activities of a biofuel manufacturer should be managed to obtain the highest possible sustainable profits. A concise discussion of the feedstock, sales of biofuel and by-products and other related expenses follows.

The choice of feedstock not only influences the total capital investment, but also influences the cost of feedstock, the location of the biofuel plant, which marketable products and by-products will be obtained and in what quantities.

The net contribution to the gross profit of a biofuel manufacturer at September 2006 prices per feedstock was the following: maize R0.74 per litre, sunflowers R2.79 per litre, soybeans R6.81 per litre, wheat R-0.77 per litre, and *jatropha curcas* (excluding the cost of feedstock) R4.68 per litre. It is clear that certain feedstocks are more profitable than others. However, the relatively high volatility of the SAFEX price per ton and the import parity prices of the feedstocks can change these calculated net contributions significantly from time to time. Furthermore, the selling prices of the by-products are also relatively volatile, due to supply and demand.

Part 3: Competition in the biofuel industry

A biofuel manufacturer can expect competition from other existing biofuel manufacturers, potential new biofuel manufacturers, alternative energy products, feedstock suppliers, and customers. It was found that potential new biofuel manufacturers and petroleum fuel as an alternative energy product are currently the largest threats to biofuel manufacturers.

These competitive forces have to be countered by employing competitive strategies. A biofuel manufacturer has to make four sets of decisions namely generic strategies, complementary strategies, functional area strategies and timing strategies. Strategies can only be developed with detailed knowledge of the key success factors and information obtained from a detailed SWOT analysis.

Aspects of profitability that a biofuel manufacturer can control or influence to a lesser or greater extent are its value chain activities and competition. Largely uncontrollable forces in the macro-environment can also affect the profitability of biofuel manufacturers, as discussed below.

Part 4: Elements of the macro-environment of biofuel manufacturers

It was found that the South African government aims to promote the manufacture and use of biofuel. Stringent requirements by the Petroleum Products Act, Act 120 of 1977, are applicable to fuel producers and distributors. Some of these regulations are relaxed for small biofuel manufacturers. For example, a manufacturer producing less than 300 000 litres of biofuel for consumption in farming operations is exempt from fuel taxes. Another example is the 40 per cent reduction in the fuel tax on biodiesel sold to final consumers. Furthermore, qualifying biofuel manufacturers enjoy beneficial wear and tear allowances for income tax purposes. The sale of biofuel and animal feed by-products is subject to VAT at the zero rate. This means that input VAT can be claimed on qualifying purchases, thereby improving a biofuel manufacturer's cash flow.

Part 5: Related matters that influence biofuel manufacturer profitability

From the findings in the abovementioned paragraphs it is clear that biofuel manufacturers are subject to a relatively high level of risk. A biofuel manufacturer should have a comprehensive risk management plan that details all the possible risks it is exposed to, the probability of occurrence, the impact on profitability should a threatening event occur, and

what actions to take to prevent or recover from unexpected happenings. Furthermore, a biofuel manufacturer can use financial instruments as a hedging tool to eliminate the risk pertaining to certain transactions, such as the quantity and cost of feedstock. Short-term insurance, although it is relatively expensive, is a valuable mechanism to protect the enterprise against possible financial losses due to fixed assets that are stolen or damaged, or the loss of gross profit when a large portion of the income-generating assets are lost. Farmers who manufacture biofuel as a channel to market their produce may suspend manufacturing for a longer or shorter period if their produce can be sold more profitably through other channels.

Recommendations

There are a large number of potential new biofuel manufacturers in South Africa, as well as a number of biofuel manufacturers that are in the process of commencing business. There are many options a new biofuel manufacturer can use to enter the biofuel industry. Based on the findings of this study, and due to the several variables and forces involved, a two-step strategy is recommended for biofuel manufacturers. First, a comprehensive business plan needs to be designed, developed, implemented and maintained. Second, a comprehensive business audit on the execution of the business plan should be implemented.

Areas were identified during the course of the research where no information was available, limited information was available, or information was vague or doubtful. Enterprises considering biofuel manufacturing were unwilling to disclose information regarding aspects of profitability. It is recommended that further research should be undertaken on these aspects. The most important of these are biofuel market surveys, the cost of *jatropha curcas* as a feedstock for biodiesel manufacturing, and the total capital investment of a biofuel plant.

Closing remarks

Selected profitability aspects of biofuel manufacturers in the Republic of South Africa were identified, described and quantified (where possible). It is acknowledged that there are still other aspects that may require further research. The findings, as discussed in more detail in this research report, should be valuable to potential new and existing biofuel manufacturers in South Africa.

CHAPTER 1

PROBLEM STATEMENT, RESEARCH OBJECTIVES AND METHODOLOGY

1.1 PROBLEM STATEMENT

1.1.1 Introduction

Energy comes from different sources and it is utilised in various forms. The supply of energy should be economically, socially, politically and environmentally sustainable in order to enable our long-term survival. Fuel refers to substances with combustion properties and that can be used in internal combustion engines. Petroleum fuel refers to fuel manufactured from crude or fossil oil. Biofuel is fuel produced from renewable biological resources. The commercial production and utilisation of biofuel is a relatively new development in the South African fuel industry. Currently, biofuel is receiving serious attention of practically all the stakeholders in the fuel industry.

This chapter provides an introduction on the oil industry *per se*, the field of study, competitive forces in the biofuel industry, macro-environment forces, forces that affect the profitability of biofuel, the objectives of the study, and the outline of the study.

1.1.2 The oil industry

Oil is a blend of organic compounds. It consists primarily of hydrogen, carbon and oxygen. This oil took millions of years to form from the remains of small aquatic plants and animals that were exposed to the effects of time and heat (San Joaquin Geological Society 2002:n.p.). Oil is one of the most utilised sources of energy in the modern world. Oil is currently the main provider of power, fuel for transport, heat and lubrication. It is also used as a source of chemical raw materials (carbon, hydrogen and oxygen) in the production of valuable commodities such as plastics, synthetic fibres, detergents, fertilisers, explosives, paints, solvents, pesticides, aromatic compounds and many other products (Tugendhat 1968:i). The supply of fossil oil is limited. There may still be vast quantities of oil reserves in the earth, but they may be located in places too remote or dangerous for these resources to be extracted profitably.

According to Stern (2005:245), oil is probably one of the most controversial of all energy resources. On the one hand, the power that is associated with possessing oil resources is a

very important reason why some governments engage in “oil wars”. On the other hand, we have developed our world to a very large extent around a depleting natural resource, the use of which has side effects that threaten the long-term survival of life on the planet if these side effects are not dealt with properly in time.

The production and use of petroleum causes air, water and soil pollution which has serious effects on the environment. This results *inter alia* in increased health care costs, fuel spill cleanup costs, possible pollution penalties and taxes. Global warming, which is mainly due to carbon dioxide emissions from fuel burning, can have a catastrophic impact on the globe. Hence, many governments now promote initiatives to reduce these emissions and enforce strict regulations through penalties and taxes (Stem 2005:246).

A country’s development depends largely on the availability of affordable fuel. No major oil fields have been discovered in South Africa and fuel therefore has to be imported to meet the demand, or has to be produced in other ways. To ensure a continued supply of fuel, the South African government has established enterprises such as Sasol Ltd (the acronym for Suid-Afrikaanse steenkool olie en gas) to manufacture fuel and other related products using coal to liquid (CTL) and gas to liquid (GTL) technology. Unfortunately, Sasol cannot meet the full local demand, and the country still relies largely on imports.

Imports have a negative impact on the balance of payments and oil prices are currently high. These two factors could prevent economic growth targets being reached. Moreover, some important oil exporting countries are currently perceived to pose a high political risk. This situation threatens the ready availability and affordability of fuel. These factors could encourage the government and citizens of the Republic of South Africa to promote the production and use of alternative energy sources such as biofuel.

Biofuel has the same chemical elements and therefore the same beneficial properties as petroleum fuel. However, it is produced from renewable biological resources or biomass. The feedstock for the manufacturing process of biofuel includes field crops, crop residues, wood and basically any other organic matter. South Africa has enough arable farm land available to produce such resources and farmers are continually searching for new and more profitable markets for their produce.

Sulphur oxide and nitrogen oxide emissions from petroleum fuel burning are hazardous to living organisms. The sulphur and nitrogen that are present in fossil oil are costly to remove and oil producers are therefore hesitant to do so unless the final consumers are willing to pay

relatively high prices. Only small traces of sulphur and nitrogen are normally found in biomass, which makes biofuel burning less hazardous to planetary health.

Biofuel can therefore be an answer to many of the problems that the government and society of the Republic of South Africa face. The increasing demand for fuel will continue to prompt price increases, which may enable oil companies to be highly profitable. However, the question is whether this profitability also currently applies to biofuel manufacturers in the Republic of South Africa. The study set out in this research report endeavours to answer this question, amongst others, qualitatively as well as quantitatively.

1.1.3 Limited information on aspects of biofuel profitability

The development of biofuel has not received much attention in the Republic of South Africa until recently, mainly because Sasol's fuel supply was previously subsidised by government, and because the cost of imported fuel was relatively low. The increase in the average nominal price of crude oil from approximately \$13/bbl (bbl stands for blue barrel, as discussed in more detail in Section 4.2.1.1) in 1998 to \$55/bbl in 2005 (Forbes 2006:n.p.) and to almost \$80/bbl in 2006 possibly presents an opportunity for various manufacturers and entrepreneurs to enter the biofuel industry. So, for example, Ethanol Africa (Pty) Ltd is establishing a plant for the manufacture of bio-ethanol from yellow maize at Bothaville. Bothaville is a well-known maize production area in the Free State province of South Africa. This plant is the first of eight plants Ethanol Africa is planning to establish at an expected cost of R700 million each (Van Burick 2006d:n.p.). Ethanol Africa (Pty) Ltd is discussed in more detail in Chapter 2.

The main objective of a biofuel manufacturer is to generate a profit on its investment in the long term. Such manufacturers may have secondary objectives, such as creating new markets for struggling producers (especially maize producers), but only if such an endeavour still supports the primary objective. The pure economic objectives of any enterprise may include a required rate of return on investment and a positive net present value of future cash flows. On the other hand, socio-economic objectives form part of a business's corporate social responsibility. They may look only like a short-term expense, but the absence of such objectives may jeopardise future business (Marx, Van Rooyen, Bosch & Reynders 1998:112).

No profit-driven South African company will, under normal circumstances, be able to raise capital from investors or financial institutions for a new business or to create shareholder

wealth without information on its profitability. A profitability analysis is therefore an important requirement for a biofuel manufacturer's decision-making.

1.2 FIELD OF STUDY

The field of study consists of two parts. Below, first, an outline of the field of study is given and then the main elements in the field of study are briefly explained.

1.2.1 Outline of the field of study

The field of study covered in this research is the environmental forces that affect biofuel manufacturers and that have a large or small impact on the profitability of these manufacturers. The main elements of the business environment that have an impact on manufacturers include biofuel manufacturers' value chain activities, competitive forces in the biofuel industry and macro-environment forces. The field of study is presented visually in Figure 1.1.

The concentric circles in Figure 1.1 represent the interacting forces and the relative size of their impact on a biofuel manufacturer's profitability. The arrows indicate the level of influence and interaction between these forces.

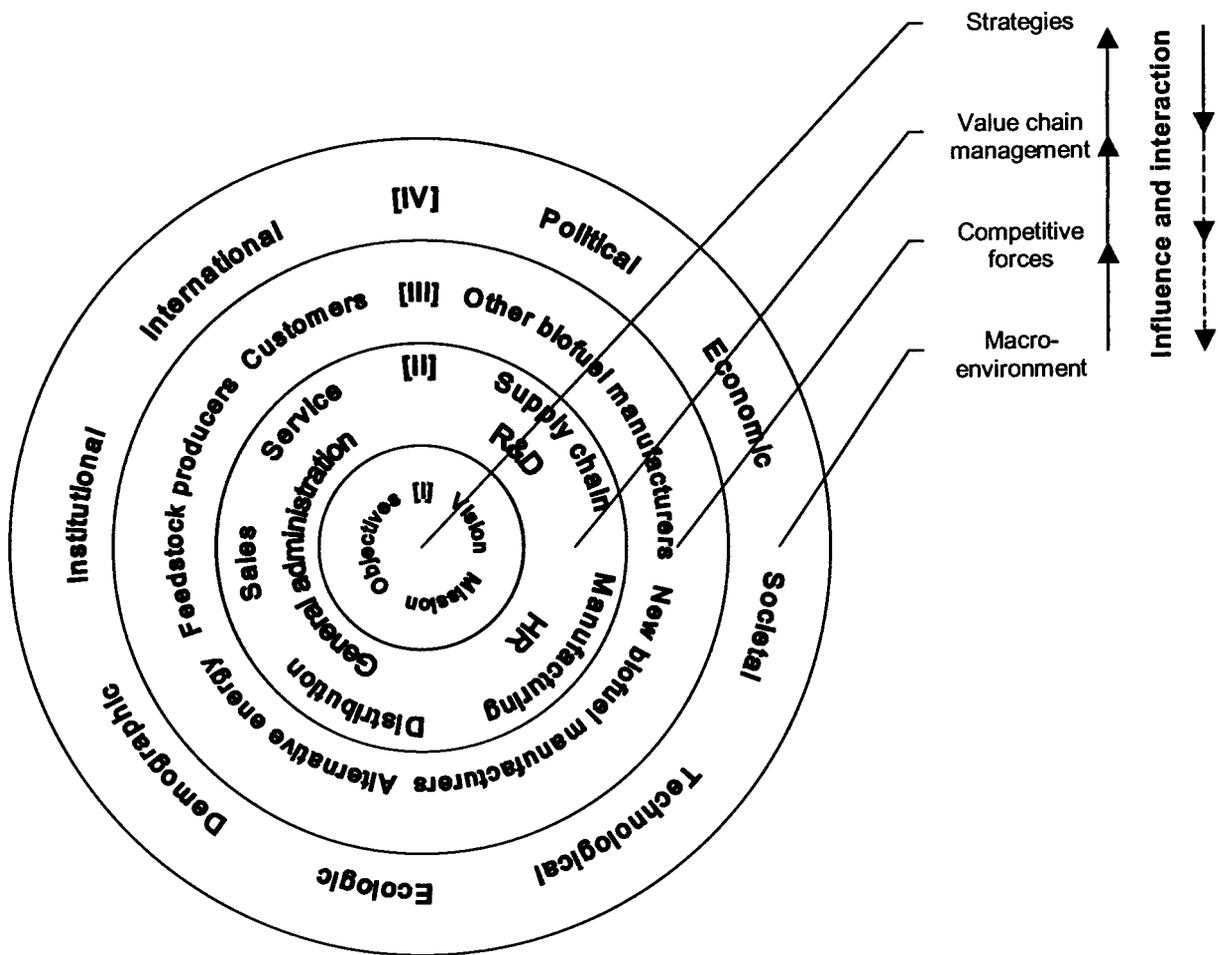
A few remarks on the main elements of the field of study as presented in Figure 1.1 may be helpful.

1.2.2 Elements of the field of study

1.2.2.1 Strategies

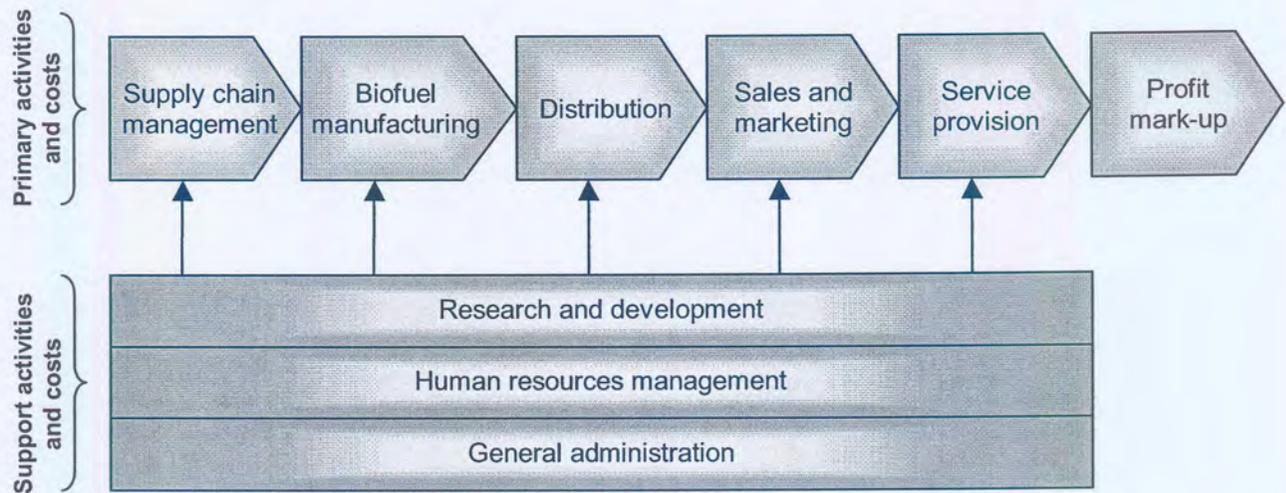
The strategies used by biofuel manufacturers are represented by the inner circle, Circle I in Figure 1.1. Biofuel manufacturers develop their strategies according to their vision, mission and objectives. These strategies include corporate strategies that cover the plan for managing the group of businesses; business strategies, such as actions to expand a biofuel manufacturer's capabilities; functional-area strategies that support the overall business of the biofuel manufacturer; and operating strategies, which provide the detail for the business and functional strategies. These strategies are tailored according to the influences of macro-environment elements and competitive forces on the biofuel manufacturer (Thompson 2005:35).

Figure 1.1 – Environmental influences on biofuel manufacturers



Source: Adapted from Marx *et al.* (1998:1), and Thompson, Strickland and Gamble (2005:51, 99)

Figure 1.2 – Main activities and costs in a biofuel manufacturer’s value chain



Source: Adapted from Thompson *et al.* (2005:99)

Figure 1.2 shows the flow of primary activities and their associated costs through a biofuel manufacturer’s value chain. These primary activities and costs, indicated by the block arrows, begin with the supply chain management and end with the profit margin that the biofuel manufacturer adds to the total cost of the biofuel produced. As indicated by the arrows, other activities support the primary activities in the value chain.

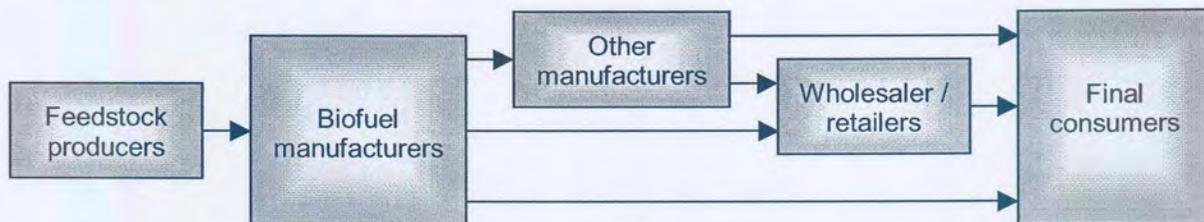
A biofuel manufacturer’s value chain activities are managed according to the set strategies which aim to attain the required rate of return for the enterprise. The value chain in this report is defined as the primary activities performed by the enterprise that directly create customer value. The related support activities performed by the enterprise facilitate and enhance the primary activities (Thompson *et al.* 2005:98).

The primary activities and costs in the biofuel manufacturer’s value chain that influence profitability may include supply chain management (feedstock, additives and consumables management), biofuel manufacturing (the conversion process), biofuel distribution management, sales and marketing management, service delivery, and the biofuel manufacturer’s profit mark-up. The support activities in the value chain that influence profitability can include research and development (feedstock, manufacturing process, equipment and computer software), human resources management (recruitment, training and development) and general administration (managing finance, legal aspects, safety, security and information systems) (Thompson *et al.* 2005:99). Activities in a biofuel

manufacturer's value chain that influence the profitability of biofuel manufacturers are discussed in Chapters 3, 4 and 5.

Biofuel manufacturers are one of several entities in the biofuel industry, as set out in Figure 1.3. Biofuel manufacturers' position in the value chain is relevant to an understanding of the logic behind the strategies followed by biofuel manufacturers through their value chain activities. Some of these entities are competitive forces that exert pressure on biofuel manufacturers, as discussed in Section 1.2.2.3.

Figure 1.3 – Main entities in the biofuel industry value chain



The blocks in Figure 1.3 indicate the various entities in the biofuel industry. The arrows indicate the flow of value added products from one entity to another. A biofuel manufacturer's customers may include any combination of other manufacturers, wholesalers and/or retailers, and final biofuel consumers. These customers may therefore be oil companies, such as Sasol, who are required to blend biofuel into their petroleum fuel or motor vehicle owners.

If, for example, there is backward integration in the value chain, these biofuel manufacturers would also be involved in the production of the required feedstock. In other words, a biofuel manufacturer could also be a grain farmer or cultivate feedstock such as *jatropha curcas* seeds. This would require other unique management skills and an expansion of the manufacturer's value chain activities.

1.2.2.3 Competitive forces in the biofuel industry

Competitive forces in the biofuel industry environment are represented in Circle III of Figure 1.1. Thompson *et al.* (2005:51), cite Michael Porter (1979), and share Porter's opinion that a biofuel manufacturer has to deal with at least five types of competitive forces. These forces are competition between existing biofuel manufacturers; the threat of potential new biofuel manufacturers; alternative energy products such as petroleum fuel and electricity generated by solar, wind and nuclear power; producers of feedstock such as grain farmers; and biofuel manufacturers' customers. Competitive forces in the biofuel industry have a vital influence on a biofuel manufacturer's strategies and value chain activities and therefore on a biofuel

manufacturer's profitability. The biofuel industry forces may also influence the macro-environment to some extent. Competitive forces that influence biofuel manufacturers' profitability are discussed in Chapter 6.

1.2.2.4 Macro-environment forces

Circle IV in Figure 1.1 contains the main macro-environment forces that affect biofuel manufacturers. A biofuel manufacturer's macro-environment includes government (through legislation), general economic conditions, societal values, demographics, and technological, ecological, institutional and international forces (Marx *et al.* 1998:1; Thompson *et al.* 2005:47). These macro-environment forces influence biofuel manufacturers and their competitiveness in the biofuel industry. Government can implement company taxes, fuel levies and regulations, such as the compulsory blending of biofuel into petrol and diesel; and this may affect a biofuel manufacturer's profitability either positively or negatively, and will also affect the profitability of its competitors. Governmental macro-environment forces that influence the profitability of biofuel manufacturers are reviewed in Chapter 7.

1.2.2.5 Forces that affect the profitability of biofuel manufacturers

From Figure 1.1, the influence and interaction between various elements in a biofuel manufacturer's environment is clear. This interaction is represented by the up and down arrows on the right hand side of Figure 1.1. In this report, the forces that have been identified as interacting to affect the profitability of biofuel manufacturers are strategies, value chain activities, competitive forces, and macro-environment forces. (Section 1.6 explains how these forces are dealt with in this report.)

1.3 DEFINITIONS USED IN THIS REPORT

The concepts below recur in this research report and are therefore defined here.

1.3.1 Biofuel

Biofuel has utility values similar to petroleum fuel. It is produced from renewable organic resources or biomass. In this context the term refers to bio-ethanol and/or biodiesel (see Chapter 2 for a more detailed discussion of biofuel.).

1.3.2 Biofuel manufacturer

The main entities in the value chain of the biofuel industry, as set out in Figure 1.3, include producers of organic feedstock, biofuel manufacturers, other manufacturers, wholesale and/or retail distributors, and final consumers. Organic feedstock producers deliver their product(s) to biofuel manufacturers for conversion to biofuel. Biofuel manufacturers' customers include other manufacturers, biofuel wholesalers or retailers, or the final consumers.

The biofuel manufacturers referred to in this report are only involved in the biofuel manufacturing segment of the value chain. Other enterprises perform the remaining activities in the value chain. In this report only biofuel manufacturers who operate in South Africa are referred to. Biofuel manufacturers are registered under the South African Companies Act, Act 61 of 1973 (South Africa 1973) as amended. This biofuel manufacturer has shareholders and directors whose main objective is to attain the required rate of return on the investment made through legal and sound business practices.

1.3.3 Profitability

Profitability is the extent to which the primary objectives of an enterprise, in this case, a biofuel manufacturer, are achieved. The primary objectives include maximisation of profit, achieving the required rate of return on investment, and creating shareholder wealth. Profit is the surplus of sales income achieved over the total expenses incurred. Return on investment is the profit as a percentage of the total assets utilised. Shareholder value is a dynamic indicator of the biofuel manufacturer's actions and future profit potential (Marx *et al.* 1998:117-119, 121).

The forces and activities included in Figure 1.1 influence a biofuel manufacturer's sales and expenditure directly or indirectly. The aspects that influence profitability referred to in this report include

- value chain activities
 - the cost of feedstock, such as grain;
 - biofuel sales; and
 - other revenues, such as from the sale of by-products, and related expenses (the exact impact on profitability of those other activities are not easily determined and are therefore only discussed briefly in this report;

- competitive forces
 - other existing biofuel manufacturers;
 - potential new biofuel manufacturers;
 - alternative energy products, such as petroleum fuel and electricity generated by wind, solar, hydro and nuclear power;
 - feedstock producers' bargaining power, in other words, farmer demands; and
 - biofuel customers' bargaining power, for example, oil companies or motor vehicle owners' demands;

- macro-environment forces
 - government forces through legislation and regulations, such as compulsory use of biofuel, levies and taxes;

Other forces, such as global economic conditions, political stability, and ecological forces exist in a biofuel manufacturer's macro-environment. The exact impacts of those other forces on a biofuel manufacturer's profitability are not easily quantifiable and are therefore not discussed in detail in this report.

1.4 OBJECTIVES OF THE STUDY

This study aims to identify, describe and quantify certain aspects and forces that influence the profitability of a biofuel manufacturer in the Republic of South Africa. This is done using the model in Figure 1.1.

Furthermore, the objectives of this research are to analyse the profitability of local biofuel manufacturers using the following focus areas:

- Introduction to biofuel in South Africa
 - Describe the properties of biofuel.
 - Determine the necessity of biofuel manufacturing in South Africa. This aspect may indicate the biofuel manufacturer's potential sustainable profitability.
 - Identify and describe the biofuel manufacturing processes and estimate the total capital investment for certain biofuel manufacturing outputs.

- Biofuel manufacturer value chain activities
 - Identify and describe the supply and estimate the cost of renewable resources or feedstock to the biofuel manufacturing process.

- Describe the market demand and estimate the selling price of biofuel, fuel production, consumption and price trends.
- Identify, describe and quantify revenues from by-products and related expenses in biofuel manufacturing.

- **Competition in the biofuel industry**
 - Describe the impact of competition on the profitability of a biofuel manufacturer with reference to the competitive forces: other biofuel manufacturers, potential new biofuel manufacturers, alternative sources of energy, farmers and consumers.
 - Suggest solutions on how to deal with competition.

- **Macro-environment forces of biofuel manufacturers**

Identify and describe governmental incentives, legislation and regulations that affect biofuel manufacturers' profitability.

- **Related matters that influence biofuel manufacturer profitability**

Identify and describe mechanisms available to a biofuel manufacturer to manage financial risks.

1.5 ASSUMPTIONS AND DELIMITATIONS

The following assumptions are made in this report:

- Biofuel manufacturers buy feedstock from local farmers, manufacture locally, sell to local customers, and sales and expenses are transacted in South African Rand.
- Biofuel manufacturing technology can be researched with relative ease and expert enterprises are locally available to build turn key operating plants.
- The gross selling price of biofuel is influenced directly by the price of crude oil.
- South Africa has in place economic and government support structures for biofuel manufacturers.

The following delimitations are stated:

- This report does not cover the impact of indirect or overhead costs. Many factors such as the physical location of the suppliers, plant and customers, experience and management style determine these costs and are unique to a certain enterprise; and it is therefore difficult to give exact figures.

- Global politics, economic conditions, society, technological advances and environmental risks have a definite influence on the oil and biofuel industry. However, a discussion of these falls beyond the scope of this research report.

1.6 OUTLINE OF THE REPORT

Secondary literature was used to obtain information on the aspects included in Figure 1.1 to clarify their impact on the profitability of biofuel manufacturers.

1.6.1 Part 1: Introduction to biofuel manufacturing in South Africa

In order to identify the aspects which have an impact on the profitability of a biofuel manufacturer, the following information is required: what biofuel is, how it is made, the necessity of biofuel in the South African context, and an indication of the size of the investment required in a biofuel manufacturing plant in relation to its capacity. These areas are discussed in Chapter 2.

1.6.2 Part 2: Biofuel manufacturer value chain activities

The production of suitable feedstock in South Africa is researched. The cost of feedstock and yields are analysed in Chapter 3. Sales are one of the most important aspects of a biofuel manufacturer's profitability and are influenced by supply, demand and price, amongst other things. Each of these factors is researched and analysed before reaching a conclusion on the achievable sales. Biofuel sales are discussed in Chapter 4. Other revenues from by-products and some other expenses are discussed briefly in Chapter 5.

1.6.3 Part 3: Competition in the biofuel industry

Competition is part of normal business in a free market economy. It forces management to develop strategies to counter competitive forces in order to gain profitable advantages. The five competitive forces discussed in Chapter 6 are competition between existing biofuel manufacturers, the threat posed by potential new biofuel manufacturers, alternative energy products, feedstock producers' bargaining power, and the customers' bargaining power. General competitive strategies are suggested.

1.6.4 Part 4: Macro-environment of biofuel manufacturers

Government plays an important role in the fuel industry through incentives, taxes, research and other regulations. An investigation of these aspects is necessary in order to identify the impact governmental regulation has on the profitability of biofuel manufacturers. These aspects are dealt with in chapter 7.

1.6.5 Part 5: Related matters that influence the profitability of biofuel manufacturers

The financial risks related to operations, sales, and the cost of feedstock can be managed through comprehensive risk management plans, hedging through financial instruments and contracts and short-term insurance, as reviewed in Chapter 8.

1.6.6 Part 6: Closing remarks

The aspects which affect the profitability of a biofuel manufacturer are summarised in Chapter 9. Recommendations are made and possible areas for future research are suggested.

PART I

BIOFUEL MANUFACTURING IN SOUTH AFRICA

CHAPTER 2: BIOFUEL, MANUFACTURING PROCESSES AND CAPITAL INVESTMENT

CHAPTER 2

BIOFUEL, MANUFACTURING PROCESSES AND CAPITAL INVESTMENT

2.1 INTRODUCTION

This chapter provides an overview of the background on biofuel and discusses the need for biofuel in South Africa. The manufacturing processes that are available for several feedstocks are discussed briefly and the capital investments required for manufacturing plants are estimated.

It is important in the context of this study to know what biofuel is, and what its historic use and its energy value are. The main source used for this background is Wikipedia (2006c:n.p.).

2.1.1 Biofuel

Biofuel refers to any fuel that is manufactured from biomass. Biomass can be defined as any recently living organism or its metabolic by-products. This includes agricultural produce such as maize, sunflowers and soybeans, agricultural waste, lumber, manure, sewage and rapeseed (see also Section 1.3.1). Unlike the sources of petroleum fuels such as crude oil, coal and natural gas, the sources of biofuel are renewable.

Biomass has energy stored up (like coal and petroleum), and this is obtained primarily through the process of photosynthesis in living plants. This biomass energy can be stored safely for a long time. (National Research Council 1999:n.p.)

2.1.2 The use of biofuel in the past

Biofuel has been used since the beginning of the motor vehicle industry. Otto von Nicklaus invented the explosion engine, which ran on ethanol. Rudolf Diesel invented the combustion engine, which ran on peanut oil. The Model T Ford, which was produced from 1903 to 1926, also ran on ethanol. However, fossil oil was extracted in large volumes and became cheaper to produce than biofuel, and soon biofuel was largely replaced. The competition between these two sources of fuel, which can impact on the profitability of a biofuel manufacturer, is discussed in detail in Chapter 6.

2.1.3 Biofuel energy value

The cost of energy in Rand per joule to the final consumer is one important factor that determines the demand for biofuel. If the total cost of biofuel per litre is higher than that of other types of fuel which also fulfil consumers' expectations, then the demand for biofuel would probably decrease significantly. In some developed countries, such as Germany, the price of food per joule is cheaper than fuel. This is one of the reasons why Germany produces relatively large quantities of biofuel.

It is therefore relevant to note the energy value of biofuels compared to the energy values of alternative sources of energy, as set out in Table 2.1. Table 2.1 lists various types of fuel in the first column and their energy content in mega-joules per kilogram for the particular fuel type in Column 2. Mega-joules per litre for the particular fuel type are listed in Column 3.

According to Table 2.1, for example, biodiesel has an energy content of 33 mega-joules per litre to 36 mega-joules per litre, compared to petroleum diesel which has an energy content of 40 mega-joules per litre. Biodiesel therefore has less energy per volume than petroleum fuel diesel and therefore less utility value to the consumer per volume. Biodiesel should therefore cost less per litre to the final consumer than petroleum fuel diesel, if utility per volume is the only requirement of the consumer. It can then be calculated that the final consumer of biodiesel may therefore expect to pay prices of between 82.5 per cent and 90.0 per cent for biodiesel of the price per litre of petroleum diesel, excluding fuel taxes and levies. The selling price of petroleum diesel, including wholesale and retail profit margins, but excluding fuel levies, taxes and transport, is around 70 per cent of the pump price. If the pump price of diesel is R7 per litre, then the final biodiesel consumer will be willing to pay between R4.04 per litre (R7 multiplied by 70 per cent and by 82.5 per cent) and R4.41 per litre (R7 multiplied by 70 per cent and by 90 per cent) for biodiesel.

Table 2.1 — Comparison of the energy content of selected types of fuel

Fuel type	Energy density Specific	Energy density volumetric
	Mega-joules per kilogram	Mega-joules per litre
Solid biofuel		
Dried plants	10 – 16	not available
Wood fuel (C ₆ H ₅ O ₁₀) _n	16 – 21	not available
Liquid biofuel		
Methanol (CH ₃ OH)	20 – 23	16
Ethanol (CH ₃ -CH ₂ -OH)	23 – 27	18 – 21
Biodiesel	38	33 – 36
Sunflower oil (C ₁₈ H ₃₂ O ₂)	39	33
Gaseous biofuel		
Methane (CH ₄)	55	23 (liquefied)
Hydrogen (H ₂)	120 – 142	9 – 10 (liquefied)
Petroleum fuel		
Coal	29 – 33	40 – 74
Crude Oil	42	28 – 31
Petrol	45 – 48	32 – 35
Diesel	48	40
Natural Gas	38 – 50	26 – 29
Uranium 235 (²³⁵ U)	77 000 000	1 470 700 000 (pure)
Nuclear fusion (² H- ³ H)	300 000 000	53 413 378 (liquefied)
Fuel cell energy storage		
Direct Methanol	4.5	3.6
Battery energy storage		
Lead-acid battery	0.1	0.1
Lithium-ion battery	0.5 – 0.7	0.9 – 1.9

Source: Wikipedia (2006c:n.p.)

Bio-ethanol can be used as a blending fuel in petroleum fuel. The energy content of bio-ethanol, according to Table 2.1, is 18 mega-joules per litre to 21 mega-joules per litre. Compared to the energy content of petrol, which is between 32 mega-joules per litre and 35 mega-joules per litre, the energy per litre of bio-ethanol is much lower. The utility value of bio-ethanol can therefore be calculated as between 51.4 per cent and 65.6 per cent of the utility of petrol. (The calculations were 18 divided by 35, and 21 divided by 32.) The final bio-

ethanol consumer may therefore expect to pay between 51.4 per cent and 65.6 per cent of the basic cost of petrol, plus wholesale and retail profit margins, per litre. If the price of petrol is R7 per litre, and the fuel taxes and levies and the cost of petrol transport amounts to around 35 per cent of that selling price, then the basic cost of petrol and the wholesale and retail profit margins should be around R4.55 per litre. The selling price of bio-ethanol should therefore be between R2.34 per litre (R4.55 multiplied by 51.4 per cent) and R2.98 per litre (R4.55 multiplied by 65.6 per cent).

Various similar calculations can be made on the basis of the data in table 2.1, however, the fuel attributes should also be more or less the same. In other words, the applications of the energy products should be more or less the same. For example, the energy density of nuclear fusion is 53 413 378 mega-joules per litre, compared to bio-ethanol's energy density of 18 to 21 mega-joules per litre, thus 2.5 to 2.9 million times higher. However, the applications of the two fuel types are different and these two fuels are not interchangeable. In certain circumstances, liquid biofuel products may be compared to each other, such as bio-ethanol to methanol or sunflower oil; and to other fuel types such as solid biofuel, which consist of dried plants and wood fuel; gaseous biofuels, such as methane or hydrogen; natural gas and/or coal.

From Table 2.1 it can be concluded that biofuel has some value as an energy product. The question of whether biofuel should be manufactured locally is answered in Section 2.2 below.

2.2 NECESSITY OF MANUFACTURING BIOFUEL IN THE SOUTH AFRICAN CONTEXT

Biofuel manufacturing in South Africa seems necessary, given the high cost of fuel imports, environmental considerations and the potential for creating new markets for the agricultural industry. These aspects are discussed in the subsections below.

2.2.1 Fuel imports

South Africa lacks commercially producible fossil oil and therefore relies heavily on fuel imports and fuel production by Sasol Ltd to meet demand. Fuel imports have a negative impact on the balance of payments. Furthermore, global inflation, driven by the escalating oil price, has resulted in an increase in the production cost of imported goods. This contributes, *inter alia*, to the country's current account deficit of R103.1 billion: the 2006 annualised increase in the production cost of imported goods was 6.1 per cent, which contributed to the current account deficit (South African Reserve Bank 2006:3, 15, 21).

2.2.2 Environmental considerations

Global warming results, *inter alia*, from excessive carbon dioxide emissions. Compared quantitatively to the rest of the world, South Africa is not a very large contributor to global warming; however, South Africa should put policies and regulations in place at an early enough stage to limit carbon dioxide emissions from fossil fuels. The net effect of carbon dioxide emissions over time is very low if the fuel is manufactured from a vegetable resource. The quantity of carbon dioxide absorbed by vegetation during the growing stage and the quantity released when such a fuel is burned are almost the same.

2.2.3 Agricultural development

South African agriculture currently contributes seven per cent (2006 annualised) to the country's gross domestic product (South African Reserve Bank 2006a:4). All people in South Africa are affected by changes in the agricultural sector, since everyone must eat to stay alive. Information on the arable land available, employment and gross farming income is given in Table 2.2, listed per province. This information was obtained from the 2002 census, conducted by Statistics South Africa with the Department of Agriculture and Land Affairs.

Table 2.2 – Provincial arable land, employment and gross farming income, 2002

Province	Total commercial arable land		Total employment		Gross farming income	
	hectares	percentage	number	percentage	R1 000	percentage
1	2	3	4	5	6	7
Western Cape	2 545 788	17.3	219 091	22.2	10 653 332	20.1
Northern Cape	454 465	3.2	114 214	11.6	3 888 950	7.3
North-West	2 408 484	17.0	90 174	9.1	5 145 873	9.7
Mpumalanga	1 596 998	11.3	124 012	12.6	7 013 824	13.2
Limpopo	1 169 742	8.2	78 955	8.0	3 811 054	7.2
Kwa-Zulu Natal	838 975	5.9	120 982	12.3	6 027 672	11.4
Gauteng	438 623	3.1	31 866	3.2	4 130 428	7.8
Free State	4 186 523	29.5	132 005	13.4	8 777 228	16.6
Eastern Cape	643 501	4.5	75 543	7.7	3 522 871	6.7
Total	14 192 099	100.0	986 842	100.0	52 971 232	100.0

Sources: Adapted from Statistics South Africa (2002:3-6) and Department of Agriculture and Land Affairs (2005:5)

Table 2.2 shows the total commercial arable land (Columns 2 and 3), the total number of farmers and paid employees (Columns 4 and 5), and the gross farming income (Columns 6 and 7) per province (Column 1). The Free State has the highest amount of commercial arable land available at 4 186 523 hectares, which is 29.5 per cent of the total arable land available in South Africa. The Western Cape has the highest employment level at 219 091 farmers and paid employees, constituting 22.2 per cent of the total number of people working in the agricultural sector. Almost one million people are making a living in the commercial agriculture sector as farmers or paid employees in South Africa. The Western Cape also has the highest gross annual farming income at R10 653 332 000 out of a total gross farming income of R52 971 232 000. These figures were obtained from the 2002 census, which is the latest census performed by Statistics South Africa. The actual figures for 2006 may differ to some extent. The information given in Table 2.2 provides evidence of the importance of agriculture in South Africa.

In many cases, South African farmers need new markets for their crops. New biofuel manufacturers can meet this need. The additional demand for certain crops may lead to higher income for farmers. This higher income can be the result of either higher prices or increased volumes sold. Johan Hoffman, director of Ethanol Africa (Pty) Ltd, states that South African maize farmers have a choice between supporting bio-ethanol manufacturing or more years of surplus maize stocks and low prices (Van Burick 2005b:n.p.). Maize surpluses between 3.5 million and 3.8 million tonnes could develop in South Africa over the next fifteen years. Bio-ethanol plants that consume 375 000 tonnes of maize annually will, largely eliminate these maize surpluses (Van Burick 2006a:n.p.). A relatively constant demand for maize generally means that surplus production leads to lower prices. However, biofuel manufacturers could require more maize than is locally produced. This may lead to price increases for maize as a feedstock for the biofuel manufacturing process. This aspect is discussed in more detail in Chapter 3.

For the South African economy as a whole, a higher income for farmers and other local businesses will be balanced by savings on fuel imports. This means that money that normally flows to foreign countries or foreign enterprises for fuel supplied could remain in the country instead. This can be achieved when biofuel, which should be manufactured locally by local enterprises, is preferred above imported petroleum fuel by final fuel consumers. In such circumstances, local farmers and enterprises in the biofuel value chain will benefit financially to some extent. An increase in the revenue of local farmers and local enterprises may also lead to job creation. Higher profits will lead to an increase in government revenues through

taxes. More taxes paid to government should lead to better services rendered by governmental institutions, and so on, multiplying the positive outcomes of such a shift.

2.2.4 Closing remarks on the necessity of local biofuel manufacturing

From the above, it is clear that South Africa should seriously consider manufacturing its own biofuel. Government plays an important role as a facilitator through incentives, taxes and regulations. (The role of government as a macro-environment force is discussed in more detail in Chapter 6.)

If South Africa does embark on the local manufacturing of biofuel, it is important to understand the various manufacturing processes which are available and suitable in the South African context.

2.3 BIOFUEL MANUFACTURING PROCESSES

Various processes have been developed over the years for different kinds of feedstock. They are described briefly in the sections below. (For a more detailed discussion of the different kinds of feedstock, see Chapter 3.)

2.3.1 Bio-ethanol

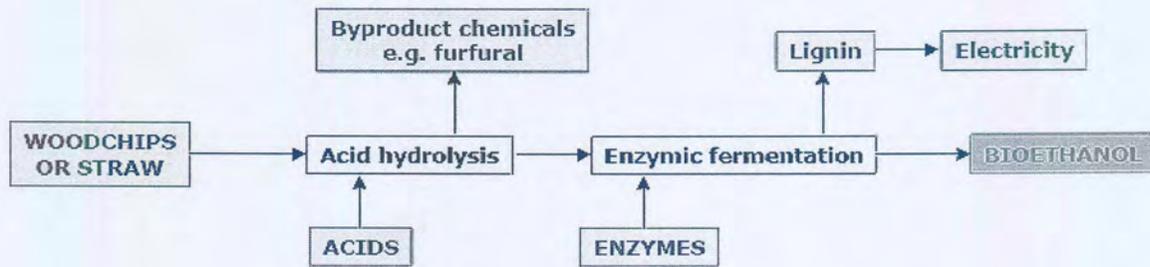
Bio-ethanol is used as a blending agent in petrol or used in a pure form in internal combustion engines in some countries. The comparative cost of bio-ethanol to other fuels is the most important determinant regarding future developments. Environmental regulations to regulate the emission of the so-called greenhouse gases may, however, improve bio-ethanol's competitiveness (National Research Council 1999).

Acid hydrolysis and the fermentation of wood and straw, the malting and the fermentation of wheat, the fermentation of maize, sugar cane and sugar beet are the most important processes used in the manufacture of bio-ethanol. A few remarks on each process are relevant here. Sections 2.3.1.1 to 2.3.1.4 are based on the report on the *International resource costs of biodiesel and bio-ethanol* published by the Department for Transport (2003:10-12).

2.3.1.1 Acid hydrolysis and the fermentation of wood and straw

The process of bio-ethanol manufacturing from wood and straw is depicted in Figure 2.1.

Figure 2.1 – Production of bio-ethanol from wood and straw



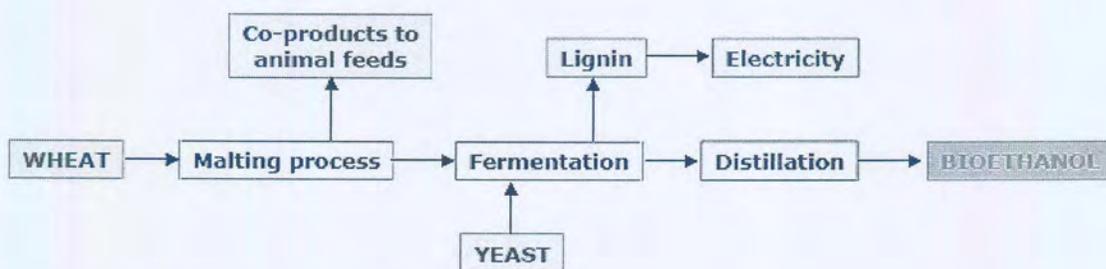
Source: Department for Transport (2003:10)

Figure 2.1 shows the process of bio-ethanol manufacturing using wood and straw as feedstock. The arrows indicate the process flow. An acid is added to wood chips or straw for an acid hydrolysis process before the mixture is subjected to enzymic fermentation, which produces bio-ethanol.

2.3.1.2 Malting and the fermentation of wheat

The malting and fermentation of wheat to produce bio-ethanol is depicted in Figure 2.2.

Figure 2.2 – Production of bio-ethanol from wheat



Source: Department for Transport (2003:11)

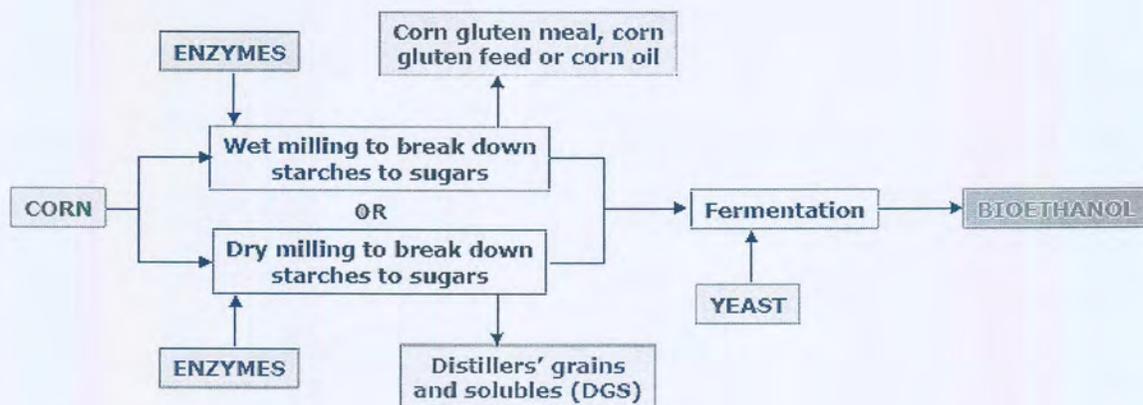
The process flow in Figure 2.2 is indicated by the arrows. Wheat is crushed or milled before enzymes in the wheat break down the starch to C₆ sugars at certain temperatures and humidity levels. This is called malting or hydrolysis. This slow process can be accelerated by

the addition of artificial enzymes. The sugars are washed out with water and the remains can be used for animal feed. Yeast is added to the sugars and at temperatures of 32°C to 35°C and at a pH of 5.2 the mixture produces ethanol, which then has to be distilled.

2.3.1.3 Fermentation of maize

Figure 2.3 depicts the production of bio-ethanol through the fermentation of maize.

Figure 2.3 – Production of bio-ethanol from maize



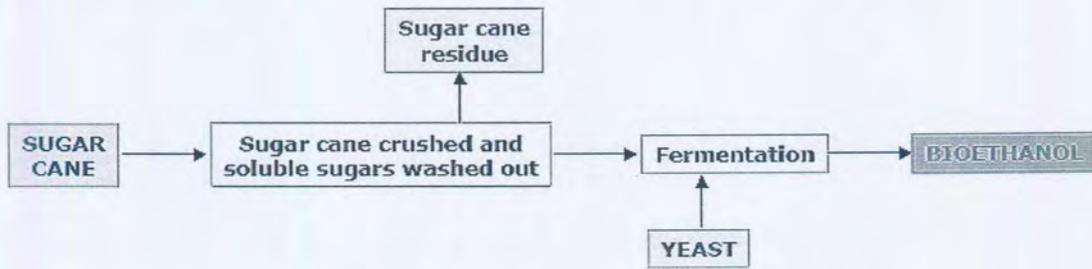
Source: Department for Transport (2003:12)

Figure 2.3 shows the basic process of bio-ethanol production using maize as feedstock. The arrows indicate the flow of the process. The maize can be either wet-milled or dry-milled before fermentation. Wet-milling produces several by-products, such as maize gluten meal, gluten feed and oil, while dry milling produces only animal feed as a by-product. Enzymes break down the starches into C₆ sugars, which are fermented and distilled, similar in the process used for wheat, as described above.

2.3.1.4 Fermentation of sugar cane and sugar beet

The production of bio-ethanol using another feedstock type, sugar cane and sugar beet, is depicted in Figure 2.4.

Figure 2.4 – Production of bio-ethanol from sugar cane and sugar beet



Source: Department for Transport (2003:12)

The arrows in Figure 2.4 show the process flow in the production of bio-ethanol from sugar cane and sugar beet. The sugar cane or sugar beet is crushed, and the soluble sugars are washed out with water. Yeast is added for fermentation, as in the processes for wheat and maize. As can be seen from this figure, this process is shorter than the process for wood, wheat or maize as feedstock. (Sugar cane and sugar beet are not discussed as a feedstock in Chapter 3, because information on its production history, biofuel yields and cost per ton is limited.)

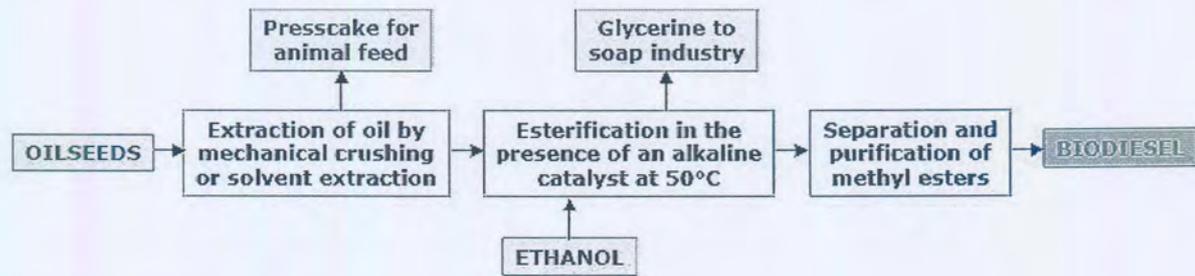
2.3.2 Biodiesel

Biodiesel can be used as a blending agent in petroleum diesel, or it can be used in a pure form in compression-ignition (diesel) engines (National Biodiesel Board 2006). Biodiesel can be produced from a range of vegetable oils, such as sunflower oil, soybean oil and rapeseed oil. The esterification of vegetable oil and the gasification and Fischer-Tropsch processing of wood and straw are the most important processes used in the manufacturing of biodiesel. A few remarks on each process are made below. Sections 2.3.2.1 to 2.3.2.2 are based on the document *International resource costs of biodiesel and bio-ethanol* released by the Department for Transport (2003:10).

2.3.2.1 Esterification of vegetable oil

The production of biodiesel through the esterification of vegetable oil is depicted in Figure 2.5.

Figure 2.5 – Production of biodiesel from vegetable oil



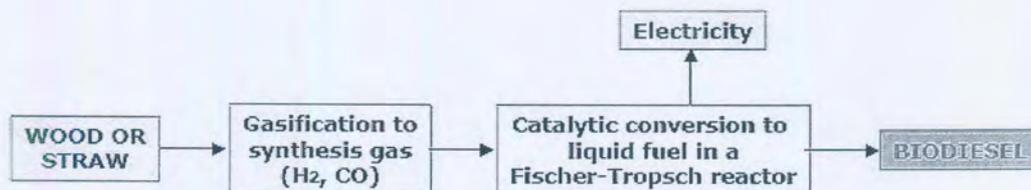
Source: Department for Transport (2003:10)

Figure 2.5 illustrates the manufacture of biodiesel from vegetable oil. The arrows show the process flow. Vegetable oil is derived from the crushing of oil seeds. The oil is mixed with ethanol or methanol at around 50°C. The esterification process produces mainly fatty acid methyl esters, in other words, biodiesel. Small quantities of glycerine are also produced and these are used in soap manufacturing. The remains of the crushed seeds or “cake” are rich in proteins and are used as animal feed.

2.3.2.2 Gasification and the Fischer-Tropsch processing of wood and straw

Biodiesel can also be manufactured through the gasification of wood and straw. This process is illustrated in Figure 2.6.

Figure 2.6 – Production of biodiesel from wood and straw



Source: Department for Transport (2003:13)

The process of biodiesel production is indicated in Figure 2.6. Again, the arrows show the process flow. Feedstock is gasified into a synthesis gas or syngas comprised mainly of hydrogen and carbon monoxide. This gas is converted into liquid fuels in a Fisher-Tropsch reactor by means of a catalyst. Much heat is generated by the reactor which can be used effectively for other purposes, such as steam generation which is required in the gasification of the wood feedstock. This process was originally developed for the large scale conversion

of coal to liquid fuels, but it can also be applied to wood or straw. The availability of wood and straw in a region dictates the size of the plant, which would normally be much smaller than one using coal as feedstock.

2.3.3 Closing remarks on manufacturing processes

Some chemical engineering firms, such as Shaval BioDiesel, can establish turn key biofuel plants. This means that a potential new biofuel manufacturer does not necessarily need to possess an in-depth knowledge of all the engineering details required to build a new biofuel manufacturing plant. The availability of such expertise makes potential new biofuel manufacturers more competitive. Conversely, a lack of knowledge may result in a competitive disadvantage, since future improvements to productivity and manufacturing efficiency may be neglected. (Competitive forces are described in detail in Chapter 6.)

The above short description of the various manufacturing processes used to produce bio-ethanol and biodiesel is necessary because the process used has a direct influence on the capital investment required.

2.4 ESTIMATED CAPITAL INVESTMENTS

2.4.1 Introductory remarks

Economies of scale are a very important aspect of the profitability of a biofuel manufacturer. The direct capital investment to biofuel output capacity ratio needs to be kept as low as possible. This means that the biofuel output capacity should be as high as possible, at the lowest possible capital investment. For example, a process that yields 4 000 litres of biofuel per day may require a capital investment of R1 million. Another process, using another type of feedstock, may also yield 4 000 litres of biofuel per day, but the process may be simpler and may therefore require a capital investment of only R800 000. Furthermore, capacity should preferably neither exceed the expected market demand for biofuel nor the expected availability of feedstock for the process. The biofuel manufacturer should also consider the fact that the higher the capital investment, the higher the maintenance costs and the depreciation expense in the financial statements may be.

Below, capital investment estimates are presented for turn key biodiesel plants, as well as a short description and the budgeted capital investment of a South African bio-ethanol manufacturer, Ethanol Africa (Pty) Ltd.

2.4.2 Turn key biodiesel plant: Shaval BioDiesel

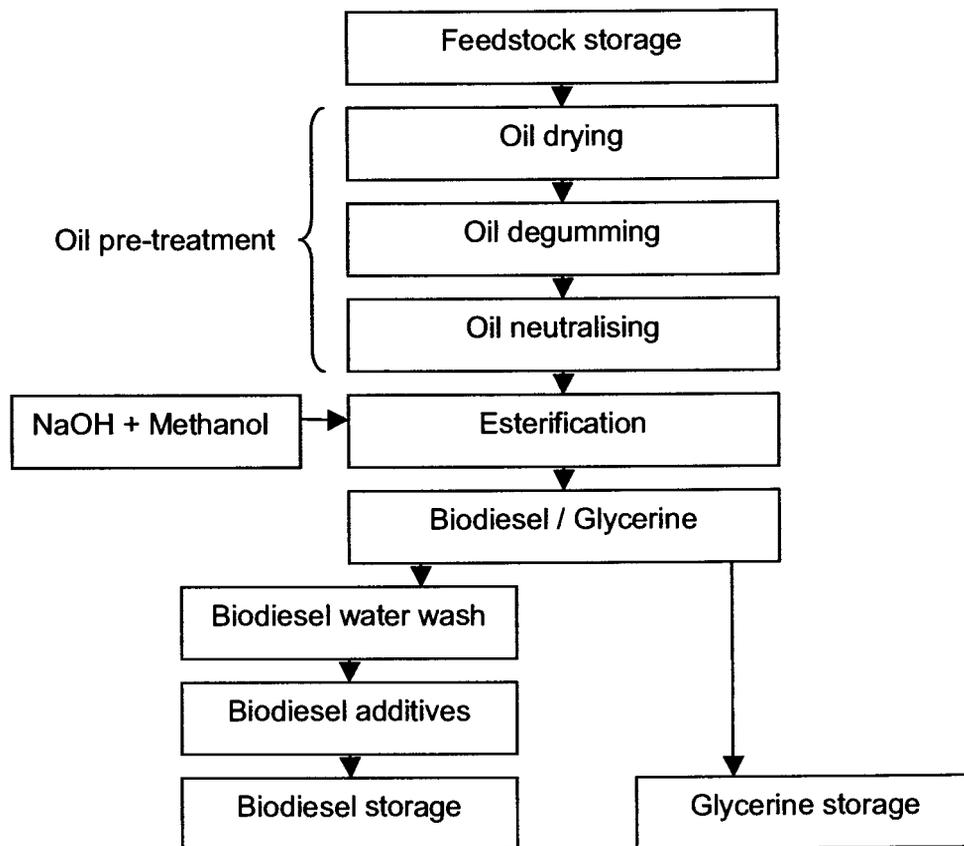
A South African firm, Shaval BioDiesel (Pty) Ltd, is a specialist in the establishment of relatively small biodiesel plants and biofuel manufacturing technology. They can establish a biodiesel plant that delivers 1 000 litres of biodiesel per day at a capital investment of approximately R560 000. For R705 000, a biodiesel plant can be established that has an output of 2 000 litres per day. A plant that delivers 4 000 litres of biodiesel per day may require an investment of approximately R862 000. This capital investment is only for the production equipment and excludes all other capital investments that may be required (Shaval BioDiesel 2006:n.p.). Other capital investments may include land, buildings, vehicles and working capital. These other capital investments may vary considerably from biofuel manufacturer to biofuel manufacturer. For example, a sunflower farmer may decide to integrate forward in the biofuel value chain. The farmer may already have the required land, buildings, vehicles and sunflower feedstock. The only additional expenditure, apart from the equipment, is the financing cost for the extra time it takes to sell the sunflowers in the form of biodiesel.

Shaval BioDiesel's batch system process, as illustrated in Figure 2.7, is somewhat more elaborate than the process described above in Section 2.3.2.1, but the process in essence remains the same. The process, as shown in Figure 2.7, basically consists of oil pre-treatment, the esterification in the reactor, the settling of biodiesel and the by-product, glycerine, the washing of the biodiesel, the addition of additives and the storage of products. The arrows in the figure indicate the process flow.

2.4.3 Ethanol Africa (Pty) Ltd – bio-ethanol manufacturer

Ethanol Africa (Pty) Ltd envisages that it will establish eight major plants at a total capital investment of R700 million each in suitable towns in maize production regions. The first bio-ethanol plant is under construction in Bothaville, in the Free State. The total annual manufacturing capacity will be in the order of 1.4 billion litres of bio-ethanol, made from maize. Maize feedstock will be produced on contract mainly by farmers in the vicinity of the manufacturing plant. Ethanol Africa will provide production credit to these farmers (Van Burick 2005a:n.p.; Van Burick 2006b:n.p.).

Figure 2.7 – Shaval BioDiesel’s batch system process



Source: Adapted from Shaval BioDiesel (2006:n.p.)

Ethanol Africa’s feasibility study indicates the following:

- One plant with an annual capacity of 180 million litres of bio-ethanol is best; and
- The export of bio-ethanol is profitable when
 - Brent crude oil prices are more than \$40 per barrel; and
 - The exchange rate higher than ZAR6/US\$1 (Van Burick 2005a:n.p.).

Assuming that there are 360 manufacturing days in a year, the total investment per daily capacity of biodiesel is R1 400 for a 500 000 litre/day plant. The R1 400 cost of Ethanol Africa’s plant does not compare well with Shaval BioDiesel’s cost of R250. However, Ethanol Africa’s cost includes the total cost of all assets and working capital, not only the direct investment in the equipment. Detailed information on Ethanol Africa’s R700 million capital investment per bio-ethanol plant could not be obtained due to non-disclosure agreements. This information would have been useful to compare the capital investment in equipment by Ethanol Africa and Shaval BioDiesel’s capital investment in equipment.

2.4.4 Total capital investment of a small biodiesel manufacturer

It is not the objective of this study to give accurate details of all the fixed assets and working capital that may be required by a biodiesel manufacturer. The cost of these fixed assets may vary considerably from biofuel manufacturer to biofuel manufacturer. For example, the cost of land varies considerably for different sizes and locations of stands. A 4 000 m² stand in one town's industrial area may cost R250 000. This is equal to R625 000 per hectare. A 10 hectare plot outside of town may cost R400 000, which equals R40 000 per hectare. Furthermore, improvements, such as electricity, water and fencing, available on the stand, plot or farm may also influence the price. Another reason why the total capital investment may vary from biofuel manufacturer to biofuel manufacturer can be the particular biofuel manufacturer's decision to rent some of these assets rather than to purchase them outright. Also, the purchasing decision between old or new assets may also influence the total capital investment. Based on the limited information available, estimated total capital investments for various capacities of a small biodiesel manufacturer using sunflowers as a feedstock are given in Table 2.3. These amounts exclude VAT and any transfer duties that may be payable.

The estimated investments are given in Columns 2, 4 and 6 per capital item (Column 1). Indications of the relative sizes of items are shown in Columns 3, 5 and 7. Details of the assumptions on the capital items (Column 1) and their respective investments (Columns 2, 4 and 6) are given below.

- 1) Land is an industrial stand of roughly 4 000 m² in a small town.
- 2) Buildings should consist of at least 60 m² of closed factory space at R1 500 per m² (Shaval BioDiesel 2006:n.p.) in a 9 x 18m store at roughly R40 000, as advertised in the *LandbouWeekblad* of 8 Sept 2006.
- 3) Sunflower feedstock may be stored in silos with a capacity of 30 tons or 60 m³ each. These silos are equipped with augers and may cost approximately R70 000 each. This equals roughly 10 days of sunflower feedstock per 1 000 litres, 2 000 litres and 4 000 litres of biodiesel manufactured. It should be noted that one large silo for a 4 000 litres per day plant may cost less per volume than four smaller silos. The size of the silo(s) depends on the required number of days of feedstock in storage available for biodiesel manufacturing (Silo Warehouse 2006:n.p.).
- 4) Feedstock equipment consists of a hammer mill at R16 000 (Staalmeester 2006:n.p.)

Table 2.3 – Total capital investment of a small biodiesel manufacturer, 2006

Capital item	Capital investments: Biofuel manufacturer					
	1 000 litres per day		2 000 litres per day		4 000 litres per day	
	Rand	percentage	Rand	percentage	Rand	percentage
1	2	3	4	5	6	7
Land ¹⁾	250 000	16.5	250 000	12.5	250 000	8.8
Buildings ²⁾	130 000	8.6	130 000	6.5	130 000	4.6
Feedstock storage ³⁾	70 000	4.6	140 000	7.0	280 000	9.8
Feedstock equipment ⁴⁾	16 000	1.1	16 000	0.8	16 000	0.6
Biofuel equipment ⁵⁾	560 000	36.9	705 000	35.2	862 000	30.3
Biofuel storage ⁶⁾	8 000	0.5	16 000	0.8	32 000	1.1
By-product storage ⁷⁾	88 000	5.8	176 000	8.8	352 000	12.4
Vehicles ⁸⁾	250 000	16.5	300 000	15.0	400 000	14.1
Working capital ⁹⁾	126 000	8.3	252 000	12.6	504 000	17.7
Other ¹⁰⁾	20 000	1.3	20 000	1.0	20 000	0.7
Total	1 518 000	100.0	2 005 000	100.0	2 846 000	100.0
Biofuel equipment cost per output capacity	560		353		216	
Total capital investment per output capacity	1 518		1 003		712	
Biofuel equipment cost per total output over 5 years or 1 800 days	0.31		0.20		0.12	
Total capital investment per total output over 5 years or 1 800 days	0.84		0.56		0.40	

⁵⁾ Biofuel equipment consists of all the equipment, delivery, set up, and training by Shaval BioDiesel. Some of the equipment used in the 1 000 litres per day plant is basically the same as for the 4 000 litres per day plant. This is the reason why the 1 000 litre per day plant costs more than a quarter of the 4 000 litre per day plant.

⁶⁾ Biofuel is storage in plastic tanks (such as a JoJo tank, for chemical storage) with a capacity of 10 000 litres at R8 000 each. This tank will hold roughly 10 days of biofuel

produced per 1 000 litres, 2 000 litres and 4 000 litres of biodiesel manufactured (JoJo Tanks 2006:n.p.).

- 7) By-products, such as glycerine, are also stored in ordinary plastic tanks. One tank with a capacity of 10 000 litres at R8 000 will be sufficient to hold 20 days of manufacturing per 1 000 litres of biodiesel per day. By-product oil cake can also be stored in a silo with a similar size than the silo used for feedstock storage. However, a larger auger and additional equipment may be necessary due to the nature of oil cake. This 60 m³ silo, including additional equipment and larger auger, may cost roughly R85 000. This should be sufficient for more or less 20 days of oil cake storage when manufacturing 1 000 litres, 2 000 litres and 4 000 litres per day of biodiesel manufacturing (JoJo Tanks 2006:n.p.; Silo Warehouse 2006:n.p.).
- 8) Vehicles may consist of a truck for the transportation of feedstock to the biofuel manufacturer and by-products to customers, as well as a fuel tanker for the transportation of biodiesel to customers. The various options a biofuel manufacturer may choose from are numerous. One option is that feedstock suppliers deliver and customers collect themselves. Another option is to hire transport as required. A biofuel manufacturer who decides to buy its own trucks should consider the size of the trucks, such as 3 ton, 5 ton or 10 ton. This size depends on the quantity of feedstock and products in storage and which configuration will result in the lowest possible capital investment and operational expenses. A rough estimation of the cost of second hand trucks is made only for the purposes of obtaining an approximate total capital investment.
- 9) Working capital is provided for 20 days supply of feedstock at R2 200 per ton per 1 000 litres per day plant. It is assumed that products will be sold on average 20 days after the date of manufacturing.
- 10) Other assets are purely a provision for tools and other small equipment that may be required.

From Table 2.3 it is evident that biofuel manufacturing equipment is the largest capital investment (36.9 per cent, 35.2 per cent and 30.3 per cent respectively for the various capacities) of a biofuel manufacturer. The total cost per output capacity decreases considerably as the output capacity increases. For example, the total capital investment for a 1 000 litre per day plant costs R1 518 per capacity litre. This figure is 51.3 per cent higher than the R1 003 total cost per capacity litre of a 2 000 litre per day plant. It is assumed that these plants have a productive lifespan of five years or 1 800 manufacturing days before major repairs and upgrading become necessary. The total capital investment for the 1 000 litre per day plant is R0.84 per litre of biodiesel produced, which is 110 per cent more than

the total capital investment of R0.40 per litre of biodiesel produced in the 4 000 litre per day plant.

A sunflower farmer, for example, may choose to integrate forward in the biofuel industry. The farmer may already possess all the assets (land, buildings, silos and tanks) except for the biofuel equipment. Again economies of scale may influence the farmer's decision on the plant size. For example, the biofuel equipment cost per output capacity increases by 63.4 per cent from R216 (4 000 litres per day plant) to R353 (2 000 litres per day plant) and increases further by 58.6 per cent to R560 (1 000 litres per day plant). The cost of the biofuel equipment over five years or 1 800 manufacturing days amounts to R0.12 per litre of biodiesel manufactured (4 000 litres per day plant). This R0.12 per litre is a decrease of 40 per cent from R0.20 per litre (2 000 litres per day plant) and a decrease of 61.3 per cent from R0.31 per litre (1 000 litres per day plant). Thus, from Table 2.3 it is evident that a feedstock farmer that integrates forward into the biofuel industry has a competitive advantage over independent biofuel manufacturers from a total capital investment perspective.

2.5 CLOSING REMARKS

The cost of biofuel to the final consumer should be less than that of other energy sources with similar utility values if the demand for biofuel is to be maintained. The choice of feedstock determines the process, which in turn determines the product: bio-ethanol or biodiesel. Once a certain process has been chosen, it might prove difficult and expensive to change the process for other types of feedstock. The capital investment in a plant is probably the largest of all the expenditures a biofuel manufacturer will incur. The cost and efficiency yields of various feedstocks are studied in Chapter 3.

In the interests of national energy security, local economic development and the preservation of the environment, South Africa should produce its own biofuel. Government therefore has to promote biofuel manufacturing through incentives and regulations. Local development in the bio-ethanol industry has already begun, with manufacturers such as Ethanol Africa (Pty) Ltd, who is regarded by some as the saviour of South African maize producers.

PART II

BIOFUEL MANUFACTURER VALUE CHAIN ACTIVITIES

CHAPTER 3: FEEDSTOCK FOR BIOFUEL MANUFACTURING

CHAPTER 4: BIOFUEL SALES

**CHAPTER 5: REVENUES FROM BY-PRODUCTS AND EXPENSES
FOR BIOFUEL MANUFACTURERS**

CHAPTER 3

FEEDSTOCK FOR BIOFUEL MANUFACTURING

3.1 INTRODUCTION

Feedstock is an important variable that influences biofuel manufacturers' profitability. In a biofuel manufacturer's value chain, feedstock forms part of the supply chain which needs to be managed efficiently. (See Section 1.2.2 and Figure 1.1 for the position of feedstock producers in the value chain.)

A number of crops have been recognised in South Africa as a viable source of feedstock for the manufacturing of biofuel. These include maize, sunflowers, soybeans, wheat, palm oil and *jatropha curcas*. (Van Burick 2006a:n.p.). The consistency of the supply, biofuel yields and costs of the various crops differ and therefore have a different impact on biofuel manufacturers' profitability. A biofuel manufacturer therefore needs to decide carefully what produce to use as feedstock.

This chapter focuses on the need for a consistent supply of feedstock to the manufacturing process, as well as the cost of feedstock. The cost of feedstock is determined *inter alia* by the purchase price per ton, transport costs and the biofuel conversion yield ratio.

3.2 CONSISTENT SUPPLY OF FEEDSTOCK

Feedstock may consist of any organic matter or biomass. However, economies of scale dictate that the most efficient quantity of feedstock should always be introduced to the manufacturing process. A consistent supply of small quantities of feedstock may require a manufacturing plant with a smaller capacity and capital investment. Large and inconsistent feedstock supplies may require a manufacturing plant with a larger capacity and capital investment. Furthermore, large supplies of feedstock result in relatively high storage costs. Inconsistent feedstock supplies can lead to costs associated with idle time. These additional capital and operating costs may have a negative impact on a biofuel manufacturer's profitability. (See Sections 2.3 and 2.4 for descriptions of suitable biofuel manufacturing processes and estimated capital investments.)

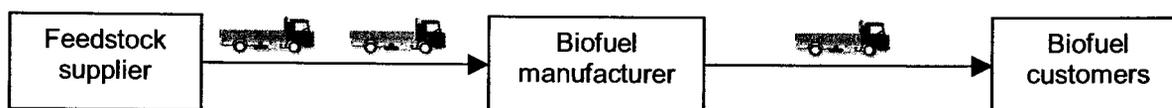
A consistent supply of feedstock to the biofuel manufacturing process is one of the factors that determine the size and capacity of a plant. Consistency can be achieved by selecting a

type of feedstock that can be produced on a continuous basis. Crops are seasonal bound, which implies that the biofuel manufacturer needs to consider storage and the grading of the feedstock if the feedstock is bought directly from farmers. Feedstock could also be acquired on a regular basis from entities that store grain in silos, such as Afgri Ltd.

3.3 LOCATION OF BIOFUEL MANUFACTURING PLANTS

The biofuel manufacturing plant should be close to the feedstock suppliers in order to minimise expensive transportation costs. The tonnage of the feedstock required is more than the tonnage of biofuel produced from that feedstock (Van Burick 2005a:n.p.). For example, one ton of maize can yield roughly 420 litres of biofuel, and one litre of biofuel weighs approximately one kilogram. The biofuel manufacturer's transportation costs per kilometre may therefore be higher for feedstock than for the value added biofuel. This concept is illustrated in Figure 3.1.

Figure 3.1 – Impact of location on a biofuel manufacturer's profitability



From Figure 3.1 it is clear that the transport ratio of feedstock to biofuel yield is more than 1:1. The manufacturing plant should therefore be as close to the supply of feedstock as possible in order to minimise the total cost of transportation.

3.4 CROP PRODUCTION, BIOFUEL CONVERSION YIELDS AND COSTS

Different crops thrive in different ecological conditions. It is therefore important to note the main provinces where certain crops are produced. Biofuel manufacturers should be located in the provinces where an abundant supply of the feedstock crop they require is produced in order to minimise transportation costs.

Different crops yield different biofuel quantities per ton (conversion yield ratio). This is primarily due to the manufacturing process, the digestible starch content and the type of yeast used. It is therefore important that the cost per ton of the feedstock should be as low as possible, given its purchase price and biofuel conversion yield ratio (The mother earth news 1980:n.p.) (Dien, Bothast, Iten, Barrios & Eckhoff 2002:n.p).

The direct cost of feedstock to a biofuel manufacturer is influenced by the total annual quantity produced and demanded in South Africa. The direct cost of feedstock is also influenced by the international total cost of the feedstock, as reflected in the import parity price. The import parity price is influenced, amongst other things, by the currency exchange rate (South African Rand/United States of America Dollar).

The production, biofuel conversion yield ratio and costs of maize, sunflowers, soybeans, wheat and *jatropha curcas* as feedstock are discussed below. Other crops such as oats, canola and sugar cane are also suitable feedstock, but in this report, these types of produce are not discussed. Data on various aspects of maize, sunflowers, soybeans and wheat were obtained from Grain SA reports. This data has been restructured to provide meaningful information for purposes of this report. This restructured information is presented in tables and graphs.

Maize is the first crop to be analysed as a feedstock for biofuel.

3.4.1 Maize as a feedstock for biofuel

3.4.1.1 Maize production

The total production of yellow and white maize in South Africa per province for the three years from 2004 to 2006 is given in Table 3.1.

Table 3.1 indicates the production of maize per province (Column 1) and the tonnage produced per year (Columns 2, 4 and 6) from 2004 to 2006. The annual provincial production as a percentage of the total production in South Africa for each year is given in Columns 3, 5 and 7. The three-year average production (Column 8 and 9) indicates the relative importance of maize production provinces. The average annual production of maize in South Africa over the past three years has been 8 930 000 tons. On average, the Free State produces the most maize, at 3 039 000 tons annually. This represents 34.0 per cent of total maize production in South Africa. Furthermore, the Free State (34.0 per cent of the total production), North-West (25.5 per cent of the total production) and Mpumalanga (24.3 per cent of the total production) are responsible for 83.8 per cent of the total maize production. A biofuel manufacturer that uses maize as its feedstock would therefore build its biofuel plant in one of these three provinces.

Table 3.1 – Maize production in South Africa, 2004 to 2006

Province	Production years							
	2003/2004		2004/2005		2005/2006 estimated		Average for 3 years	
1	2	3	4	5	6	7	8	9
	1 000 tons	percentage	1 000 tons	percentage	1 000 tons	percentage	1 000 tons	percentage
Western Cape	0	0.0	0	0.0	0	0.0	0	0.0
Northern Cape	511	5.4	557	4.9	385	6.5	484	5.4
Free State	3 100	32.7	4 113	36.0	1 905	32.3	3 039	34.0
Eastern Cape	82	0.9	88	0.8	70	1.2	80	0.9
Kwazulu-Natal	390	4.1	400	3.5	322	5.5	371	4.2
Mpumalanga	2 219	23.4	2 807	24.6	1 482	25.1	2 169	24.3
Limpopo	115	1.2	120	1.0	54	0.9	96	1.1
Gauteng	483	5.1	483	4.2	280	4.8	415	4.6
North-West	2 568	27.1	2 863	25.0	1 397	23.7	2 276	25.5
Total	9 467	100	11 430	100	5 893	100	8 930	100

Source: Adapted from Grain SA (2006a:n.p.)

3.4.1.2 Biofuel yields from maize

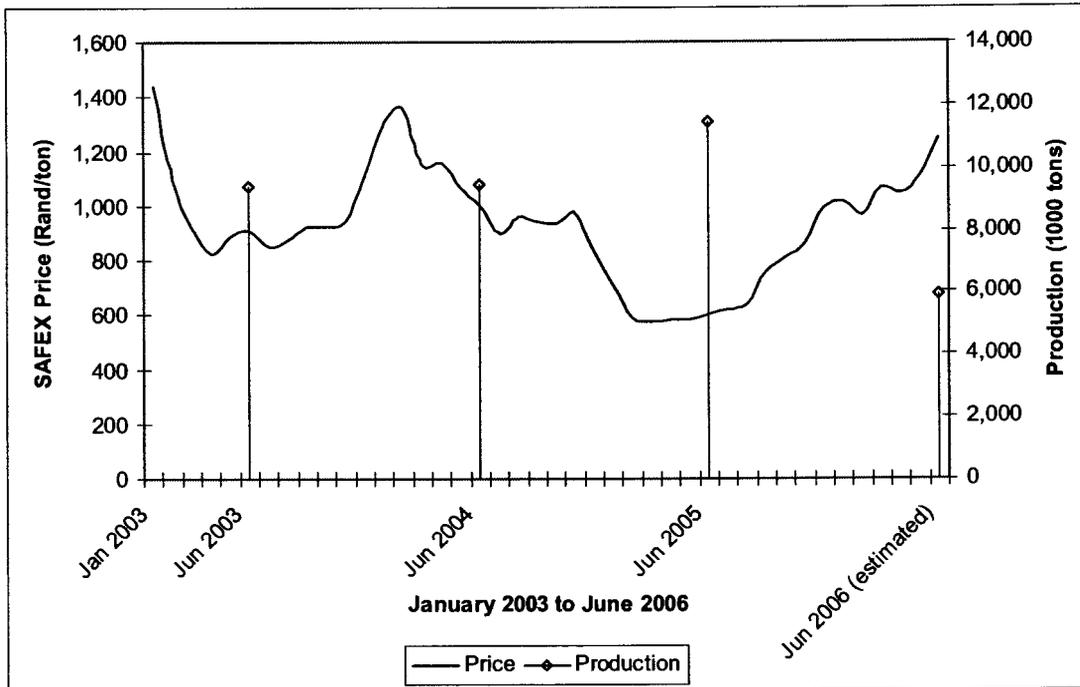
One ton of maize can yield 420 litres of bio-ethanol. Furthermore, an estimated 330kg of animal feed is produced as a by-product per ton of maize used for bio-ethanol manufacturing (Van Burick 2005a:n.p.).

3.4.1.3 Cost of maize

The maize SAFEX (South African Futures Exchange) price per ton and the production quantities from January 2003 to June 2006 are indicated in Figure 3.2.

The graph in figure 3.2 shows the impact of maize production in 1 000 tons per annum (Y-axis right) on the SAFEX price per ton (Y-axis left). The vertical lines indicate the annual maize production quantities as well as the dates: June 2003, June 2004, June 2005 and June 2006 (estimated). From Figure 3.2 it is clear that the estimated production of maize in 2006 (5 893 000 tons) was 48.4 per cent lower than the 11 430 000 tons produced in 2005. This resulted in a 108.1 per cent increase in the price of maize from R600 per ton in June 2005 to R1 249 per ton in June 2006.

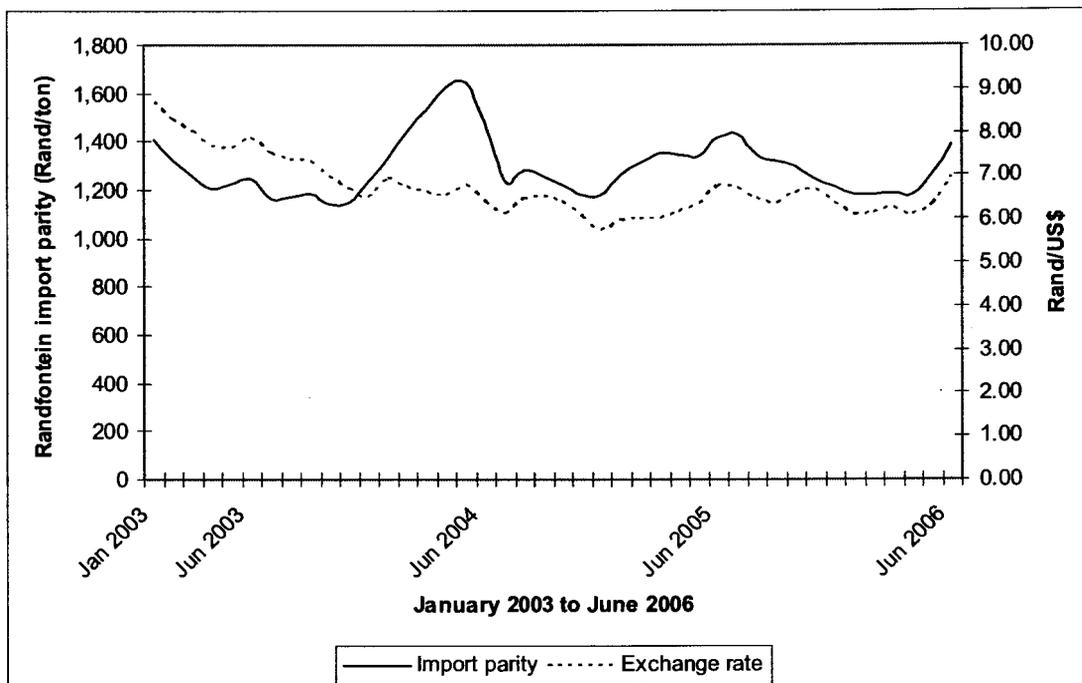
Figure 3.2 – Maize price and production, January 2003 to June 2006



Sources: Adapted from Grain SA (2006a:n.p.) and Grain SA (2006e:n.p.)

The influence of the exchange rate on the import parity prices of maize is indicated in Figure 3.3.

Figure 3.3 – Maize import parity and exchange rate, January 2003 to June 2006



Source: Adapted from Grain SA (2006e:n.p.)

The graph in figure 3.3 reveals the impact of the Rand/US\$ exchange rate (dotted line) on the Y-axis (right) as well as the import parity price per ton (solid line) on the Y-axis (left) over the period from January 2003 to June 2006 (X-axis). The correlation coefficient between the movements in the average monthly Rand/US\$ exchange rate and the import parity price of maize is calculated at 0.6. This means that the Rand/US\$ exchange rate influences the maize import parity directly. However, the influence is not as strong as expected (a correlation coefficient of one is strongest). This may be due to changes in the international basic cost of maize as a result of international supply and demand. The movement in the average monthly exchange rate, according to Figure 3.3, correlates by a factor of 0.4 to the SAFEX price. Other local market forces also have an effect, which may result in the lower correlation.

3.4.1.4 Cost of biofuel from maize

According to Figure 3.2, the SAFEX cost of maize in June 2006 was R1 249 per ton. One ton of maize converts into 420 litres of bio-ethanol. The direct feedstock cost per litre of bio-ethanol in June was therefore R2.97 per litre.

Sunflowers are analysed next. A similar structure as the one used in the discussion of maize is followed.

3.4.2 Sunflowers as a feedstock for biofuel

3.4.2.1 Sunflower production

The production of sunflowers in South Africa per province for the three years from 2004 to 2006 is indicated in Table 3.2.

Table 3.2 indicates the production of sunflowers per province (Column 1) and the tonnage produced per year for three years (Columns 2, 4 and 6). The annual provincial production of sunflowers as a percentage of the total production in South Africa is given in Columns 3, 5 and 7. The three-year average production (Columns 8 and 9) indicates the relative importance of sunflower production provinces. The Free State province produces the most sunflowers at 252 000 tons annually on the three-year average, which is 41.4 per cent of the total production in South Africa.

Table 3.2 – Production of sunflower in South Africa, 2004 to 2006

Province	Production years							
	2003/2004		2004/2005		2005/2006 Estimated		Average for 3 years	
1	2	3	4	5	6	7	8	9
	1 000 tons	percentage	1 000 tons	percentage	1 000 tons	percentage	1 000 tons	percentage
Western Cape	0	0.0	0	0.0	0	0.0	0	0.0
Northern Cape	1	0.2	1	0.2	2	0.4	1	0.2
Eastern Cape	0	0.0	0	0.0	0	0.0	0	0.0
Free State	276	42.6	260	41.9	221	39.7	252	41.4
Kwazulu-Natal	0	0.0	0	0.0	0	0.0	0	0.0
Mpumalanga	46	7.1	46	7.4	59	10.6	50	8.2
Limpopo	37	5.7	36	5.8	41	7.4	38	6.2
Gauteng	23	3.5	14	2.3	15	2.7	17	2.8
North-West	265	40.9	263	42.4	220	39.5	249	40.9
Total	648	100	620	100	557	100	608	100

Source: Adapted from Grain SA (2006b:n.p.); Grain SA (2006e:n.p.)

North-West produces, on the three year average, almost as much as the Free State, at 249 000 tons per annum. This is 40.0 per cent of the total production. The total average annual production of sunflowers in South Africa is 608 000 tons of which the Free State and North-West collectively produce 82.3 per cent. A biofuel plant which uses sunflowers as feedstock should therefore be in the Free State or in North-West.

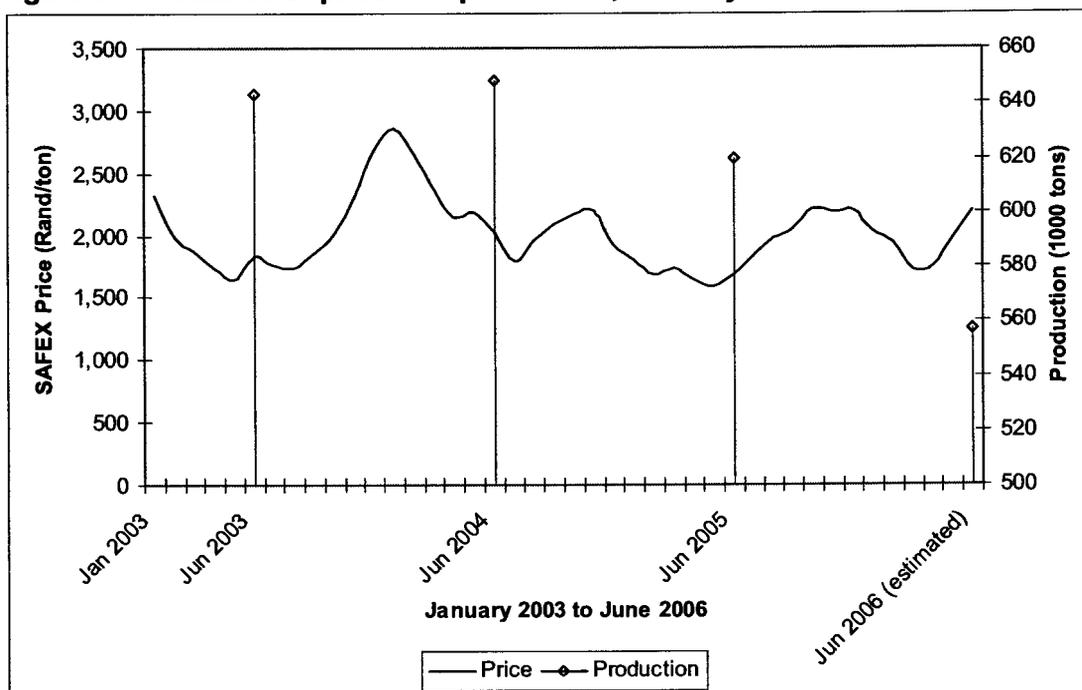
3.4.2.2 Biofuel yields from sunflower

One hectare of sunflowers can yield an average of 560 litres of biodiesel (Van Burick 2006a:n.p.; Grain SA 2006b:n.p.). This translates to an average yield of 350 litres of biodiesel per ton of sunflowers if roughly 1.6 tons of sunflowers are produced per hectare. An estimated 620 kilograms of oil cake and 18 per cent glycerine can also be obtained (Shaval BioDiesel 2006:n.p.).

3.4.2.3 Cost of sunflowers

The sunflower SAFEX price per ton and the production quantities are indicated in Figure 3.4.

Figure 3.4 – Sunflower price and production, January 2003 to June 2006



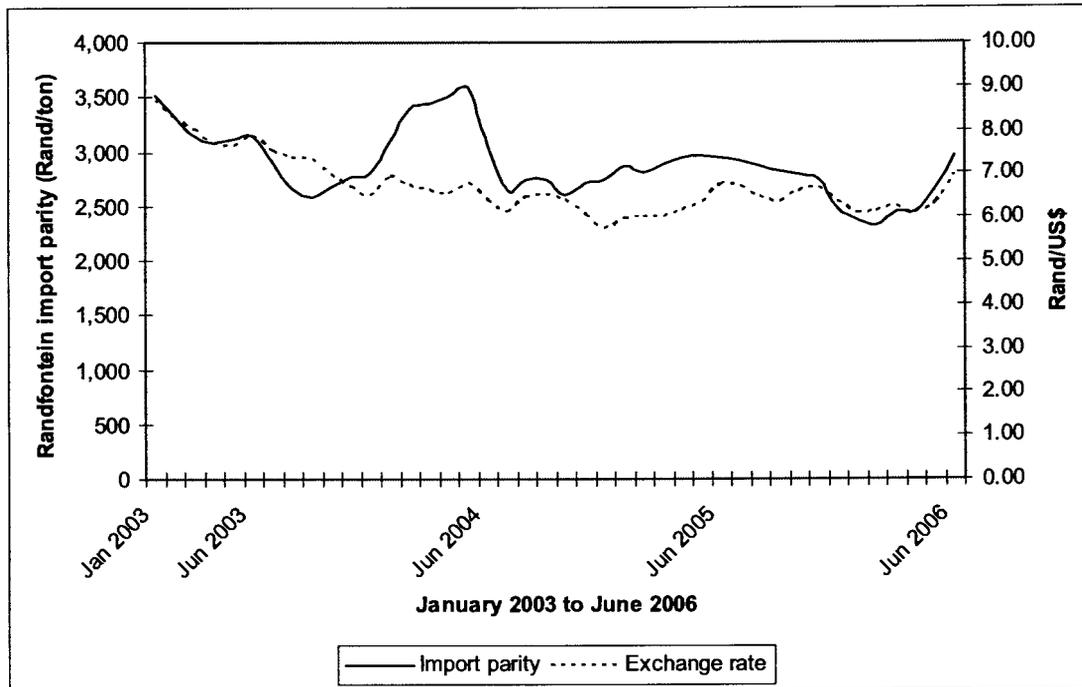
Sources: Adapted from Grain SA (2006b:n.p.) and Grain SA (2006e:n.p.)

The graph in figure 3.4 shows the impact of sunflower production in 1 000 tons per annum (Y-axis right) on the SAFEX price per ton (Y-axis left). The vertical lines indicate the annual sunflower production quantities as well as the dates: June 2003, June 2004, June 2005 and June 2006 (estimated). The production of sunflowers decreased by 10.1 per cent; from 620 000 tons in 2005 to 557 000 tons in 2006. This contributed to the 30.3 per cent increase in the price of sunflowers from R1 682 per ton in June 2005 to R2 192 per ton in June 2006.

The influence of the exchange rate on the import parity prices of sunflowers are indicated in figure 3.5.

The Rand/US\$ exchange rate (Y-axis right), shown as a dotted line in Figure 3.5, affected the import parity price per ton of sunflowers (Y-axis left), shown as a solid line, over the period January 2003 to June 2006 (X-axis). The correlation coefficient between the average monthly movement of the Rand/US\$ exchange rate and the import parity price of sunflowers is calculated at 0.6. Thus, movements in the exchange rate influence the import parity price to a large extent. The movement between the monthly average exchange rate and the SAFEX price of sunflowers correlates with a factor of 0.4. It is noted that these correlation coefficients between the movement of the average monthly exchange rate and import parity or SAFEX prices of maize and of sunflowers are the same. This may be coincidental.

Figure 3.5 – Sunflower import parity and exchange rate, January 2003 to June 2006



Source: Adapted from Grain SA (2006e:n.p.)

3.4.2.4 Cost of biofuel from sunflowers

The price of sunflowers, according to Figure 3.4, was R2 192 per ton in June 2006. The direct cost of feedstock in biodiesel manufacturing was therefore R3.91 per litre, if sunflowers were used as feedstock. This calculation is based on the assumption that 560 litres of biodiesel are produced from one ton of sunflowers.

Soybeans are discussed below.

3.4.3 Soybeans as a feedstock for biofuel

3.4.3.1 Soybean production

The production of soybeans in South Africa per province for the three years from 2004 to 2006 is given in Table 3.3.

Table 3.3 – Soybean production in South Africa, 2004 to 2006

Province	Production years							
	2003/2004		2004/2005		2005/2006 estimated		Average for 3 years	
1	2	3	4	5	6	7	8	9
	1 000 tons	percentage	1 000 tons	percentage	1 000 tons	percentage	1 000 tons	percentage
Western Cape	0	0.0	0	0.0	0	0.0	0	0.0
Northern Cape	0	0.0	0	0.0	2	0.5	1	0.3
Eastern Cape	0	0.0	1	0.4	1	0.3	1	0.3
Free State	29	13.2	30	11.0	59	15.4	39	13.4
Kwazulu-Natal	36	16.4	39	14.3	61	15.9	46	15.8
Mpumalanga	110	50.0	137	50.3	203	53.0	150	51.4
Limpopo	10	4.5	27	9.9	30	7.8	23	7.9
Gauteng	8	3.6	9	3.3	11	2.9	9	3.1
North-West	26	11.8	29	10.6	18	4.7	24	8.2
Total	220	100	273	100	383	100	292	100

Source: Adapted from Grain SA (2006c:n.p.)

The production of soybeans per province (Column 1) and the tonnage produced per year (Columns 2, 4 and 6) are indicated in Table 3.3. Columns 3, 5 and 7 show the annual provincial production of soybeans as a percentage of the total production in South Africa. The three-year average production is given in Columns 8 and 9, which indicates the relative importance of soybean production in those provinces. The three-year average annual production of soybeans in South Africa is 292 000 tons, of which Mpumalanga produces on average 150 000 tons. This is 51.4 per cent of the total soybean production in South Africa and exceeds that of the other provinces by far. Kwazulu-Natal (15.8 per cent of the total) and the Free State (13.4 per cent of total) on average produce collectively 85 000 tons of soybeans per annum. Mpumalanga is therefore the preferred province for the location of a biofuel plant that uses soybeans as its feedstock.

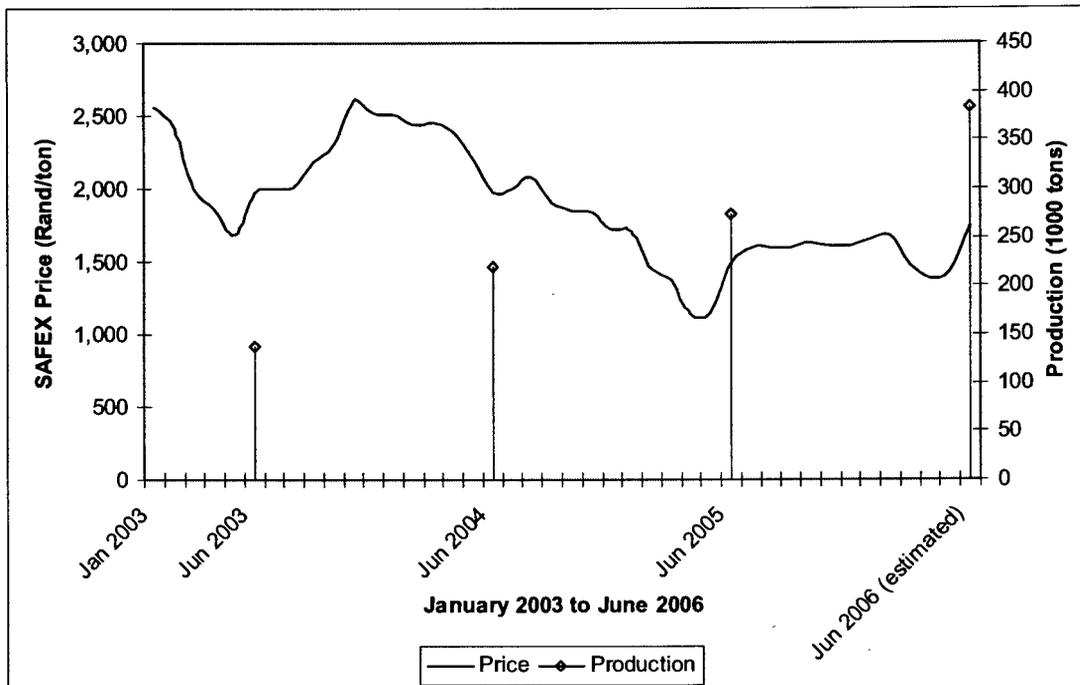
3.4.3.2 Biofuel yields from soybeans

The biofuel manufacturer can expect to obtain an average of 260 litres of biodiesel from one ton of soybeans. It should be noted that other estimates indicate a yield of 170 litres of biodiesel per ton of soybeans. Furthermore, an estimated 800 kg of animal feed is produced as a by-product per ton of soybeans (Van Burick 2006a:n.p.; Grain SA 2006c:n.p.).

3.4.3.3 Cost of soybeans

The soybean SAFEX price per ton and production quantities are indicated in Figure 3.6.

Figure 3.6 – Soybean price and production, January 2003 to June 2006

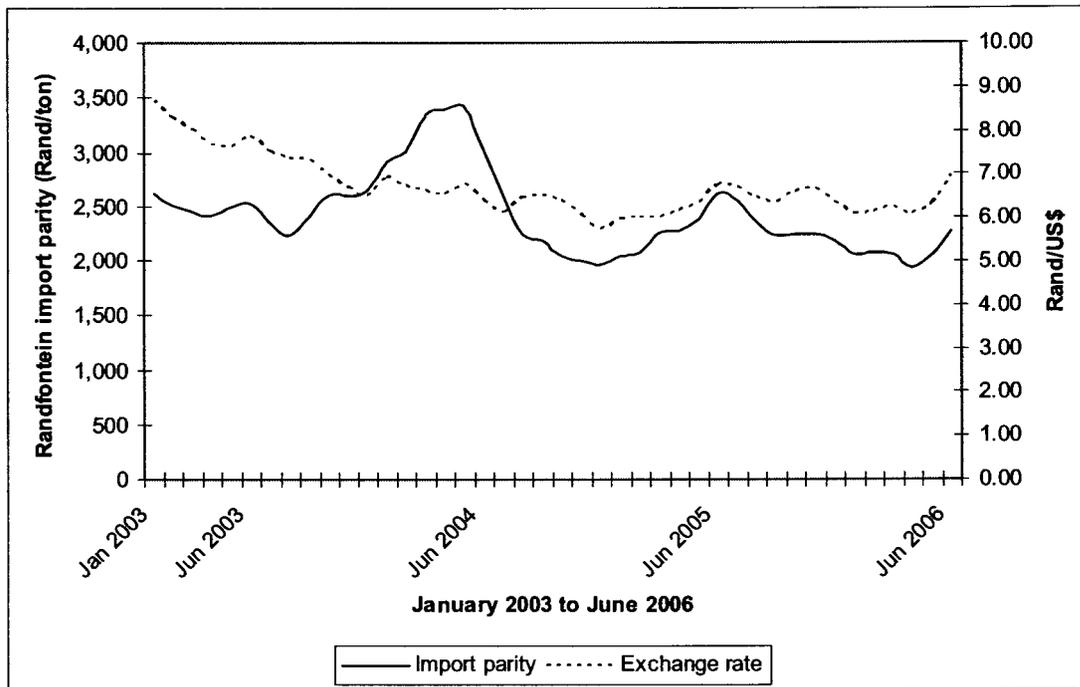


Sources: Adapted from Grain SA (2006c:n.p.) and Grain SA (2006e:n.p.)

The graph in figure 3.6 reveals the impact of soybean production in 1 000 tons per annum (Y-axis right) on the SAFEX price per ton (Y-axis left). The vertical lines indicate the annual production quantities of soybeans as well as dates: June 2003, June 2004, June 2005 and June 2006). The production of soybeans increased by 40.3 per cent from 273 000 tons in 2005 to an estimated 383 000 tons in 2006. An unexpected increase in the price of soybeans followed. The price increased by 17.1 per cent from R1 492 per ton in June 2005 to R1 747 per ton in June 2006. This increase may be attributed to an increase in the import parity price and/or other market influences, such as a general increase in the demand for soybeans.

The influence of the exchange rate on the import parity prices of soybeans are indicated in Figure 3.7.

Figure 3.7 – Soybean import parity and exchange rate, January 2003 to June 2006



Source: Adapted from Grain SA (2006e)

Figure 3.7 indicates the impact of the Rand/US\$ exchange rate (Y-axis right) on the import parity price per ton of soybeans (Y-axis left) over the period from January 2003 to June 2006 (X-axis). A relatively weak, although still positive, correlation coefficient of 0.4 exists between the movement in the monthly average exchange rate and the import parity price of soybeans. The correlation coefficient between the monthly average Rand/US\$ and the SAFEX price per ton of soybeans is even weaker at 0.3. The relatively low production quantities of soybeans (a three-year average of 292 000 tons) in South Africa, compared to maize (a three-year average of 8 930 000 tons) may make the soybean market more volatile than the maize market. Small market influences, such as an increase in the demand for soybeans as feedstock for biofuel manufacturing, may have relatively large effects on the price of soybeans per ton. The direct cost per ton of soybeans as a feedstock for biofuel manufacturing is therefore a relatively large financial risk for a biofuel manufacturer. A biofuel manufacturer using soybeans as a feedstock should produce the soybeans itself, in an attempt to hedge against the relatively large fluctuations in the direct cost per ton of soybeans, to some extent.

3.4.3.4 Cost of biofuel from soybeans

According to Figure 3.6, the SAFEX cost per ton of soybeans in June 2006 was R1 747. The direct feedstock cost to produce biodiesel was therefore R6.72 per litre, if 260 litres of biodiesel was yielded from one ton of soybeans.

Wheat is the fourth crop to be discussed as a feedstock for biofuel.

3.4.4 Wheat as a feedstock for biofuel

3.4.4.1 Wheat production

The production of wheat in South Africa per province for the three years from 2004 to 2006 is set out in Table 3.4.

Table 3.4 – Wheat production in South Africa, 2004 to 2006

Province	Production years							
	2003/2004		2004/2005		2005/2006 estimated		Average for 3 years	
1	2	3	4	5	6	7	8	9
	1 000 tons	percentage	1 000 tons	percentage	1 000 tons	percentage	1 000 tons	percentage
Western Cape	530	34.4	520	31.0	645	35.1	565	33.5
Northern Cape	280	18.2	300	17.9	287	15.6	289	17.1
Eastern Cape	9	0.6	14	0.8	14	0.8	12	0.7
Free State	480	31.2	510	30.4	551	30.0	514	30.5
Kwazulu-Natal	32	2.1	34	2.0	43	2.3	36	2.1
Mpumalanga	36	2.3	80	4.8	82	4.5	66	3.9
Limpopo	35	2.3	63	3.8	60	3.3	53	3.1
Gauteng	9	0.6	14	0.8	14	0.8	12	0.7
North-West	130	8.4	145	8.6	143	7.8	139	8.2
Total	1 540	100	1 680	100	1 839	100	1 686	100

Source: Adapted from Grain SA (2006d:n.p.)

Table 3.4 indicates the production of wheat (Columns 2, 4 and 6) per production year per province (Column 1). The relative size of each province, expressed as a percentage of the total production, is given in Columns 3, 5 and 7. The average three-year production, as indicated in Columns 8 and 9, shows which provinces in South Africa can be considered the

main wheat producers. The Western Cape is the largest producer of wheat, at a three-year average of 565 000 tons per annum. The Free State produces, on the three-year average the second most wheat at 514 000 tons annually. The Western Cape (33.5 per cent of the total production) and the Free State (30.5 per cent of the total production) collectively produce 64 per cent of the total three-year average annual production of wheat in South Africa. This is, on average, 1 079 000 tons of wheat out of a total 1 686 000 tons per annum. A biofuel manufacturer that uses wheat as a feedstock for biofuel manufacturing should preferably be in the Western Cape or in the Free State.

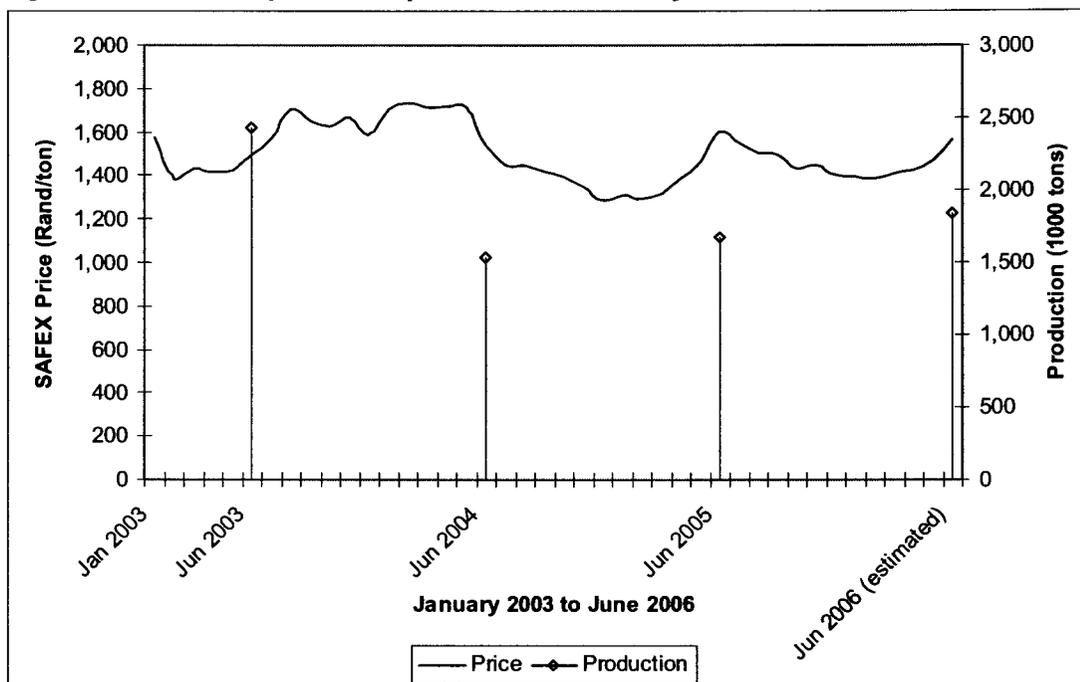
3.4.4.2 Biofuel yields from wheat

The conversion yield for wheat is estimated at 420 litres of bio-ethanol per ton of wheat. This yield is approximately the same as for maize (The mother earth news, 1980).

3.4.4.3 Cost of wheat

The wheat SAFEX price per ton and production quantities are indicated in Figure 3.8.

Figure 3.8 – Wheat price and production, January 2003 to June 2006



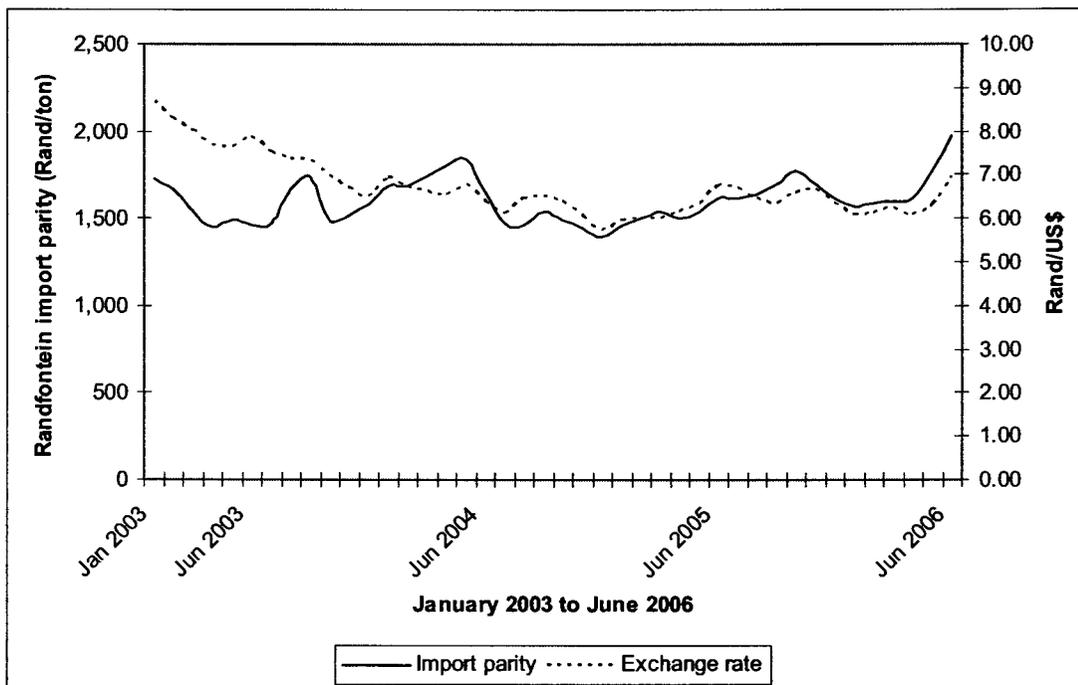
Sources: Adapted from Grain SA (2006d:n.p.) and Grain SA (2006e:n.p.)

The impact of wheat production in 1 000 tons per annum (Y-axis right) on the SAFEX price per ton (Y-axis left) is shown in Figure 3.8. The vertical lines indicate the annual production

quantities as well as the dates: June 2003, June 2004, June 2005 and June 2006. In 2006, an estimated 1 839 000 tons of wheat were expected to be produced, while in 2005, a total of 1 680 000 tons were produced. This 9.4 per cent increase in the tonnage of wheat produced resulted in an expected 2.4 per cent decrease in the price of wheat from R1 608 per ton in June 2005 to R1 568 per ton in June 2006.

The influence of the exchange rate on the import parity prices of wheat is indicated in Figure 3.9.

Figure 3.9 – Wheat import parity and exchange rate, January 2003 to June 2006



Source: Adapted from Grain SA (2006e:n.p.)

Figure 3.9 reveals the influence of the Rand/US\$ exchange rate (Y-axis right) on the import parity price per ton (Y-axis left) of wheat over the period from January 2003 to June 2006 (X-axis). The correlation coefficient between the movements of the monthly average exchange rate and the import parity price of wheat is 0.6 and it is in line with the correlation coefficients for maize and sunflowers. The correlation coefficient between the movements of the monthly average exchange rate and the SAFEX price per ton of wheat is also 0.6, which is the highest of the four grains. A biofuel manufacturer should therefore expect an increase in the direct cost of wheat as a feedstock when the Rand/US\$ exchange rate increases.

3.4.4.4 Cost of biofuel from wheat

The SAFEX price of wheat in June 2006 was R1 568 per ton, according to Figure 3.8. If 420 litres of bio-ethanol is manufactured from one ton of wheat, the direct cost of wheat as a feedstock for bio-ethanol manufacturing in June 2006 was R3.73 per litre.

The last feedstock to be discussed for the purposes of this report is *Jatropha curcas*. The biofuel yields and the cost of *Jatropha curcas* as a feedstock follow a short description of its production.

3.4.5 *Jatropha curcas* as a feedstock for biofuel

3.4.5.1 *Jatropha curcas* production

Jatropha curcas L., also known as physic nut, is a relatively small tree that produces seeds with high oil content. A tree can be expected to have a productive seed-bearing lifespan of approximately 35 years. Currently, this tree occurs in many parts of the world, including the Republic of South Africa. However, the tree does not thrive in all areas in South Africa and not much information is available on the commercial production of *Jatropha curcas* in the Republic of South Africa. *Jatropha curcas* cultivated for oil production is normally planted at 2m x 2m; 2.5m x 2.5m; or 3m x 3m planting distances, depending on soil fertility and the availability of water. This is equivalent to a plant density of 2 500, 1 600 or 1 111 plants per hectare. This tree is drought-resistant and it may grow in marginal soil. It is locally regarded as a suitable feedstock for the production of biodiesel. The seeds, however, contain substances that are toxic to humans and animals. The press cake can therefore only be used or sold as organic manure (Heller 1996:40-42, Van Burick 2006a:n.p.).

3.4.5.2 Biofuel yields from *Jatropha curcas*

Jatropha curcas seeds yield 3 000 to 6 000 litres of biodiesel per hectare. The yield depends *inter alia* on the quantity of water that the tree received during the year (Van Burick 2006a:n.p.). Duke (1983:n.p.) states that 6 to 8 tons of seed per hectare with an oil content of 37 per cent can be expected. This is equivalent to 2 100 to 2 800 litres of biodiesel per hectare without irrigation. It can therefore be calculated that some 350 litres of biodiesel are yielded per ton of *Jatropha curcas* seeds produced. This is calculated by dividing 2 100 litres per hectare by six tons of seed per hectare.

3.4.5.3 Cost of *Jatropha curcas*

In the Republic of South Africa, *Jatropha curcas* is produced on a commercial scale for the manufacturing of biodiesel. Currently, the producers of *Jatropha curcas* seeds are relatively small and there is no open market for these seeds. These producers normally use the seeds themselves to manufacture biodiesel. If a biofuel manufacturer chooses *Jatropha curcas* seeds as its main feedstock at this stage, the manufacturer has to produce the feedstock itself. The total cost of *Jatropha curcas* as feedstock is the aggregate of all the capital and operating costs to produce *Jatropha curcas*, divided by the annual tonnage of the seeds produced. (It is not the objective of this report to determine the detailed direct and indirect costs that may be associated with the production of *Jatropha curcas*.)

Further research should therefore be done on the production and associated costs to produce *Jatropha curcas* seeds for biodiesel manufacturing in the Republic of South Africa.

3.5 COMPARISON BETWEEN MAIZE, SUNFLOWER, SOYBEAN, WHEAT AND *JATROPHA CURCAS* AS A FEEDSTOCK

Maize, sunflowers, soybeans, wheat and *Jatropha curcas* are compared in Table 3.5. The information in Table 3.5 was obtained from preceding figures and paragraphs. This table does not intend to suggest the best crop as feedstock for the manufacturing of biofuel. Excluding the income from by-products, the following remarks can be made about Table 3.5:

- Maize has the largest potential as a feedstock for bio-ethanol manufacturing, both on the basis of the average three-year annual production (8 903 000 tons) and the direct cost of feedstock per litre (R2.97 per litre). The total potential bio-ethanol that can be manufactured from all the maize that is produced in South Africa is 3 739 million litres. Maize is therefore a preferred feedstock for bio-ethanol to be blended in E10-fuel (10 per cent of bio-ethanol per litre of petrol) or E85-fuel (85 per cent of bio-ethanol per litre of petrol). South Africa consumes roughly 10 000 million litres of petrol per annum (Department of Minerals and Energy 2005:40), which means that 1 000 million litres of bio-ethanol are required for E10 fuel. In other words, 2 381 000 tons of maize are required for bio-ethanol manufacturing for E10 fuel.
- The Free State seems to be a relatively important province for the production of feedstock, since three of the largest feedstocks (tonnage wise) namely maize, sunflowers and wheat are produced mainly in this province. The Free State may therefore be the obvious choice for the location of a biofuel manufacturing plant.

Table 3.5 – Comparison between maize, sunflowers, soybeans, wheat and *Jatropha curcas* as a feedstock

Feedstock	Average three year production	Main production provinces	SAFEX price June 2006	Import parity price June 2006	Exchange rate June 2006	Conversion yield per ton of feedstock	Type of biofuel	Feedstock direct cost	Total potential biofuel
	1 000 tons	Province (percentage of total production)	Rand/ton	Rand/ton	Rand/US\$	Litres		Rand/litre	Million litres
Maize	8 903	Free State (34.0) North-West (25.5) Mpumalanga (24.3)	1 249	1 387	6.98	420	Bio-ethanol	2.97	3 739
Sunflower	608	Free State (41.4) North-West (40.9)	2 192	2 956	6.98	350	Biodiesel	3.91	340
Soybean	292	Mpumalanga (51.4)	1 747	2 272	6.98	260	Biodiesel	6.72	76
Wheat	1 686	Free State (30.5) Western Cape (33.5)	1 568	1 979	6.98	420	Bio-ethanol	3.73	708
<i>Jatropha curcas</i>	Not available	Not available	Not applicable	Not applicable	Not applicable	350	Biodiesel	Not available	Not available

- Soybeans at 260 litres of biodiesel per ton of feedstock and a direct cost of feedstock per litre of R6.72 perform relatively poor compared with other feedstocks. In this regard, however, it must be emphasized that income from the by-products of soybean feedstock is substantial.
- *Jatropha curcas* seeds yield roughly 350 litres of biodiesel per ton of feedstock. This yield is the same as for sunflowers. However, the total cost to produce one ton of *jatropha curcas* seeds as feedstock cannot be determined exactly at this stage. A *jatropha curcas* tree produces seeds productively for 35 years and therefore the total cost per ton of seeds may be relatively low. It should be noted that the by-products are not marketable as animal feed, but can only be used as organic fertilisers.

3.6 CLOSING REMARKS

Biofuel manufacturers would probably locate their manufacturing plants in the area where the crop to be used as their feedstock is produced in sufficient quantities. This is done to minimise transportation costs.

The direct cost of a certain crop as feedstock is mainly determined by the production quantities and import parity price of that crop. The import parity price is largely influenced by the Rand/US\$ exchange rate, as well as the basic international price of the crop, which is a result of international supply and demand. The conversion yield of the relevant feedstock has a large impact on the total cost per biofuel litre manufactured.

The various crops as feedstock also yield various marketable by-products such as glycerine for soap manufacturing, for the use in animal feeds, or organic fertiliser. The direct cost per litre of biofuel manufactured should therefore not be the only factor when deciding on which crop to use as feedstock. Income from the sale of by-products may, for instance, influence the profitability of a biofuel manufacturer substantially.

CHAPTER 4

BIOFUEL SALES

4.1 INTRODUCTION

The sale of biofuel is one of the most important aspects that influence a biofuel manufacturer's profitability. Sales as a value chain activity should therefore be managed properly. (See Figure 1.2 for a visual representation of the value chain activities of a biofuel manufacturer that affect on profitability.)

Biofuel sales are a function of the supply of, demand for and price of this product. In one respect, biofuel manufacturers are positioned closer to agriculture as an industry than the oil industry, because the direct cost of sales is primarily driven by the cost of agricultural feedstock. However, the selling price of biofuel is largely linked to the price of crude oil, since biofuel has, to a large extent, the same utility as petroleum fuel. An analysis of oil prices and oil production is therefore relevant to the objectives of this study. The market demand for biofuel in general and the total supply of biofuel by all biofuel manufacturers should greatly influence biofuel manufacturers' profitability. In this chapter, attention is paid to the prices of petroleum fuel and biofuel, which are largely the result of the supply of and demand for fuel.

4.2 FUEL PRICE AND CONSUMPTION

The petroleum fuel price is analysed focusing on the history of oil prices, oil demand, oil supply and economic forecasts.

4.2.1 Oil price

The price of oil, such as the North Sea Brent crude oil price, is given in US dollars per barrel. A description of the unit of measure is therefore relevant to an understanding of the price of fuel in the South African context.

4.2.1.1 Barrels, the measuring unit of oil

Barrels were used as containers in the 1860s when the oil industry started to flourish in the United States of America. The volumes of those initial barrels varied widely, which caused oil

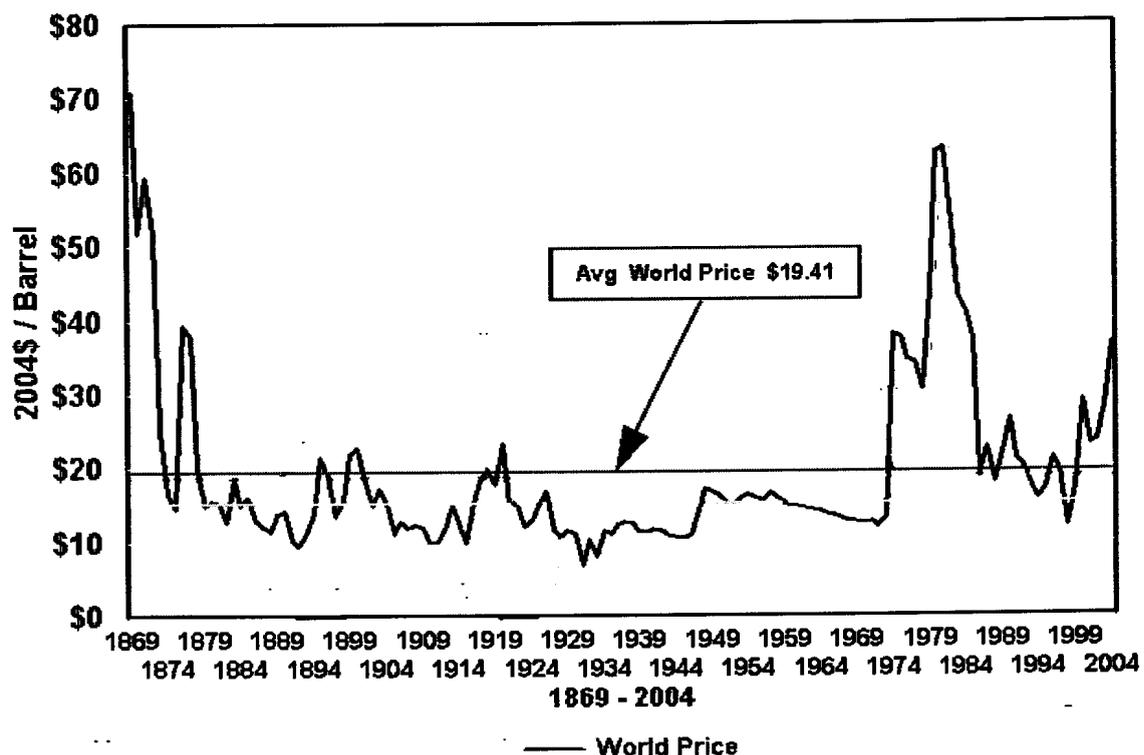
pricing to be problematic. In order to promote uniformity, the capacity of a barrel was set in 1870 at 42 gallons (Pees 2004:n.p.).

The Standard Oil Company of John D. Rockefeller largely dominated the early oil industry in the United States and in the world. Standard Oil painted their barrels blue. The prices were quoted in US dollars per blue barrel. The shortened form of barrel today is bbl, which still refers to Standard Oil's blue barrel. Today oil is no longer kept in barrels, but the price is still quoted in US dollars per barrel. So, for example, in South African terms a price of US\$70/bbl amounts to R3.08 per litre at R7/US\$ and 158.98 litres per barrel.

4.2.1.2 Trends in crude oil prices

The history of crude oil prices from 1869 to 2004 in 2004 US dollars is set out in Figure 4.1.

Figure 4.1 – Crude oil prices from 1869 to 2004 in 2004 US dollars



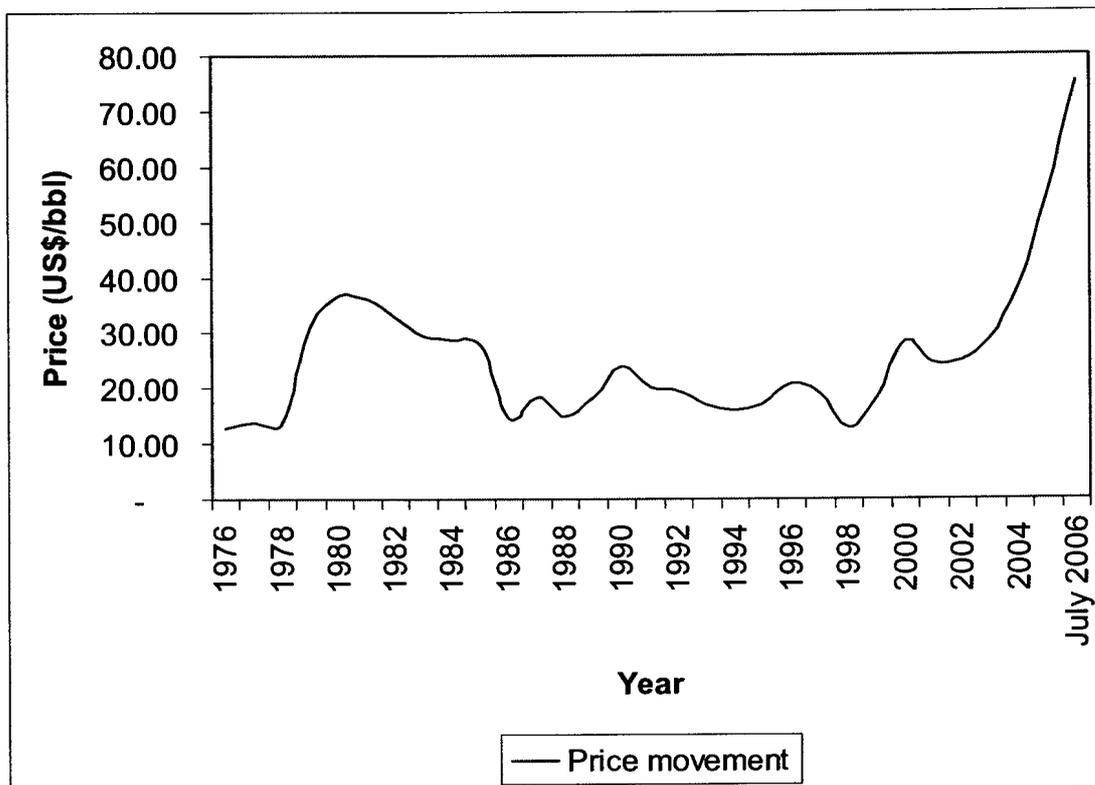
Source: WTRG Economics (2005:n.p.)

The graph in Figure 4.1 shows the price of oil from 1869 to 2004, expressed in 2004 US dollars. Over this period, the average world crude oil price was \$19.41/bbl. Prior to the 1870s oil was a highly valued and scarce commodity, primarily obtained from whales. The rich oil fields in the US Oil Region and Azerbaijan have been commercially exploited since the

mid-nineteenth century. This abundance of crude oil led to a decrease in the price of crude oil (Tarbell 1904; Mir-Babayev 2002:n.p.).

A new trend has, however, developed over the past few years: the price of oil has increased considerably. The price movement of North Sea Brent crude oil over the past 10 years is shown in Figure 4.2.

Figure 4.2 – North Sea Brent crude oil spot prices, 1976 to July 2006



Source: Adapted from BP 2006:16; WTRG Economics (2006:n.p.)

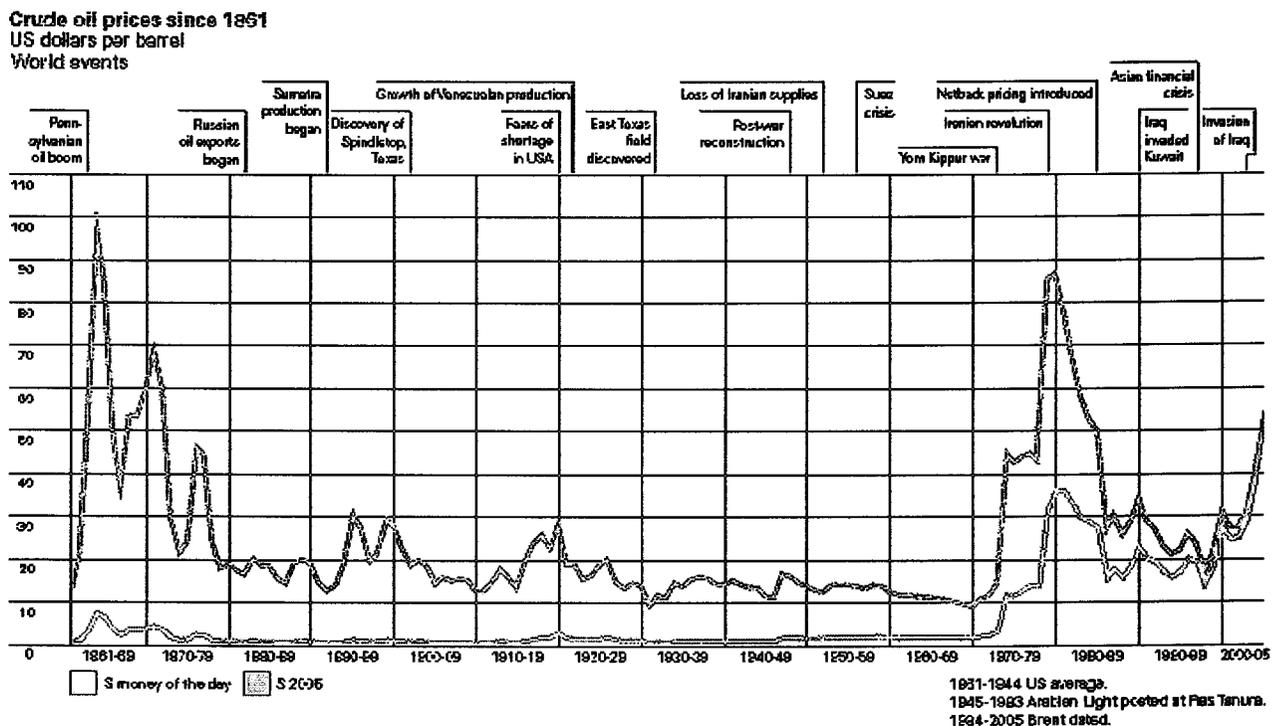
The North Sea Brent offshore oil platform commenced production in July 1976. The price of its crude oil at the time was US\$12.80/bbl. The price increased considerably, from US\$18/bbl in 1999 to \$76/bbl on 14 July 2006. The exact reasons for this considerable increase in the average price of oil are not known. One explanation may be high price setting at low volumes. This practice will protect oil companies' reserves and yield sustainable profits in the long run. This was also practised by the Organisation of the Petroleum Exporting Countries (OPEC). (Cowen 2000:10). To a large extent, fuel has become a necessity for economic survival and price increases are thus tolerated by the market.

Previous oil crises and price fluctuations can largely be attributed to particular world events. The impact of these events is discussed below.

4.2.1.3 The impact of world events on oil prices

World events may influence the supply of, demand for and price of fuel. Biofuel manufacturers should be aware that these types of events may influence their profitability. Aspects of the macro-environment are discussed in Chapter 7 and 8. The following graphs (Figures 4.3 to 4.8) from British Petroleum Plc (BP 2006a) and WTRG Economics (2005) show the impact of world events and OPEC production variances on oil prices.

Figure 4.3 – Major world events and oil prices, 1861 – 2005



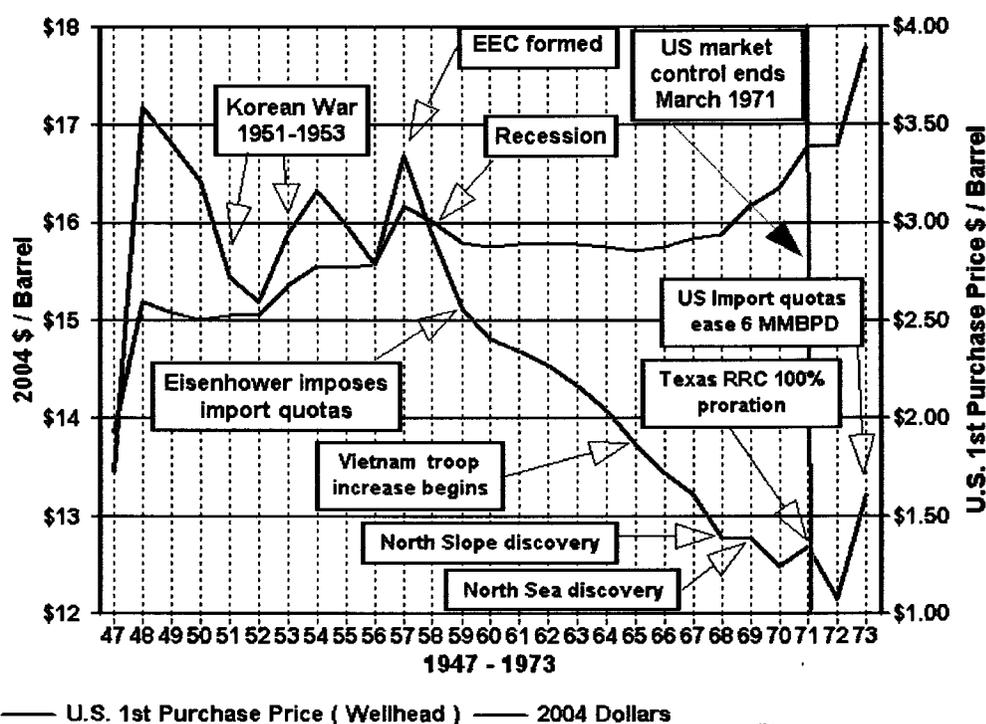
Source: BP (2006a:16)

The graph in Figure 4.3 shows the impact of selected world events from 1861 to 2005 on the 2005 US dollar oil price. The Arab oil embargo in 1973 and the Iranian Revolution in 1979 contributed to steep increases in the price of oil. These two events are respectively referred to as the world's first and second oil crisis. The third oil crisis resulted in a collapse in the oil price in 1986 after a considerable decline in oil prices from the high prices in the early 1980s. Oil producers became aware of the need for joint action if reasonable oil prices and market stability were to be achieved. This was achieved through oil production cuts. The outbreak of hostilities in the Middle East in the 1990s contributed to oil price increases in panicking markets. This fourth oil crisis was largely prevented through production output increases by OPEC members. The South East Asia economic downfall in 1998 caused oil prices to collapse again. A recovery was made thanks to OPEC and leading non-OPEC producers'

collective actions (OPEC 2006). Other events and oil production quotas also has an impact on the fuel price. These include the North Sea oil field discoveries in 1969, United States of America market control slacks in 1971 and 1982 and the 11 September 2001 terrorist attacks.

OPEC is a major role player in the oil industry. Increases and cuts in the OPEC production quotas imposed on its member countries have had a noticeable influence on the oil price. Detailed graphs indicating world events and crude oil prices are presented in Figures 4.4 to 4.8.

Figure 4.4 – World events and oil prices, 1947 – 1973

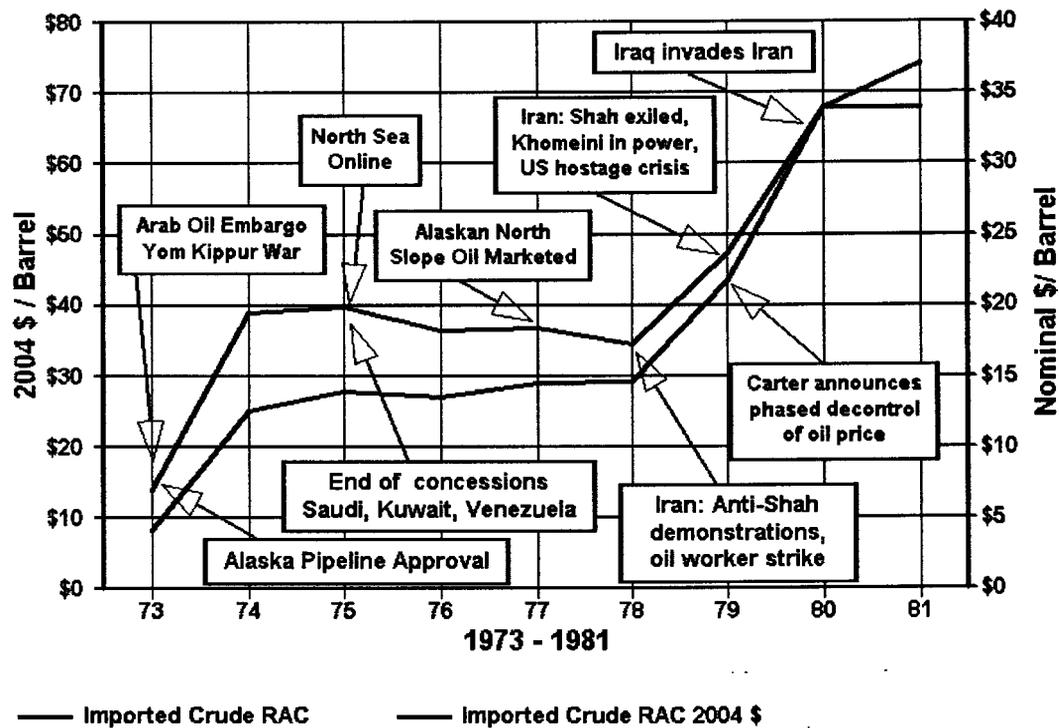


Source: WTRG Economics (2005:n.p.)

Figure 4.4 reveals the impact of selected world events from 1947 to 1973 on the 2004 US dollar real oil price. The Korean War, which lasted from 1951 to 1953, led crude oil prices to increase. The United States of America’s recession from around 1958 led to oil price decreases. Further decreases in the price of crude oil resulted from the North Slope and North Sea discoveries in 1968 and 1969. When the United States of America relaxed its control over oil markets in 1971, the price of crude oil decreased.

World events and crude oil prices during the period from 1973 to 1981 are shown in Figure 4.5.

Figure 4.5 – World events and oil prices, 1973 – 1981

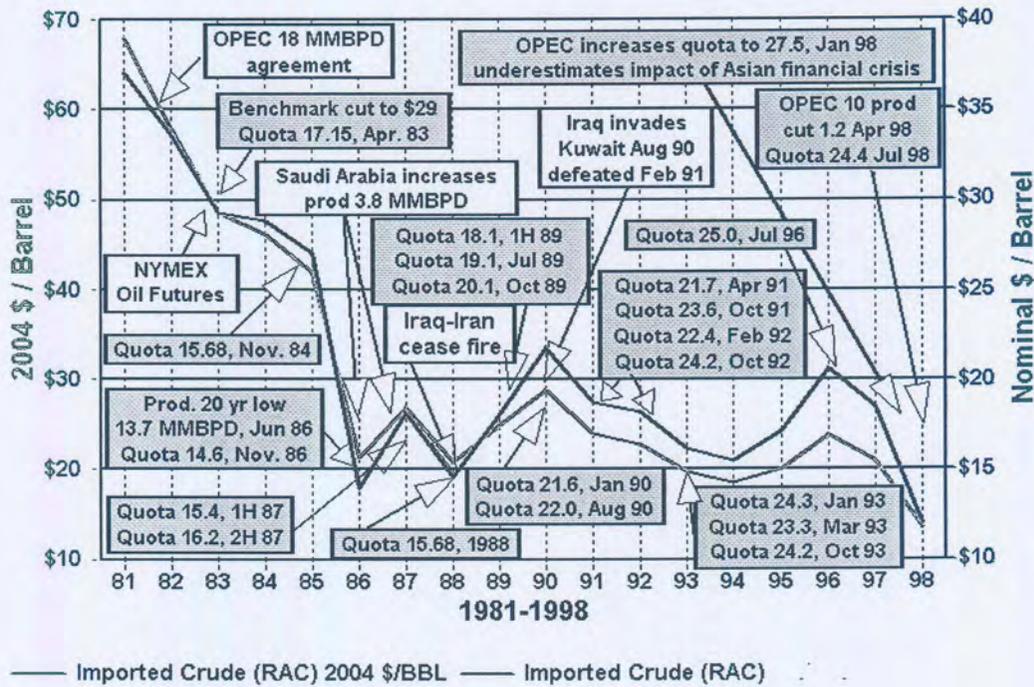


Source: WTRG Economics (2005:n.p.)

The graph in Figure 4.5 indicates the impact of selected world events on the 2004 US dollar oil price from 1973 to 1981. The Arab oil embargo of 1973 caused a rise in the price of crude oil. Brent oil production in the North Sea commenced in 1976 and North Slope marketed oil from 1977. These increases in oil production stabilised the oil price for a few years before the Iranian revolution in 1978 caused steep increases. World events in the period from 1981 to 1998 are shown in Figure 4.6.

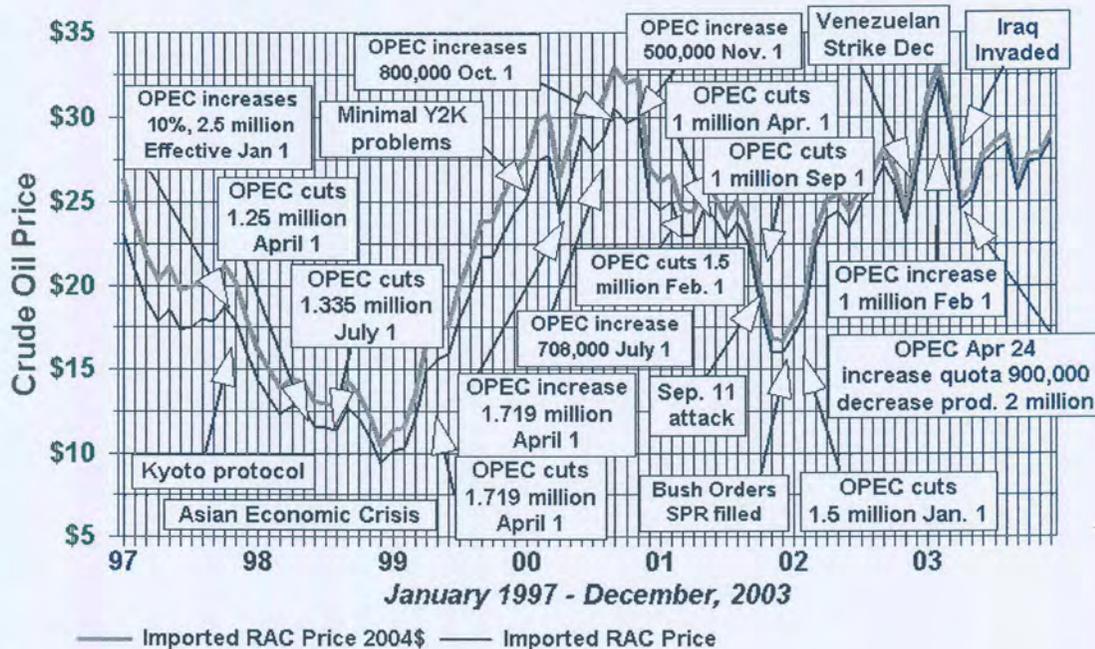
The impact of selected world events on the 2004 US dollar oil price from 1981 to 1998 is shown in Figure 4.6. OPEC realised the power it possessed and began to influence the international price of oil through several production increases and cuts by its member countries. OPEC supply increases and cuts and the influence on oil prices for the period from 1997 to 2003 are shown in Figure 4.7.

Figure 4.6 – World events and oil prices, 1981 – 1998



Source: WTRG Economics (2005:n.p.)

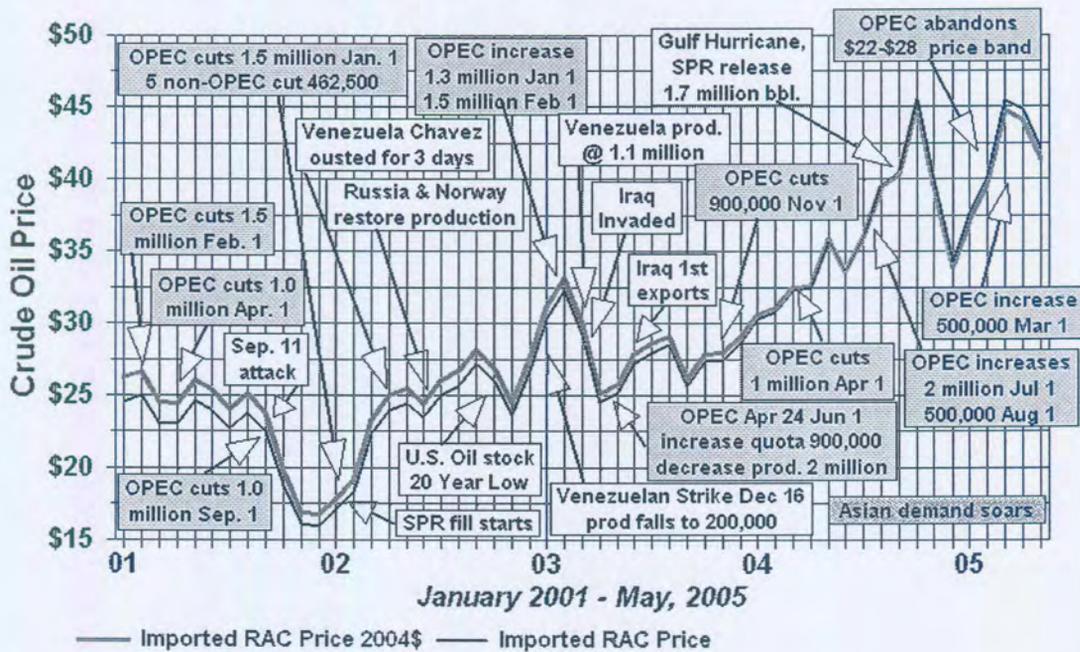
Figure 4.7 – World events and oil prices, 1997 – 2003



Source: WTRG Economics (2005:n.p.)

Figure 4.7 shows the impact of selected world events on the 2004 US dollar oil price from 1997 to 2003. The oil price was largely influenced by several OPEC supply increases and cuts. More world events from 2001 to 2005 are shown in Figure 4.8.

Figure 4.8 – World events and oil prices, 2001 – 2005



Source: WTRG Economics (2005:n.p.)

The graph in Figure 4.8 indicates the impact of selected world events on the 2004 US dollar oil price from 2001 to May 2005. The September 11 terrorist attacks, the Iraq war and various OPEC production increases and cuts influenced the oil price.

South African biofuel manufacturers' profitability is subject to world events and actions by organisations such as OPEC. Local biofuel manufacturers have no influence over these types of macro-environmental forces. However, biofuel manufacturers should be aware of the probability that events may occur that may impact on their profitability. These risks should be accounted for in a comprehensive risk management plan.

4.2.2 Oil demand

The demand for fuel at a certain price has a great impact on a biofuel manufacturer's profitability. Table 4.1 shows the global demand for oil at certain oil prices from 1965 to 2005.

Table 4.1 – Global oil demand at certain oil prices, 1965 – 2005

Year	Average world population	Change in average population	Annual oil consumption	Change in annual oil consumption	Peak oil price	Change in peak oil price
1	2	3	4	5	6	7
	Millions	Percentage	Billion barrels	Percentage	2005 US\$ per barrel	Percentage
1965	3 310	not available	11.39	not available	9	not available
1968	3 520	+6.3	14.25	+25.1	9	0
1971	3 750	+6.5	18.89	+32.6	15	+0.7
1974	3 990	+6.4	21.68	+14.8	59	+2.9
1977	4 200	+5.3	23.23	+7.1	42	-0.3
1980	4 410	+5.0	23.41	+0.8	88	+1.1
1983	4 650	+5.4	21.18	-9.5	63	-0.3
1986	4 890	+5.2	22.54	+6.4	36	-0.4
1989	5 150	+5.3	24.04	+6.7	34	-0.1
1992	5 400	+4.9	24.43	+1.6	30	-0.1
1995	5 610	+3.9	25.51	+4.4	25	-0.2
1998	5 870	+4.6	26.62	+4.4	18	-0.3
2001	6 140	+4.6	27.74	+4.2	31	+0.7
2004	6 410	+4.4	29.80	+7.4	55	+0.8
2005	6 490	+1.2	30.70	+3.0	61	+0.1

Source: Adapted from McKillop (2006:n.p.)

Table 4.1 *inter alia* reveals the average world population (Column 2), annual consumption (Column 4), and peak oil prices in US\$ per barrel (Column 6) for a given year (Column 1). The changes in the average world population (Column 3), annual consumption (Column 5) and peak oil prices (Column 7) are also shown. In 2005, a total of 30.7 billion barrels of oil were consumed by 6 490 million people. Even at a peak oil price of US\$61/bbl in 2005, oil consumption increased by 3.1 per cent from 2004 to 2005. The correlation coefficient between the annual oil consumption (Column 4) and the peak oil price (Column 6) can be calculated at 0.46. However, a negative correlation factor was expected. In other words, an increase in price should result in a decrease in consumption. Furthermore, the correlation coefficient between the annual oil consumption (Column 4) and the average world population (Column 2) is calculated at 0.92.

It is also evident from Table 4.1 that the increase in average oil consumption (Column 5) is not the result of lower peak prices (Column 7). For example, oil consumption increased by 4.4 per cent from 1992 to 1995, while the peak price of oil decreased by only 0.2 per cent. From 2004 to 2005, the increase in consumption was 3 per cent, and the peak price increased by 0.1 per cent as well. The positive correlations reveal that the increase in oil consumption is driven, by *inter alia* the increase in world population and a rise in living standards. Thus, the demand for oil seems relatively price inelastic and is therefore not very sensitive to variations in the price of oil.

4.2.3 Oil supply

Fossil oil is a diminishing natural resource. However, in the short term, the sustainable supply of fossil oil may have a negative impact on biofuel manufacturers' profitability. Information on the fossil oil reserves in the world is therefore relevant to this report. Current proven fossil oil reserves are shown by region in Table 4.2.

Table 4.2 – Proven oil reserves by region, 1985 to 2005

Region	1985		1995		2005	
	Billion bbls	percentage	Billion bbls	percentage	Billion bbls	percentage
North America	101.5	13.2	89.0	8.7	59.5	5.0
South and central America	62.9	8.2	83.8	8.2	103.5	8.6
Europe and Eurasia	78.6	10.2	81.5	7.9	140.5	11.7
Middle East	431.3	56.0	661.5	64.4	742.7	61.9
Africa	57.0	7.4	72.0	7.0	114.3	9.5
Asia Pacific	39.1	5.1	39.2	3.8	40.2	3.3
World	770.4	100.0	1 027.0	100.0	1 200.7	100.0

Source: BP (2006a:6)

From Table 4.2 it is clear that the proven oil reserves of North America (United States of America and Canada) have decreased by 41.4 per cent, from 101.5 billion barrels in 1985 to 59.5 billion barrels in 2005. North America now only has five per cent of the world's proven oil reserves. Africa's proven oil reserves increased by 100 per cent, from 57 billion barrels in 1985 to 114 billion barrels in 2005. Oil reserves in all other regions of the world increased from 1985 to 2005 as well. The total proven world oil reserve in 2005 is 1 200.7 billion barrels. This figure reveals a 55.9 per cent increase from 1985. The Middle East in 2005 had the most proven oil reserves in the world, at 742.7 billion barrels or 61.9 per cent of the total

proven world oil reserves. Proven oil reserves are shown according to OPEC membership in Table 4.3.

Table 4.3 – Proven oil reserves by OPEC membership, 1985 to 2005

OPEC membership	1985		1995		2005	
	Billion bbls	per cent	Billion bbls	per cent	Billion bbls	per cent
OPEC	535.8	69.5	785.1	76.4	902.4	75.2
Non-OPEC	234.6	30.5	241.9	23.6	298.3	24.8
World	770.4	100.0	1 027.0	100.0	1 200.7	100.0

Source: BP (2006a:6)

Table 4.3 indicates the portion of proven oil reserves under the control of OPEC members. From Table 4.3, it is clear that OPEC members controlled 535.8 billion barrels or 69.5 per cent of proven world oil reserves in 1985. Their control over the world's total proven oil reserves increased to 902.4 billion barrels or 75.2 per cent in 2005. Given the political risks that are sometimes associated with OPEC members, this relatively high percentage is concerning.

From Tables 4.2 and 4.3 it is evident that petroleum fuel can still be supplied in adequate quantities from the world's proven oil reserves. (Petroleum fuel as a competitive force in the biofuel industry is discussed in Chapter 6.)

The economic forecast on fossil oil supply and oil prices are reviewed below.

4.2.4 Economic forecasts on petroleum fuel

It is widely accepted that a country's economic growth depends, *inter alia*, on the availability of affordable fuel. The price of Brent crude oil, according to Figure 4.2, increased from around US\$12.70/bbl in 1998 to over US\$75/bbl in 2006. This 490 per cent nominal increase over the past eight years is relatively high and could therefore hamper economic growth. However, the estimated economic growth on the gross domestic product and forecasts for certain countries does not appear to be impaired. This is shown in Table 4.4.

Table 4.4 – Economic growth of certain countries on GDP basis, 1990 to 2006

Country / region	Gross domestic product						
	Average annual growth percentage		Actual annual growth percentage			Estimated annual growth percentage	
	1990-2000	2000-2004	2002	2003	2004	2005	2006
South Africa	2.1	3.2	3.5	3.0	3.5	5.0	4.0
Sub-Saharan Africa	2.5	3.9	3.4	4.0	4.8	Not available	5.7
Europe	2.1	1.3	1.0	0.7	2.0	1.7	2.0
World	2.9	2.5	1.9	2.8	4.1	4.7	4.9

Sources: Adapted from Worldbank (2006:n.p.); South African Reserve Bank (2006b:1); McKillop (2006:n.p.); US Central Intelligence Agency (2006:n.p.)

Table 4.4 shows the growth percentages in the gross domestic products for various years for South Africa, Sub-Saharan Africa, Europe and the world. South Africa's economic growth increased from an average growth rate of 2.1 per cent from 1990 to 2000, to five per cent in 2005. Sub-Saharan Africa's economic growth rate has increased steadily, from around 2.5 per cent during the period from 1990 to 2000, to an estimated 5.7 per cent in 2006. The world economic growth rate has increased from 1.9 per cent in 2002 to 4.7 per cent in 2005. The world economic growth rate, as shown in Table 4.4, was on average more than 2.5 per cent since 1990. McKillop (2006:n.p.) believes that economic growth was not seriously obstructed by increasing fuel prices. The relatively high fuel prices can therefore be expected to remain high in the foreseeable future. The risk to biofuel manufacturers that the price of fuel might decrease significantly is therefore relatively low.

It can be deduced from Tables 4.2 and 4.3 that the world's proven oil reserves have increased by 16.9 per cent over the ten years from 1995 to 2005. The growth in oil consumption over the same period can be deduced from Table 4.1, namely 19.2 per cent. Thus, the increase in oil consumption exceeds the increase in proven oil reserves. Furthermore, the world's current proven oil reserve of 1 200.7 billion barrels will be consumed within 39 years at a consumption rate of 30.7 billion barrels per annum. This period of 39 years excludes any growths in oil reserves and consumption. In the long run, petroleum fuel supply may not keep pace with global fuel consumption. The demand for biofuel will therefore increase steadily over time. This demand for biofuel is further increased

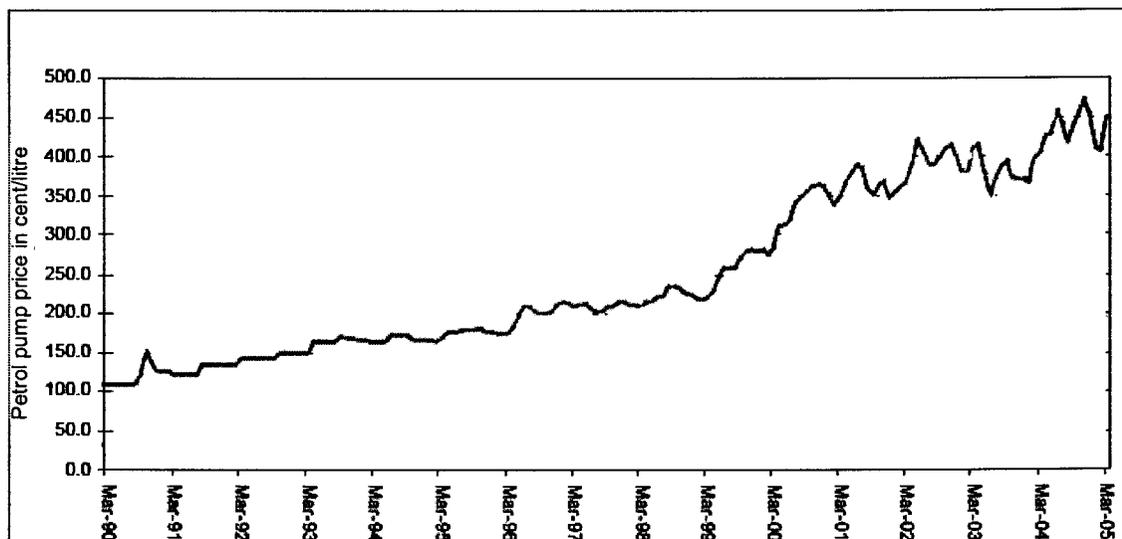
by governmental incentives to use biofuel to protect the environment, develop the local agricultural industry, and save on expensive fuel imports.

4.2.5 Fuel prices in the Republic of South Africa

The pump fuel price in the Republic of South Africa consists of an international element and a number of domestic elements. The international element, also referred to as the basic fuel price, is the import parity price of fuel. The import parity price is the cost a fuel importer would incur to import fuel from an international refinery. The main costs included in the basic fuel price are the fuel purchase price and transportation to a South African port. Other costs included in the basic fuel price are insurance against losses at 0.15 per cent of the free on board (FOB) and transportation costs; ocean loss allowance at 0.3 per cent of FOB, transportation and insurance; wharfage at R18.72 per kilo-litre of fuel; 25 days coastal storage at 2.132 cents per litre; and 25 days stock financing costs at the current prime rate less two per cent (Sasol 2005:1-3).

The domestic cost elements include transportation from the nearest harbour, delivery costs at the fuel depot, the oil companies' wholesale or marketing margin, the retail margin and slate levy, which are payable to the oil companies for the time delays in pump prices. Taxes and levies included in the fuel pumps price include an equalisation fund levy, fuel tax, a customs and excise levy, a road accident levy, and a slate levy (Sasol 2005:3-4). The South African petrol pump price history from March 1990 to March 2005 is shown in Figure 4.9.

Figure 4.9 – South African petrol pump price history, March 1990 to March 2005.



Source: Sasol (2005:6)

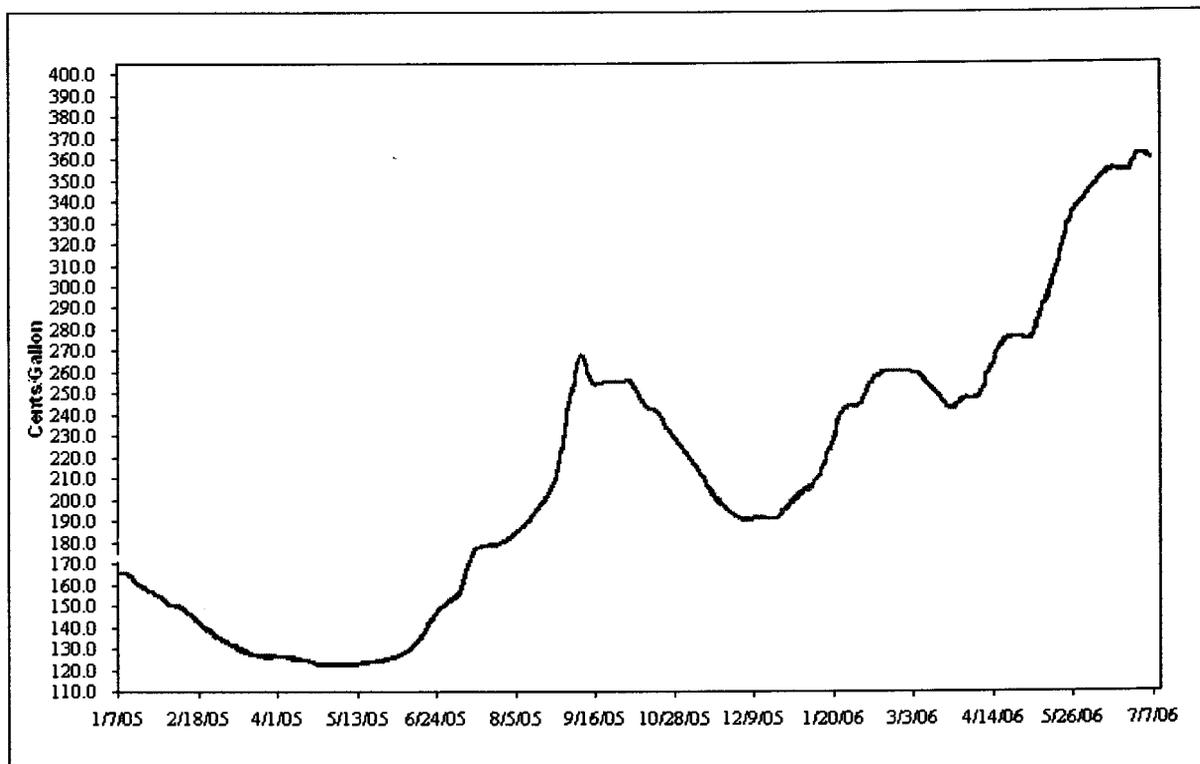
The changes in the petrol pump price in South Africa are indicated by the graph in Figure 4.9. From the graph it is clear that the pump price of petrol increased by roughly 350 per cent from around R1.00 in March 1990 to R4.50 in March 2005. The pump price of petrol has since increased further to around R7 per litre in 2006. This represents a further increase of 55.6 per cent. The trend of increasing petrol prices is a direct result of the increase in the cost of crude oil. The price of diesel is not regulated with regard to the retail margin; however, the cost elements are basically the same and the price trend is similar to that for petrol.

At this stage some remarks on the price of and demand for biofuel seem necessary.

4.3 BIOFUEL PRICE

The selling price of biofuel is an import variable which greatly influences biofuel manufacturers' profitability. The selling price movement of ethanol in Chicago (USA) in US cents per gallon from January 2005 to July 2006 is given in Figure 4.10.

Figure 4.10 – Ethanol market prices in Chicago, USA, January 2005 – July 2006



Source: California Energy Commission (2006:n.p.)

Figure 4.10 shows that the price of ethanol in Chicago was US\$1.65 per gallon in January 2005. In July 2006 the ethanol price increased to US\$3.60 per gallon. This represents an increase of 118.2 per cent over 19 months. In South African terms, US\$3.60 per gallon amounts to R6.65 per litre at R7 per US Dollar and 3.785 litres per gallon. The price of Brent crude oil, according to Figure 4.2, increased from approximately US\$47/bbl to US\$75/bbl over the same period. The growing demand for fuel and the rising oil price are probably the main reasons for the increase in the price of ethanol.

In South Africa, the current ethanol selling price is approximately R2.80 per litre. This price is based on the fuel price, excluding fuel levies. Ethanol Africa (Pty) Ltd estimated the price of bio-ethanol at R2.60 per litre in their business feasibility study (Van Burick 2006d:n.p.). As discussed in Section 2.1.3, the selling price of bio-ethanol should be between 51.4 per cent and 65.6 per cent of the basic cost of petrol per litre plus the wholesale and retail profit margins. This is due to its lower energy content, and therefore the lower utility, of bio-ethanol compared to petrol. At a pump price of R7 per litre of petrol, which includes all levies, the selling price of bio-ethanol should be between R2.34 per litre and R2.98 per litre. Furthermore, the selling price of bio-diesel in South Africa is currently equal to that of diesel produced from fossil oil (Van Burick 2006d:n.p.). However, the final biodiesel consumer may be willing to pay only between 82.5 per cent and 90.0 per cent of the price per litre of petroleum diesel, excluding taxes and levies. This is due to the lower energy content of biodiesel, compared to that of petroleum diesel. Lower energy content means less utility. At a pump price of R7 per litre of diesel, which includes taxes and levies, a biodiesel consumer may be willing to pay between R4.04 per litre and R4.41 per litre of biodiesel.

In Section 4.4, some remarks are made on perceptions of and the possible demand for biofuel by South African final consumers.

4.4 BIOFUEL DEMAND

Biofuel has been commercially manufactured for a number of years by countries such as the United States of America, Germany and Brazil. The practice of blending bio-ethanol into petrol and the use of biodiesel has been accepted by the final fuel consumers of these countries. Commercial manufacturing of bio-ethanol and biofuel is relatively new in the Republic of South Africa. However, it is clear that not much effort would be required to convince South African fuel consumers to accept the use of biofuel. The benefits that an oil-poor country, such as the Republic of South Africa, could gain from the use of biofuel are evident. The demand for biofuel is therefore expected to outgrow the demand for petroleum

fuel, especially if crude oil prices remain relatively high and global economic growth is maintained. As discussed in Section 3.5, enough maize feedstock is available for E10 fuel (10 per cent bio-ethanol in petrol). However, biofuel that replaces petroleum fuel requires more feedstock than is currently produced. A total of 23 809 000 tons of maize would be required to manufacture 10 000 million litres of petrol per annum, which is the current demand for petrol. Currently only 8 903 000 tons of maize are produced annually on average, which also has to meet the demand for maize as food. One option that counters this possible future shortage of maize as a feedstock for bio-ethanol is to increase the current area used for maize production. Environmental factors would have to be carefully considered, though.

4.5 CLOSING REMARKS

The increasing demand for fuel is driven by global economic growth, which contributes to relatively high fuel prices. Furthermore, the growth in fossil oil reserves has not kept pace with the growth in fuel consumption. South African biofuel manufacturers' sustainable profitability is thus promoted by current global economic trends, as well as by the benefits for a country from the use of biofuel.

CHAPTER 5

REVENUES FROM BY-PRODUCTS AND EXPENSES FOR BIOFUEL MANUFACTURERS

5.1 INTRODUCTION

The direct cost per ton of various types of feedstock was discussed in Chapter 3, and the sale of biofuel was discussed in Chapter 4. The gross profit can be calculated by subtracting the direct cost per litre of biofuel manufactured from the selling price per litre of biofuel. Comparing the gross profits per feedstock type to each other may not give a true reflection of the potential profitability of biofuel manufacturers. Revenues that may arise from the sale of the various by-products could be substantial. The sale of by-products is relevant to the objectives of this report and is therefore discussed briefly. A further brief discussion of the direct cost of additives and financing costs is also helpful. It should be noted that the various manufacturing processes using various feedstocks generally result in different by-products, yields and related expenses.

5.2 SALE OF BY-PRODUCTS

5.2.1 Animal feed as a by-product of biofuel manufacturing

Maize, sunflowers, soybeans and wheat as feedstocks for biofuel manufacturing have by-products which can be used as animal feeds and therefore have a market value. Product yields were discussed in Section 3.4. The revenues from the sale of these respective by-products to final consumers at retail prices are briefly discussed. Maize is examined first, followed by sunflowers, soybeans, wheat and *jatropha curcas*.

5.2.1.1 Animal feed as a by-product of maize

One ton of maize yields 330 kilograms of a by-product (see Section 3.4.1.2) that is suitable for animal feed. Hominy chop or meal is a mixture of the bran coating, the germ and a part of the starchy portion of the maize kernel. Hominy chop is a well-known substance in cattle, pig and chicken feed in South Africa. It was sold to final customers for approximately R1 200 per ton in September 2006 (Alzu Feeds 2006:n.p.; OTK 2006:n.p.). The by-product from maize as a feedstock for bio-ethanol manufacturing should contain more or less the same

nutritional value per kilogram as hominy chop. Any difference in the nutritional values may lead to adjustments to the selling price of this biofuel by-product. The biofuel manufacturer may therefore gain revenue from the sale of animal feed to the amount of R396 per ton of maize used as feedstock, or R0.94 per litre of bio-ethanol manufactured. This revenue should be compared to the revenue from sunflower oil cake, which is discussed below.

5.2.1.2 Animal feed as a by-product of sunflowers

Sunflower oil cake retailed for R1 600 per ton in September 2006 (Alzu Feeds 2006:n.p.; OTK 2006:n.p.). Oil cake is used as a substance in animal feed by meat and dairy producers. Biofuel manufacturers may have revenues from the sale of 620 kilograms of sunflower (see Section 3.4.2.2) oil cake to the amount of R992 per ton of sunflower feedstock or, stated differently, R2.83 per litre of biodiesel manufactured. (Shaval BioDiesel 2006:n.p.). Soybean oil cake, which is also a by-product of biodiesel manufacturing, is considered below.

5.2.1.3 Animal feed as a by-product of soybean

Soybeans as a feedstock in biofuel manufacturing may yield 800 kilograms of animal feed per ton of soybeans used (see Section 3.4.3.2). In September 2006, soybean oil cake sold for roughly R2 300 per ton (Alzu Feeds 2006:n.p.; OTK 2006:n.p.). This amount is relatively high, since this animal feed has high nutritional values and is sought after by meat and dairy producers. Biofuel manufacturers can therefore expect revenue from the sale of soybean oil cake to the amount of R1 932 per ton of soybeans used in manufacturing biofuel, or R7.07 per biodiesel litre manufactured.

5.2.1.4 Animal feed as a by-product of wheat

Wheat bran is a well-known type of animal feed in South Africa. It sold for R900 per ton in September 2006 (Alzu Feeds 2006:n.p.; OTK 2006:n.p.). It is assumed that the 330 kilograms of by-product from wheat as feedstock has the same nutritional value per unit as wheat bran and therefore has the same selling price (see Section 3.4.4.2). Revenue from the sale of the wheat animal feed by-product is R297 per ton of wheat used in the manufacturing process, or R0.71 per litre of bio-ethanol manufactured.

Another valuable by-product that results from the biodiesel manufacturing process is glycerine. Glycerine is therefore discussed briefly below.

5.2.2 Glycerine as a by-product of biodiesel manufacturing

Glycerine is a substance found in sunflowers, soybeans and *jatropha curcas* seeds and is therefore a by-product of biodiesel manufacturing. Glycerine can be used in several applications, such as an agent in cattle dip, detergents, various pharmaceuticals, tobacco and some foods (ICIS pricing 2006a:n.p.). A biofuel manufacturer that produces relatively large quantities of glycerine may consider horizontal integration by processing the glycerine further into marketable products, such as cattle dip or soap. However, this would constitute a new business with its own strategies, markets and financial requirements. Biofuel manufacturers should consider whether or not they have the capabilities they require to venture into this new industry. (The biofuel manufacturer under discussion in this report is only active in the biofuel industry, where it enjoys certain competitive advantages due to its distinct competencies. The competitive advantages and competencies of this biofuel manufacturer are discussed in Chapter 6.) Another option is selling the glycerine to other manufacturers. These manufacturers then use glycerine as an additive or raw material in manufacturing or processing their products.

Glycerine in liquid form is sold in drums or in bulk. Drums are used for quantities between 20 and 100 tons. Glycerine in bulk is sold in units of 500 tons. A biofuel manufacturer would normally not produce such large quantities of glycerine and would therefore most probably sell in drums. The international spot price of glycerine per drum is between €550 (Euros) per ton and €600 per ton or GBP360 (Great Britain Pound) per ton to GBP390 per ton. In South African terms, this translates to an average selling price of between R4 860 per ton and R5 520 per ton at exchange rates of R13.50/GBP1 and R9.20/€1 (ICIS pricing 2006b:n.p.). (Costs associated with the selling of glycerine, such as transportation and customs and excise, are excluded for purposes of this report.)

5.2.2.1 Glycerine as a by-product of sunflower and soybean processing

Sunflower seeds contain 18 per cent glycerine (Shaval BioDiesel 2006:n.p.). A biodiesel manufacturer that uses sunflower as feedstock may have revenues from glycerine of between R874.80 per ton and R993.6 per ton of sunflowers used. This implies revenues of between R2.50 per litre and R2.84 per litre (at an average of R2.67 per litre) of biodiesel manufactured from sunflowers. Glycerine yields from soybeans are also roughly 18 per cent per ton of feedstock (Shaval BioDiesel 2006:n.p.). The revenue from glycerine from soybeans is therefore also between R874.80 per ton and R993.6 per ton of soybeans used.

At the lower biodiesel litres yield per ton of feedstock, this comes to between R3.36 per litre and R3.82 per litre (at an average of R3.59 per litre) of biodiesel manufactured.

5.2.2.2 Glycerine as a by-product of *Jatropha curcas* processing

Jatropha curcas seeds contain seven per cent glycerine (Parsons 2005:n.p.). This translates to 70 kilograms of glycerine per ton of feedstock or 560 kilograms of glycerine per hectare of *Jatropha curcas* cultivated at eight tons per hectare. Such a glycerine yield would generate revenue of between R340.20 per ton and R386.4 per ton of *Jatropha curcas* seeds or between R0.97 per litre and R1.10 per litre (at an average of R1.04 per litre) of biodiesel manufactured.

Organic fertiliser is also a by-product from *Jatropha curcas* seeds used in biodiesel manufacturing. This by-product from *Jatropha curcas* is not suitable as animal feed because it contains toxic elements. This by-product can therefore only be used as organic fertiliser, as discussed below.

5.2.3 Organic fertiliser as a by-product of biofuel manufacturing

5.2.3.1 Organic fertiliser as a by-product of *Jatropha curcas* processing

The by-products of *Jatropha curcas* seeds in biofuel manufacturing are toxic to humans and animals. These by-products can therefore either be used as an organic fertiliser for the *Jatropha curcas* trees, or sold as organic fertiliser. There is currently not a high demand for *Jatropha curcas* organic fertiliser and a relatively small customer segment should be focused on. Furthermore, the revenue from the sale of the organic fertiliser and the cost to fertilise the trees may be equal. Due to a lack of information on the revenue from the sale of *Jatropha curcas* organic fertilisers, they are not discussed in this report.

In the manufacture of biofuel, biofuel manufacturers have to incur certain expenses. In this regard, the cost of methanol, caustic soda, biofuel additives and financing costs are discussed briefly in the sections below.

5.3 EXPENSES RELATED TO THE MANUFACTURE OF BIOFUEL

Methanol, caustic soda and biodiesel additives are the main complementary products used in the manufacture of biodiesel. Because only limited information is available on the costs of yeast and enzymes used in bio-ethanol manufacturing, they are not discussed here.

5.3.1 Methanol used in biodiesel manufacturing

Methanol (CH_3OH), in quantities of 180 litres per 1 000 litres of biodiesel, is added during the manufacturing process. At a cost of approximately R3 per litre of methanol, the cost of methanol per litre of biodiesel manufactured is R0.54 per litre (Shaval Biodiesel 2006:n.p.).

5.3.2 Caustic soda used in biodiesel manufacturing

Caustic soda (NaOH) is added in the manufacturing process in quantities of 5 kilogram per 1 000 litres of biodiesel. Caustic soda costs \pm R5 per kilogram. The cost of caustic soda therefore amounts to R0.03 per litre of biodiesel manufactured (Shaval BioDiesel 2006:n.p.).

5.3.3 Biodiesel additives used in biodiesel manufacturing

Biodiesel can be used without additives or substances that enhance biodiesel attributes. However, if the biodiesel needs to be stored for periods longer than six months or the biodiesel is to be used in very cold conditions, at least one additive is required. This biodiesel additive may be acquired from Shaval BioDiesel (Pty) Ltd, and it costs R0.07 per litre of biodiesel manufactured.

5.3.4 Financing cost in manufacturing biodiesel

The financing costs normally consist of the interest a biofuel manufacturer pays on loans to finance capital investments. The finance costs in year one for various biodiesel plant capacities that use sunflowers as feedstock are shown in Table 5.1. Table 5.1 should be read in conjunction with Section 2.4.4, which gives detailed information on the capital items and the respective investments required.

Table 5.1 – Calculation of estimated finance cost in year one for various biodiesel plant capacities using sunflowers as a feedstock

Capital investment (100 per cent loan at 15 per cent interest)	Finance period Months	1 000 litre per day plant			2 000 litre per day plant			4 000 litre per day plant		
		Capital investment	Finance costs in year one		Capital investment	Finance costs in year one		Capital investment	Finance costs in year one	
		Rand	Rand	Percentage	Rand	Rand	Percentage	Rand	Rand	Percentage
1	2	3	4	5	6	7	8	9	10	11
Land and buildings	240	380 000	56 782	25.8	380 000	56 782	19.8	380 000	56 782	14.0
Feedstock equipment	60	86 000	12 487	5.7	156 000	22 650	7.9	296 000	42 977	10.6
Biofuel equipment	60	560 000	81 308	37.0	705 000	98 902	34.6	862 000	120 927	29.8
Storage	36	96 000	12 569	5.7	192 000	25 239	8.8	384 000	50 277	12.4
Vehicles	60	250 000	35 072	16.0	300 000	42 086	14.7	400 000	56 115	13.8
Working capital		126 000	18 900	8.6	252 000	37 800	13.2	504 000	75 600	18.7
Other	36	20 000	2 619	1.2	20 000	2 619	0.9	20 000	2 619	0.6
Total		1 518 000	219 737	100.0	2 005 000	286 078	100.0	2 846 000	405 297	100.0
Total finance cost per litre in year one with 360 manufacturing days			0.61			0.39			0.28	
Biofuel equipment finance cost per litre in year one with 360 manufacturing days			0.23			0.14			0.08	

Table 5.1 shows the calculated finance costs (Columns 4, 7 and 10) for the various capital investments (Column 1) in the first year of their respective financing periods (Column 2). Columns 3, 6 and 9 show the respective capital investments for each capital investment category (Column 1) as discussed in Section 2.4.4. It is assumed that all the capital investments are financed through 100 per cent loans at 15 per cent interest per annum. The finance cost is largest at R81 803 (37.0 per cent) for biofuel equipment with a capacity of 1 000 litres per day, R98 902 (34.6 per cent for a 2 000 litres per day plant) and R120 927 (29.8 per cent for a 4 000 litres per day plant). The second highest finance cost for the 1 000 and 2 000 litre per day plants is the interest on the loans to acquire land and buildings, at R56 782 (25.8 per cent and 19.8 per cent respectively). For the 4 000 litre per day plant, the second highest finance cost relates to financing working capital, at R75 600 (18.7 per cent). The total finance cost that a biodiesel manufacturer may expect to pay is R219 737 for the 1 000 litre per day plant, which requires an investment of R1 518 000, or R286 078 (for the 2 000 litre per day plant, requiring R2 005 000) or R405 297 (for the 4 000 litres per day plant, requiring R2 846 000). The total finance costs for the different plant sizes that a biodiesel manufacturer may expect to pay per litre of biodiesel manufactured increases by 39 per cent from R0.28 per litre (for the 4 000 litre per day plant) to R0.39 per litre (for the 2 000 litre per day plant). A biofuel manufacturing plant with a capacity of 1 000 litres per day have a finance cost in the first year of R0.61 per litre manufactured. The economy of scale concept is clearly evident from these figures.

A sunflower farmer who manufactures biodiesel may only need to acquire the biofuel equipment. That farmer may therefore expect a finance cost of R0.23 per litre of biodiesel for a 1 000 litre per day plant that operates 360 days per annum; R0.14 per litre of biodiesel (for the 2 000 litre per day plant); or R0.08 per litre of biodiesel (for the 4 000 litre per day plant). Opportunity costs that may result from biodiesel manufacture should be taken into consideration by the sunflower farmer.

5.4 SUMMARY OF SALES AND EXPENSES IN BIOFUEL MANUFACTURING

Feedstock is one of the most significant aspects of a biofuel manufacturer's business. The choice of feedstock directly affects the sales of biofuel and by-products, as well as the cost of feedstock and other direct expenses. A summary of the sales and costs per litre of biofuel per feedstock type is given in Table 5.2.

Table 5.2 – Summary of sales and direct costs per litre of biofuel manufactured from various feedstock types

Element of profit	Bio-ethanol from maize	Biodiesel from sunflowers	Biodiesel from soybeans	Bio-ethanol from wheat	Biodiesel from <i>Jatropha curcas</i>
1	2	3	4	5	6
	Rand per litre of biofuel manufactured				
Sales: biofuel	2.80	4.28	4.28	2.80	4.28
Sales: animal feed	0.94	2.83	7.07	0.71	0.00
Sales: glycerine	0.00	2.67	3.59	0.00	1.04
Sub-total 1	3.74	9.78	14.94	3.51	5.32
Cost of feedstock	3.00	6.35	7.49	4.28	Not available
Cost of enzymes and yeast	Not available	0.00	0.00	Not available	0.00
Cost of methanol	0.00	0.54	0.54	0.00	0.54
Cost of caustic soda	0.00	0.03	0.03	0.00	0.03
Cost of additives	Not available	0.07	0.07	Not available	0.07
Sub-total 2	3.00	6.99	8.13	4.28	0.64
Contribution to gross profit (Sub-total 1 less Sub-total 2)	0.74	2.79	6.81	-0.77	4.68
Net direct cost(-) / income(+) (Excluding Sales: Biofuel)	-2.06	-1.49	+2.53	-3.57	+0.4

Table 5.2 shows the direct sales per litre and costs per litre of biofuel manufactured (Column 1) from the feedstocks maize (Column 2), sunflowers (Column 3), soybeans (Column 4), wheat (Column 5) and *jatropha curcas* seeds (Column 6). From Table 5.2 it is evident that, currently, biodiesel has a 52.8 per cent higher selling price than bio-ethanol. Biodiesel is currently sold as diesel at the basic price of diesel, which is R4.28, according to Table 7.2. Bio-ethanol is sold as ethanol, and it is therefore not sold at the basic price of petrol. The basic price of petrol is roughly R3.91, according to Table 7.1, which is R1.11 higher than the price of ethanol. A bio-ethanol manufacturer who sells bio-ethanol as petrol should conform to the standards of petrol, as discussed in Section 7.3.4.1. This requires that such a manufacturer must sell biofuel at the regulated price of petrol. Animal feed is sold at the retail prices of the various animal feeds sold to final consumers. The cost of feedstock is the SAFEX price per ton on 26 August 2006.

From Table 5.2 it is evident that soybeans give the highest contribution to gross profit, at R6.81 profit per litre of biodiesel, and wheat gives the lowest at a R0.77 loss per litre. The main reason for this is probably the sale of animal feed. Soybeans yield roughly 800 kilograms of animal feed at a relatively high retail price of R2 300 per ton. *Jatropha curcas* seeds are the second most profitable, at R4.68 per litre of biodiesel. However, this amount excludes the cost of *jatropha curcas* seed production. It can be assumed that the total production cost per ton of *jatropha curcas* seeds is lower than that of the other feedstock types. This can be assumed since the biofuel yield per ton of feedstock is 350 litres, which is the same as for sunflowers, but the yield per hectare is much higher than that of sunflowers. Sunflowers yield around 560 litres per hectare, while *jatropha curcas* yields 3 000 to 6 000 litres per hectare.

A feedstock producer who intends to manufacture his/her own biodiesel should compare the net direct cost to manufacture the biodiesel with the cost of petroleum diesel. (This is discussed in more detail in Section 5.5.)

5.5 COMPARISON BETWEEN THE NET DIRECT COST OF BIODIESEL AND THAT OF PETROLEUM DIESEL

A farmer or group of farmers who intend to manufacture biodiesel for their own consumption in farming operations should compare the net direct cost to produce biodiesel with the cost of petroleum diesel. The net direct cost is the total direct cost less the revenue from the sale of the by-products. According to Table 5.2, the net direct cost to manufacture diesel from sunflowers is R1.49 per litre. Manufacturing biodiesel from soybeans will result in a net direct

income of R2.53 per litre, due to the high sales value of the by-products. Biodiesel manufactured from *Jatropha curcas* seeds results in a net direct income of R0.40 per litre. However, this R0.40 per litre excludes the cost to acquire the *Jatropha curcas* seeds. The respective amounts should be compared to the cost of petroleum diesel.

A breakdown of the costs of petroleum diesel is presented in Table 7.2. Table 7.2 shows that the cost of petroleum diesel excluding the retail margin was R6.34 per litre on 6 September 2006. Assuming that the average retail margin is R0.50 per litre, the cost of petroleum diesel on 6 September 2006 was R6.84 per litre. The retail margin is not regulated and therefore differs from diesel supplier to diesel supplier. A farmer may claim back the fuel tax of R1.00 per litre (South African Revenue Services 2006:n.p.) if the diesel was used in farming operations. The cost of petroleum diesel to the farmer is therefore R5.84 per litre. This R5.84 per litre is R4.39 per litre or 291.9 per cent higher than the net direct cost of biodiesel manufactured from sunflowers. It is R8.37 per litre higher than the net direct income from biodiesel manufactured from soybeans. Compared to the net direct income from biodiesel manufactured from *Jatropha curcas*, petroleum diesel is R6.24 per litre more expensive. It should be noted that the net direct cost excludes the amortised capital investment and financing costs per litre of biodiesel manufactured. These two costs are relatively fixed for a certain process and the cost per litre therefore varies according to the actual quantity of biofuel manufactured.

5.6 CLOSING REMARKS

From the preceding sections it is clear that revenue from the sale of the by-products has a material influence on the decision on which feedstock to use. For example, the income from the sale of biodiesel manufactured from soybeans is relatively low. This is due to the relatively low biofuel yield rate of 260 litres compared to that from other feedstocks, such as sunflowers (350 litres per ton) and *Jatropha curcas* (350 litres per ton). (See Table 3.5 for a breakdown of feedstock properties.) However, the income from the sale of the by-products from soybeans, oil cake and glycerine, is substantially higher than from the sale of by-products from the other feedstocks. Revenues from by-products is R10.66 per litre of biodiesel manufactured from soybeans, which is more than the R5.50 per litre of sunflowers' animal feed and glycerine by-products, R0.94 per litre of maize's animal feed by-products and R1.04 per litre from *Jatropha curcas*'s glycerine by-product. This is due to the biofuel yield ratios and the quantity and nutritional value of the oil cake. All the grains that are used as feedstock yield a by-product that is, *inter alia*, suitable for animal feed. *Jatropha curcas* seeds contain toxic elements and therefore have no marketable value as animal feed.

The cost of feedstock and process additives, such as methanol, caustic soda and biofuel additives, and the finance costs per litre of biodiesel manufactured collectively form a relatively substantial portion of the total cost of biodiesel manufactured. Although the total cost per litre of biofuel may seem relatively high, a farmer who manufactures his/her own biodiesel for use in farming operations instead of purchasing petroleum diesel may be financially better off.

PART III

COMPETITION IN THE BIOFUEL INDUSTRY

CHAPTER 6: COMPETITIVE FORCES AND STRATEGIES

CHAPTER 6

COMPETITIVE FORCES AND STRATEGIES

6.1 INTRODUCTION

Competition in the context of this report refers to actions taken by various entities in the biofuel industry to outperform other role players or to gain a competitive advantage over others. It also refers to the opposition that a biofuel manufacturer may receive from other entities for following certain business strategies. Biofuel manufacturers operate in an industry with several competitive forces (see Section 6.2) which may have an impact on their profitability. The relationship and interaction between forces such as strategies, value chain activities, and the macro-environment on the one hand, and the competitive forces on the other, is represented in Figure 1.1.

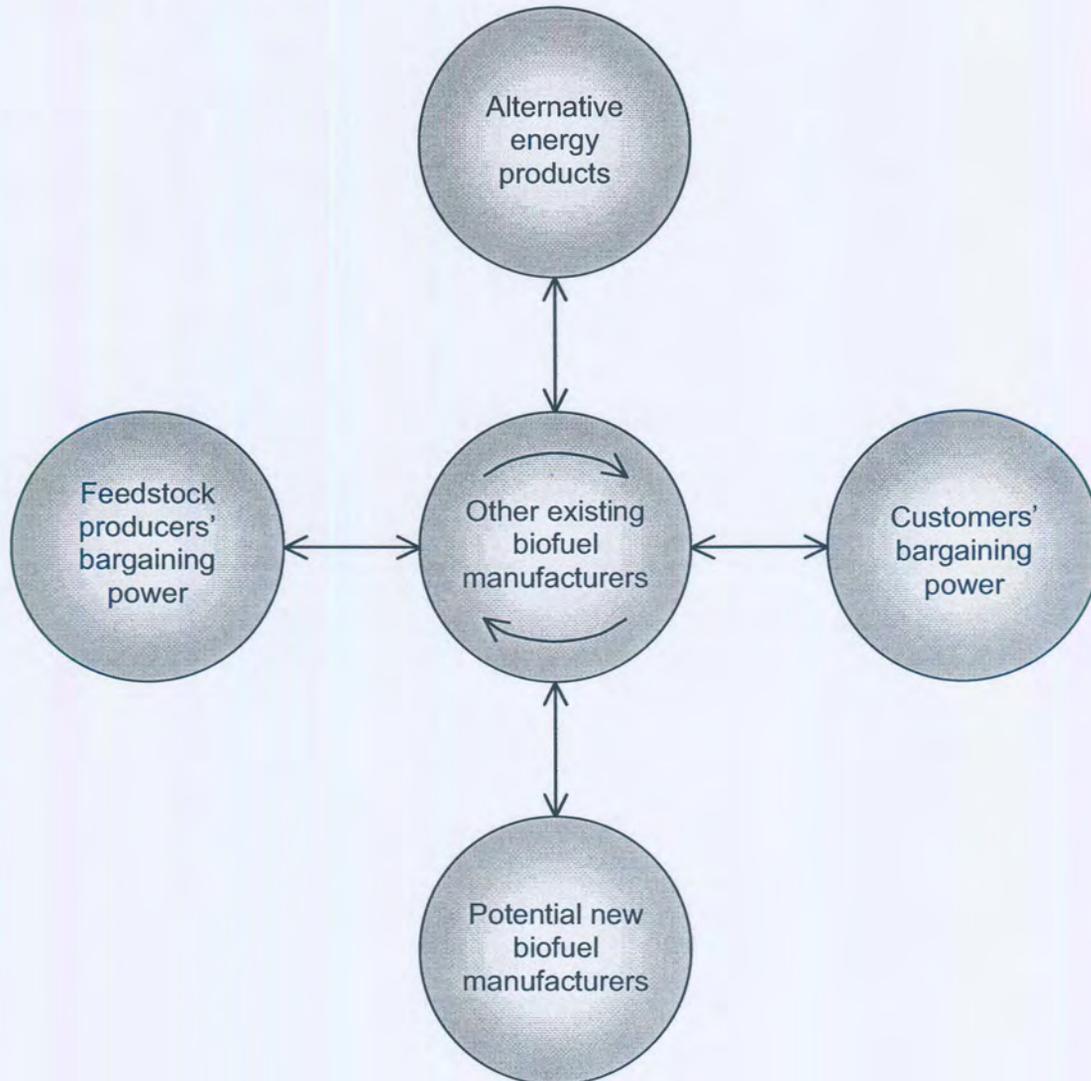
This chapter focuses on competitive forces in biofuel manufacturers' external environment which may exert pressure on their profitability. Biofuel manufacturers can counteract these competitive forces by employing a number of competitive strategies. These strategies aim to gain competitive advantages for biofuel manufacturers. They are discussed in Section 6.3.

6.2 COMPETITIVE FORCES

The main groups of competitive forces in the biofuel industry are other existing biofuel manufacturers, potential new biofuel manufacturers, alternative energy products, feedstock producers and customers. Section 6.2 is based mainly on the work by Thompson *et al.* (2005:50-68).

The five competitive forces in the biofuel industry are presented visually in Figure 6.1 below.

Figure 6.1 – Five forces of competition in the biofuel industry



Source: Adapted from Thompson *et al.* (2005:51)

Figure 6.1 indicates the competitive forces in the biofuel industry. The arrows indicate the pressures that the different entities or groups exert on each other in order to gain competitive advantages. The five forces of competition, namely other existing biofuel manufacturers, potential new biofuel manufacturers, alternative energy products, feedstock producer bargaining power and customer bargaining power, are discussed below. It should be noted that there may also be pressures that are exerted between these other entities that do not directly involve biofuel manufacturers. For example, fuel customers may also exert pressure on alternative energy products. This pressure is not indicated by an arrow in Figure 6.1, because the interactions between those external entities fall beyond the scope of this report and are therefore not discussed.

6.2.1 Other existing biofuel manufacturers

The competition for market share amongst competing biofuel manufacturers is probably the strongest of the five forces of competition. Biofuel manufacturers should therefore continuously employ offensive and defensive strategies. This is done to obtain a better market position, increased sales, an increased market share and a unique competitive advantage.

Strategies to outmanoeuvre competing biofuel manufacturers may include lower prices, better product performance, higher quality, and a stronger brand image and appeal. Other strategies may include bigger or better distribution networks and better customer service capabilities. The intensity of competition between existing biofuel manufacturers may indicate which strategies to employ.

At present, competition in the biofuel industry of South Africa is relatively weak, for the following reasons:

- the demand for biofuel in South Africa has not yet grown because blending ethanol into petroleum fuel has not yet become compulsory;
- there are not many biofuel manufacturers in South Africa yet; and
- the commercial manufacture of biofuel only became viable in recent years when the average price of crude oil increased to more than US\$70 per barrel.

It is therefore to be expected that potential new biofuel manufacturers will enter the biofuel industry in the foreseeable future.

6.2.2 Potential new biofuel manufacturers

The relatively uncomplicated nature of biofuel manufacturing may result in a large pool of potentially new entry candidates. Some of these entrants, such as existing oil companies and Ethanol Africa Ltd, referred to in Section 2.4.3, may have the financial resources and capabilities to be formidable market contenders.

The entry barriers to biofuel manufacturing in South Africa are relatively low. This is due to the factors that necessitate the localised manufacturing of biofuel, such as farmers that need new markets for their crops, and the desire to improve the country's balance of payments by not importing expensive oil. If legislation makes the use of biofuel compulsory, then the biofuel market should increase substantially. Furthermore, the current price of fuel is

relatively high, due to the high oil price of more than US\$70 per barrel. Therefore, new entrants to the biofuel manufacturing industry can most probably expect relatively high profits.

Large oil companies, such as BP and Sasol, are doing research and profitability studies on biofuel manufacturing to ensure their long-term sustainability (BP 2006b:n.p.; Van Burick 2006a:n.p.). One of the keys to profitability is the availability and sustainability of feedstock in sufficient quantities. Furthermore, a biofuel plant should be located as close as possible to the feedstock producing area in order to minimise the cost of transport. Therefore, the large oil companies will not be able to dominate the biofuel market easily.

An economic feasibility study performed by Ethanol Africa indicated that a biofuel plant reaches its manufacturing optimum at 180 million litres per annum. The manufacturing optimum refers to the lowest total cost per litre produced (Van Burick: 2005a:n.p.). This relatively small plant size may be a managerial burden for large oil companies, which normally operate a few very large capacity refineries. The economies of scale for a biofuel plant may not compare well to their relatively large crude oil refineries. Furthermore, biofuel may be only one of several alternative sources of energy in which large oil companies may invest for long-term sustainability. It should be noted that this situation might change in future, when proven fossil oil reserves become too low for sustainable profitability.

It is, for instance, known that Sasol is considering establishing a manufacturing plant capable of producing 100 000 tons of biodiesel per annum. One kilogram of biodiesel is more or less equal to one litre of biodiesel. This biodiesel manufacturing plant will use 580 000 tons of soybeans and 11 000 tons of methanol. The required 580 000 tons of soybeans is more than the total soybean production in South Africa as indicated in Table 3.3. It can be assumed that the large demand for soybeans may prompt more farmers and emerging farmers to produce soybeans. It is to be expected that the price of soybeans will be influenced to a relatively large extent. The required amounts of methanol will be produced by Sasol's other manufacturing plants (Van Burick 2006b:n.p.). Sasol therefore has a competitive advantage over smaller biofuel manufacturers for (at least) two reasons. The first is the availability of sufficient quantities of methanol at a relatively low total cost per litre. The second is the benefits from economies of scale due to the large scale of such a production plant. Other biofuel manufacturers may not have ready access to large quantities of methanol. Furthermore, a small biofuel manufacturer's total cost per litre to acquire methanol may be higher than the total cost per litre at which Sasol produces methanol.

The threat of potential new biofuel manufacturers can therefore be relatively strong for existing biofuel manufacturers. If there are too many biofuel manufacturers, bankruptcies may occur and probably biofuel prices will be lower. The crux of the matter is that the fuel consumption market would then have to be shared amongst many biofuel manufacturers, with all the financial consequences of such an oversupply of biofuel.

Biofuel is one of several energy products derived from renewable resources. The availability of these alternative energy products, such as petroleum petrol and diesel, and wind, hydro, solar and nuclear power can influence the profitability of an existing biofuel manufacturer.

6.2.3 Alternative energy products

6.2.3.1 Opening remarks

Petroleum fuels are made from crude oil, coal and natural gas. The competitive pressures exerted by petroleum fuel on biofuel manufacturers are relatively strong, because these fuels are still currently sufficiently available. Furthermore, the profit margin on petroleum fuel may be higher than for biofuel. In other words, oil producing countries and oil companies can sell petroleum fuel at lower prices than biofuel, and still be profitable. The petrol selling price in South Africa is regulated by law and the price of petroleum diesel is regulated to a lesser extent. Should these price regulations be withdrawn, biofuel manufacturers may struggle to compete with petroleum fuel.

The commercial manufacture of biofuel in South Africa is relatively new. Fuel consumers are accustomed to petroleum fuel and they may still need to be convinced also to use biofuel as a source of energy. The competitive pressure biofuel manufacturers may experience from petroleum fuel as an alternative source of energy is relatively large. Other countries, such as Australia, Germany and Brazil, have used biofuel for several years now, either in its pure form or as a blending agent in petroleum fuel. Therefore, the South African market is aware of biofuel and may not resist its use. Still, extensive marketing strategies should be implemented by biofuel manufacturers and the government to educate the final consumers on the benefits of biofuel.

Other alternative energy products to biofuel include wind power, solar power, hydro power and nuclear power. These energy products may not have comparable or better performance, storage and safety features compared to biofuel. For example, biofuel may result in more electricity generated by diesel generators per time interval than electricity generated through

wind power. The competitive pressures that these sources of energy put on biofuel manufacturers are therefore lower than those from petroleum fuel.

Energy demand generally stands in relation to the number of people (consumers) in a country, as discussed in Section 4.2.2. Most people are indifferent to which energy product they use, as long as the energy product is affordable, fulfils a need and does not create long-term negative side effects. For example, the final consumer is usually indifferent to whether the electricity in his/her house was generated by hydro power generators, nuclear power reactors or diesel engine generators running on biodiesel. Furthermore, the consumer's need for energy is limited to a certain extent. An effort of biofuel manufacturers to sell quantities of biofuel, even at discounted prices, may therefore only lead to oversupply and wastage. Thus, if one energy product totally fulfils a consumer's specific need, the demand for another energy product is practically zero.

Profitable alternative sources of energy are also being researched and developed by traditional oil companies. For instance, BP Plc has adopted the slogan "Beyond petroleum", although BP originally stood for "British Petroleum". BP has a renewable and alternative energy programme which focuses on solar, wind, hydrogen and gas-fired power technologies. BP believes that these technologies have reached a tipping point and that they can create a profitable, high-growth, global business within the next decade (BP 2006b:n.p.).

All commercially manufactured energy products, whether they are derived from fossil or renewable resources, need to have one aspect in common to remain viable. That is the sustainable availability of the primary resource in sufficient quantities at the lowest possible total cost per unit. This criteria is applicable *inter alia* to petroleum fuel, wind power, solar power, hydro power, nuclear power and biofuel. The competitive forces that a biofuel manufacturer can expect to face from each of these alternative energy products are relevant to this research report. Given the above opening remarks, the main competitive forces faced by biofuel manufacturers are discussed below.

6.2.3.2 Petroleum fuel: oil

Biofuel manufacturers can expect competition from major oil companies and other role players in the oil industry, such as OPEC. The nature and extent of the competitive forces exercised by such role players are best illustrated by their history, as discussed below. Actions taken in the past by certain role players in the oil industry may be repeated in future. Furthermore, the strategies employed by those role players are also indicative of what biofuel

manufacturers should do to gain a competitive advantage. The history of the Standard Oil Company, its offspring oil companies, and OPEC are subsequently discussed to confirm this viewpoint.

a. History of the Standard Oil Company

Ida Tarbell (1904) gives a comprehensive account of the Standard Oil Company in her book titled *The history of the Standard Oil Company*. She was the daughter of an oil man in the Oil Region in Pennsylvania, in the United States of America, who, like others, claims to have gone bankrupt primarily due to the strategies employed by the Standard Oil Company.

The Standard Oil Company was founded by John D. Rockefeller in 1865. His goal was to dominate the United States of America's and the world's oil supply. Standard Oil was by far the largest oil refinery and distributor in the United States of America and through its bargaining power it dictated the volume and price of oil sold. Standard Oil's strategy was aimed at selling high prices and in low quantities in order to sustain long-term profits. The price that Standard Oil paid for oil produced by the small oil producers was relatively low and only limited quantities of oil were bought. This had a negative impact on the small oil producers' profitability, to the extent that many small oil producers went bankrupt.

The Sherman Antitrust Act, previously known as Act of July 2, 1890, ch.647, 26 Stat. 209, as amended, was the first government action in the United States of America to limit monopolies, starting with the Standard Oil Trust. Standard Oil Trust was forced to dissolve the trust in 1892 after it was sued by the state of Ohio. However, only Standard Oil of Ohio was separated from the group of enterprises. The state of New Jersey changed its company laws allowing a company to hold shares in other companies in any state. The Standard Oil Trust was reborn in 1899 as a holding company known as the Standard Oil Company of New Jersey. The United States Justice Department sued Standard Oil of New Jersey successfully in 1911 under the federal anti-trust law. Standard Oil was forced to separate into 34 companies, each with its own distinct board of directors. John D. Rockefeller retired from management and became a prominent shareholder in each of the new companies. These companies formed the core of today's oil industry (Wikipedia 2006a:n.p.; Wikipedia 2006b:n.p.).

The successor companies to the Standard Oil include:

- Standard Oil of Ohio (Sohio), now part of BP;
- Standard Oil of Indiana (Standolind), renamed Amoco (American Oil Co), now part of BP;

- Standard Oil of New York (Socony), merged with Vacuum, renamed Mobil, now part of ExxonMobil;
- Standard Oil of New Jersey (Esso) (Eastern States Standard Oil), renamed Exxon, now part of ExxonMobil. (Carter Oil, Imperial Oil and Standard Oil of Louisiana were kept part of Standard Oil of New Jersey after the break-up);
- Standard Oil of California (Socal), renamed Chevron;
- Standard's Atlantic and Richfield, merged to form Arco (Atlantic Richfield Co.), now part of BP;
- Standard Oil of Kentucky (Kyso), acquired by Standard Oil of California (now Chevron);
- Continental Oil Company (Conoco), now part of ConocoPhillips; and
- Ohio Oil Company, now known as Marathon Oil Company, a rival of Sohio.

Three of these Standard Oil companies, together with four others, became known as the Seven Sisters. Their history is described by Richard Cowen (2000:2-10). The history of the Seven Sisters is reviewed below.

The strategic value of oil became evident after World War I. This prompted the United States of America's government to put political and economical pressure on American companies to penetrate the European-dominated syndicates in the Middle East.

BP, Shell and Exxon negotiated the Achnacarry Agreement in 1928, setting out several principles designed to prevent competition in oil marketing. The American market was excluded because of its strong anti-trust legislation. Mobil, Gulf, Chevron and Texaco later joined these founder companies. The results of this agreement were very rewarding to the oil producers. Oil prices were stable and new oil producers were quickly dealt with using various strategies. One of the strategies employed by these major oil companies was the promotion of "conservation" policies that would limit "wasteful" production. Pumping oil too rapidly from an oil field could damage the sustainable long-term production of oil. Consequently, in Texas, legislation was approved that prohibited oil production which was in excess of the market demand. The major oil companies dropped their offering for oil to US\$0.25 per barrel in January 1933 and soon afterwards dropped their offering, further, to US\$0.10 per barrel. For obvious reasons, this cut in the price of oil resulted in a cut in production by small oil producers. This was the "drop in market demand" that the major oil companies had planned. The major oil companies bought tens of millions of oil barrels at these very low prices, forcing the independent oil companies out of business. In September 1933, the oil price was increased to \$1 per barrel, with the major oil companies back in control and the small oil producers out of business.

The major oil companies agreed that their Middle East oil would be marketed without much competition. A report in 1952 by the US government mentioned that the seven international oil companies that operated in the Middle East were controlling oil prices collectively. This report gave rise to the expression of “The Seven Sisters”. The Seven Sisters dominated the oil industry at that time and manipulated the oil production in OPEC member countries. OPEC was later formed as a defence strategy against the Seven Sisters multinational companies.

b. History of OPEC

OPEC was formally established on 14 September 1960 by the members representing Iran, Iraq, Kuwait, Saudi Arabia and Venezuela. The 1960s were OPEC’s formative years. OPEC set out its objectives and engaged only in low profile activities. The Secretariat, with its headquarters in Vienna (Austria) was established; resolutions were adopted; and negotiations with companies commenced. OPEC was later joined by Qatar, Indonesia, the Socialist People’s Libyan Arab Jamahiriya, the United Arab Emirates, Algeria, Nigeria, Ecuador (until 1992) and Gabon (until 1994) (OPEC 2006:n.p.).

OPEC’s main objectives were to

- co-ordinate and unify petroleum policies among member states in order to secure reasonable and stable oil prices for petroleum producers;
- supply petroleum to consuming nations efficiently, economically and regularly; and
- secure a reasonable return on investment for those investing in the industry.

Both OPEC and the major oil companies wanted a large volume of oil to be sold at high prices. This would result in large amounts of revenues to OPEC members. Furthermore, the oil companies were then assured of a supply of crude oil from satisfied OPEC members to their global markets (Cowen 2000:10).

Egypt and Syria invaded Israel in October 1973 without warning, starting a war that humiliated the Arab nations. OPEC, with a new realisation of its power, simply announced a 70 per cent increase in the price of Middle East oil from \$3 to \$5.11 per barrel. A further increase of 128 per cent to \$11.65 per barrel was achieved in January 1974 through a mutual agreement to cut production by 10 per cent. The oil companies had built up stocks based on hints received of an impending war. Thus, there was no short supply of oil, but only an increase in price (Cowen 2000:9). (See Section 4.2.1.3 regarding OPEC, world events and the price of oil.)

The major oil companies, such as BP, Shell, and Exxon, were able to enforce their strategies because they dominated the oil industry. The remaining companies of the original Seven Sisters are ExxonMobil, Chevron, Shell and BP, who operate under well-known brand names in South Africa today.

Biofuel manufacturers may base their economic feasibility studies on certain oil price assumptions. However, from the history it is evident that the price of oil can be manipulated by major oil companies and role players such as OPEC. The price of oil is currently high, relative to the oil price history as described in Section 4.2. Although the oil companies and oil exporting countries prefer relatively high oil prices, it cannot be assumed that oil prices will remain high in the long term. OPEC, in agreement with oil companies, may decide to employ low selling price strategies to outmanoeuvre other fuel companies. Another reason for a potential future decrease in the oil price may be a drop in the demand for oil as a result of a cooling off period in global economic growth.

Oil companies and role players such as OPEC have at least two possible strategies if the demand for biofuel were to increase considerably above that for petroleum fuel. One strategy may be to enter the biofuel industry. Oil companies already have technologically advanced refineries, well-developed research facilities and established distribution channels to accomplish this strategy. Small biofuel manufacturers may not have the financial resources and/or skills to prevent the oil companies from entering and dominating the biofuel industry. Another strategy that OPEC, in agreement with the major oil companies, may employ, is to decrease the selling price of their oil. This strategy would force a number of biofuel manufacturers, who depend on high fuel prices to be profitable, out of the biofuel market.

Regulation may compel oil companies to blend biofuel into their petroleum fuel. However, the oil companies will make an effort to keep their biofuel costs to a minimum. Biofuel manufacturers should therefore consider the long-term viability of their businesses if they depend on oil companies as their primary customers. (Oil companies as customers for biofuel manufacturers were discussed in Section 5.2.5.)

6.2.3.3 Petroleum fuel: coal and natural gas

Sasol uses coal to liquid (CTL) and natural gas to liquid (GTL) technologies to manufacture petrol and diesel, amongst other products and by-products. The process involves gasification and the use of a Fischer-Tropsch reactor. The same process can be used to manufacture biodiesel, as discussed in Section 2.3.2.2. The fuels produced are largely the same, except

for the difference in the feedstock used. Sasol uses fossilised coal or natural gas as feedstock, while a renewable resource, such as grain, can be used for manufacturing biofuel. The cost of coal or natural gas as a feedstock for manufacturing fuel may be lower, but the source of this feedstock is limited. In the short run, petroleum fuel manufactured from coal or natural gas may therefore exert some competitive pressure on biofuel, but should not be regarded as a major threat to biofuel manufacturers' profitability in the long run.

6.2.3.4 Wind power

As with biofuel manufacturing, the usable resources for wind power are limited to certain geographic areas. In the Republic of South Africa there are currently two pilot wind power projects, managed by Eskom, in the Western Cape. The Western Cape's winds are considered perfect for wind energy. The prevailing winds come from two directions and normally blow during peak electricity consumption periods. Eskom estimates that wind resources on South Africa's coast are approximately 1 000 megawatts. One wind farm with a capacity of 100 megawatts can be built in a relatively short period of time. However, the cost of electricity generated from wind power is relatively high (Eskom 2006a:n.p.). Thus, wind power may be an alternative source of energy to biofuel for electricity generation in the Western Cape, but, generally speaking, the competitive pressure from wind power on biofuel manufacturing is negligible.

6.2.3.5 Solar power

The Republic of South Africa has one of the highest solar irradiation levels in the world. This solar energy can be used to generate heat and electricity. Certain limiting factors that need to be considered are the initial cost of the solar power system, the cost of energy storage, the quantity of sunshine available at the site, and the quantity of the collected solar heat that is actually used (National Research Council 1980:349; Eskom 2006c:n.p.). Solar power is a possible and inexpensive alternative source of energy in electricity and heat generation. However, solar power does not exert much competitive pressure on biofuel, due to the limitations on the use of solar power.

6.2.3.6 Hydro power

The usable resources for hydro power are limited to certain geographic areas. South Africa is a relatively dry country and only few rivers, such as the Vaal River, are suitable for major hydro electric schemes. Eskom has concluded that although micro hydro power is an option

in remote areas, it is not an economically feasible option for South African circumstances (Eskom 2006b:n.p.). Hydro power therefore seems not to pose a major competitive threat to biofuel manufacturing.

6.2.3.7 Nuclear power

The uncertain availability of natural uranium (U_3O_8), the primary resource for nuclear power, creates some concern about reliance on nuclear power. Radioactivity is released into the environment at all stages of the nuclear cycle. Furthermore, the possibility of reactor accidents makes nuclear power more controversial than any other energy source. It is therefore evident that the generation of nuclear power is unacceptable if it is done by many uncontrolled companies or individuals (National Research Council 1980:214). Only a small number of controlled institutions, such as Eskom, may use nuclear power. The competitive pressure that biofuel manufacturers may experience from nuclear power is therefore relatively low.

6.2.4 Feedstock producer bargaining power

Biofuel manufacturing is receiving attention worldwide. Surpluses in the production of crops such as maize, sunflowers, soybeans and wheat in the Republic of South Africa may decrease, or have already been eliminated, possibly due to the increasing demand for these crops for biofuel manufacturing. Imported crops may become more expensive in the Republic of South Africa due to a possible increase in the demand for biofuel in exporting countries.

In the South African free market system, feedstock producers try to maximise their profit by selling to the highest bidder. Feedstock producers in a certain area may also collectively demand higher prices for their crops. Biofuel manufacturers are, however, not the only buyers of the relevant feedstock. If the demand for the specific feedstock would increase, biofuel manufacturers will probably have to pay more for their feedstock. Such an increase in the demand for feedstock may be driven by human and/or animal consumption, or by other biofuel manufacturers. (Refer to Table 3.5 for an indication of the relatively limited availability of feedstock in South Africa.)

Biofuel manufacturers are largely limited to a certain crop as feedstock due to the manufacturing process chosen and consequently to a certain regional location. The relatively small size of biofuel manufacturers in general makes it difficult for biofuel manufacturers to withstand opposition from or to exert much influence over feedstock producers. Furthermore,

feedstock producers may integrate forward in the biofuel industry value chain and can thus become powerful competitors to independent biofuel manufacturers. Some grain producers can market their crops through other non-traditional channels. For example, if the prevailing price of maize is low and the foreseeable price of beef is high, it will probably be worthwhile for maize producers to market their maize through cattle. This is done by feeding the maize to cattle for meat production. The same principle applies to the manufacture of bio-ethanol from maize. Ethanol Africa (Pty) Ltd is an example of maize farmers who ventured into biofuel manufacturing. One of the main reasons for this shift may be the relatively low prices received when marketing maize through traditional channels.

Alternatively, the increased demand for crops as feedstock for biofuel manufacturing may encourage a number of farmers and emerging farmers to produce feedstock. South Africa has unused arable land available for more feedstock production, especially for maize, sunflowers and soybeans. The selling price per ton of the feedstock involved may thus not necessarily increase due to the increased supply. In such circumstances, feedstock producers will benefit financially from an increase in the quantity sold rather than from a selling price increase. Biofuel manufacturers could benefit from this scenario, provided there are not too many biofuel manufacturers, causing a considerable increase in demand.

From the above it is evident that the competitive pressures biofuel manufacturers may face from feedstock producers can therefore be relatively substantial.

6.2.5 Customer bargaining power

Biofuel manufacturers' customers may include other manufacturers, wholesalers and retailers and final consumers. (See Figure 1.3 for a depiction of the customers in the biofuel industry value chain.)

South African bio-ethanol manufacturers' primary customers may be oil companies who are forced by government to blend bio-ethanol into their petroleum fuel. Bio-ethanol manufacturers may find that there are limitations on the price and of the quantities of bio-ethanol they sell. This may be due to the bargaining power of oil companies. Oil companies may exercise their bargaining power, since bio-ethanol is the most suitable blending fuel and it is not recommended that it be used as a fuel in a pure form. Oil companies may also decide to manufacture their own bio-ethanol if they cannot buy it at a suitable price from bio-ethanol manufacturers. As discussed before, bio-ethanol manufacturers' plant sizes are bound to be relatively small, due to the limited availability of feedstock at acceptable prices.

Due to price levels and available feedstock quantities, bio-ethanol manufacturers may experience strong competitive pressures from oil companies as buyers of bio-ethanol.

Wholesalers and retailers in the biofuel industry sell biofuel to final consumers. The final consumers of fuel consist of the entire economically active population. Due to their lifestyle, there is normally a strong demand for fuel. It is unlikely that final consumers will integrate backward into the biofuel value chain. Furthermore, switching to other forms of energy for transportation may not be a viable option for final consumers. The competitive pressure that a biofuel manufacturer may experience from biofuel wholesalers and retailers as well as the final consumers as buyers of biofuel may therefore be weak. This would be the case when the fuel meets the customers' quantitative and qualitative requirements. These requirements may include fuel efficiency, no smog and pollution, effective engine performance and low enough prices.

6.2.6 Closing remarks on competitive forces

As explained above, biofuel manufacturers face a number of competitive forces. Although there are not many biofuel manufacturers in South Africa yet, many new biofuel manufacturers may enter the biofuel industry in the foreseeable future. These new biofuel manufacturers may include feedstock suppliers that integrate forward in the biofuel value chain, as well as existing oil companies that may decide to diversify and also become biofuel manufacturers.

Nuclear, coal, wind, solar and hydro energy are suitable for electricity generation. The largest use of biofuel is most likely to be energy for internal combustion engines in motor vehicles, trucks and tractors. It is clear that the main alternative or substitute energy product for biofuel is petroleum fuel, made from crude oil, coal or natural gas. Competitive pressures on biofuel manufacturers may, moreover, be exerted by major oil companies and international organisations such as OPEC, because these companies and producers can also enter the field of biofuel manufacturing and/or manipulate the price of petroleum fuel.

In view of the existing and potential competitive forces, biofuel manufacturers should develop competitive strategies to gain competitive advantages and to minimise the pressures of these competitive forces on the biofuel industry.

6.3 COMPETITIVE STRATEGIES FOR BIOFUEL MANUFACTURERS

6.3.1 Introductory remarks

As discussed in Section 6.2, biofuel manufacturers may face pressure from various entities in the biofuel industry value chain and also from substitute products. Biofuel manufacturers should therefore counter these pressures and gain a competitive advantage over their competitors. A competitive advantage refers to any aspect of the business that is managed better by a particular biofuel manufacturer than by its competitors and that results in higher profits. The outcome of a competitive advantage should be an increase in profitability. Certain key factors that result in lower unit costs and/or higher sales and consequently an increase in profitability should be addressed. These factors may include biofuel attributes, resource management, marketing and other competencies that a biofuel manufacturer may or should possess.

Furthermore, for optimal competitiveness, a biofuel manufacturer needs to analyse its strengths, weaknesses, opportunities and threats, as well as those of its competitors. This so-called SWOT analysis is a powerful tool that can be used to develop strategies which build on a biofuel manufacturer's competencies and address its weaknesses. For example, a biofuel manufacturer can have a distinct disadvantage regarding the cost of feedstock, compared with the substitute product, petroleum fuel. Feedstock such as grain may have a relatively high value due to its other markets. Petroleum fuel producers have to invest in property, plant and equipment to extract crude oil. However, the direct cost of the crude oil as a feedstock is practically zero. Biofuel manufacturers thus have to compensate for this weakness by employing strategies to minimise the cost of their feedstock or to increase their biofuel sales.

Biofuel manufacturers should use the information from the key success factors and SWOT analysis to develop their strategies. Firstly, the so-called generic competitive strategies can be developed. There are five generic competitive strategies from which biofuel manufacturers could choose. These generic strategies include a low selling price, broad differentiation, a focused low selling price, focused differentiation and the best selling price. Secondly, complementary strategies may be considered. Complementary strategies include strategic alliances, mergers and acquisitions, value chain integration, outsourcing, offensive and defensive moves. Thirdly, biofuel manufacturers have to develop functional area strategies that support their generic and complementary strategies. The functional areas in the biofuel manufacturing business may include research and development, production,

sales and marketing, human resources and finances. A timing strategy is the fourth choice biofuel manufacturers have to make when implementing the chosen strategies. A good strategy produces the required results when the timing is right. Biofuel manufacturers therefore have to decide between being fast movers, fast followers and late movers for each of their chosen strategies. Each timing choice has certain benefits and drawbacks.

Selected key success factors, the SWOT analysis and competitive strategies are discussed briefly in this report. This discussion is based mainly on the work done by Thompson *et al.* (2005:81–203). Detailed strategies depend on a particular biofuel manufacturer's objectives, its management style and the competitive pressures it experiences. This research report therefore does not aim to suggest all the detailed strategies a biofuel manufacturer should employ. Biofuel manufacturers' menu of strategic choices is set out in Figure 6.2.

The four sets of strategic choices a biofuel manufacturer should make are indicated by the rectangular blocks in Figure 6.2. These strategic choices are generic strategies, complementary strategies, functional area support strategies and timing strategies. The arrows in Figure 6.2 show the support or input that is given to a particular set of strategic choices. This information from the SWOT analysis, knowledge of key success factors, and functional area strategies, supports the generic and complementary strategies.

The key success factors, the SWOT analysis, generic competitive strategies, complementary strategies, functional area support strategies and timing strategies are discussed below.

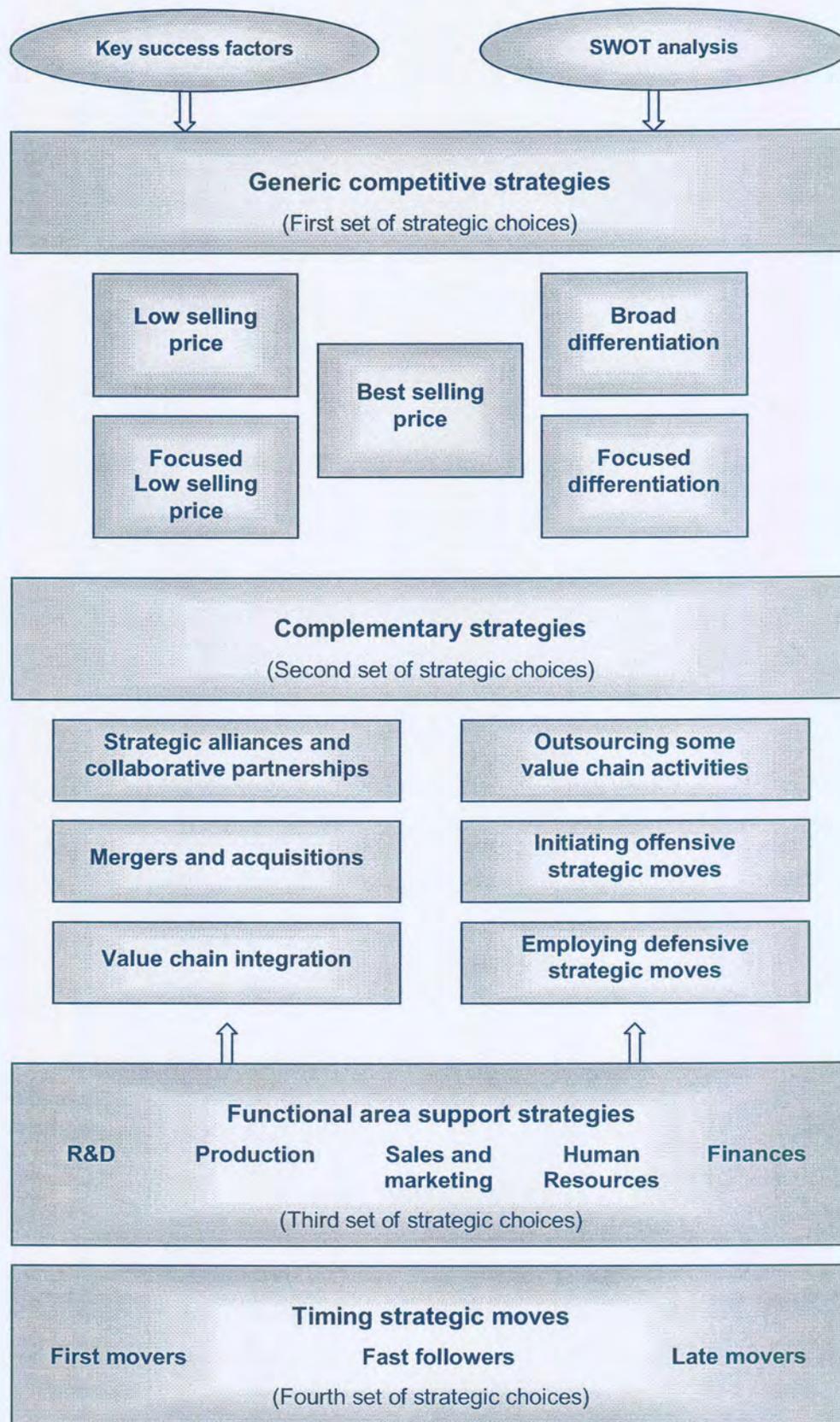
6.3.2 Key success factors

The main difference between competitively strong and weak biofuel manufacturers is their ability to address the key factors required to be profitable. These factors may include the manufacturer's biofuel attributes, resource management and marketing (Thompson *et al.* 2005:81-82).

6.3.2.1 Biofuel attributes

A biofuel manufacturer should be an expert in biofuel technology. Better quality, performance and other attributes may result in an increase in the demand for its biofuel. An increase in the demand may result in higher sales. A biofuel manufacturer should therefore give a lot of attention to research and development. This is necessary to optimise the quality of the biofuel produced and to establish a technically viable plant for the production of biofuel.

Figure 6.2 – The biofuel manufacturer’s menu of strategic options



Source: Adapted from Thompson *et al.* (2005:142)

6.3.2.2 Resource management

A biofuel manufacturer should invest in improving its manufacturing processes for higher efficiency and lower costs. Low production costs can be achieved through economies of scale and by capturing learning-curve advantages. High utilisation of the plant and equipment is necessary to optimise production costs. A biofuel manufacturer therefore benefits most financially from a relatively large capital investment. (See Section 2.4, regarding feedstock availability versus plant size and cost.). Overall low cost should be achieved as far as possible in order to meet the low price expectations of biofuel manufacturers' customers. These customers include other manufacturers, wholesale and retail distributors and final consumers.

6.3.2.3 Marketing

A biofuel manufacturer should have access to a strong network of customers and avoid becoming dependent on a single large customer. This *caveat* applies whether the biofuel manufacturer's customers are other manufacturers, wholesale and retail distributors, or final biofuel consumers. Furthermore, a biofuel manufacturer should have an effective marketing communication strategy, based on a well-known and well-valued brand name. For example, a favourable display of the biofuel brand name at fuel stations should be secured. Guarantees and warranties by the biofuel manufacturer may contribute to the customers' perceived value of the brand. Biofuel orders should be filled quickly and accurately with polite and personalised customer service. This will enhance the customers' buying experience, which may in turn secure future sales.

6.3.2.4 Capabilities

A biofuel manufacturer should be able to distribute biofuel to its customers in a fairly short time. Lost sales should be avoided as far as possible, since a biofuel manufacturer may not only lose a current order, but may lose future orders as well. Thus, proper logistic management is essential for a successful biofuel manufacturer. Biofuel manufacturers should also be strong in e-commerce, product innovation, and quality control. They must be capable of managing their supply chains effectively. This can largely be achieved with a skilled and committed workforce.

To ensure that proper attention is given to the key success factors, a biofuel manufacturer should perform a SWOT analysis.

6.3.3 SWOT analysis

A SWOT analysis is a powerful tool which biofuel manufacturers can use to identify their resource and management strengths and weaknesses. It also identifies possible opportunities that biofuel manufacturers should pursue or threats they should avoid. The value of a SWOT analysis lies in the conclusions that are made about a biofuel manufacturer's situation. The conclusions from the SWOT analysis should assist biofuel manufacturers with their strategy development and improvement. A short discussion of each of the four elements of the SWOT analysis is relevant to the objectives of this report.

6.3.3.1 Strengths

Competencies are the required capabilities a biofuel manufacturer should possess in order to conduct its business. Distinctive competencies are capabilities which a biofuel manufacturer possesses and which its competitors cannot match. A biofuel manufacturer's resource strengths or competitive capabilities should therefore be developed into distinctive competencies in order to gain competitive advantages over competitors. A biofuel manufacturer may, for example, be able to secure an exclusive long-term contract to sell its bio-ethanol as a blending fuel to an oil company. Another example of a distinctive competency may be a biofuel manufacturer's knowledge of how to manufacture more biofuel per ton of feedstock than the accepted norm (Thompson *et al.* 2005:91-97).

6.3.3.2 Weaknesses

A biofuel manufacturer's resource and management weaknesses and competitive disadvantages should be addressed as soon as possible. These weaknesses may, for example, be a lack of, or deficiency in, the required manufacturing or marketing skills or fixed assets. Weaknesses in the biofuel industry are generally described as the biofuel manufacturer's inability to meet key success factors, such as manufacturing biofuel with customers' preferred attributes.

A biofuel manufacturer's value chain activities have associated costs. The costs are measured according to the type of activity or input and the accountant's preferences. For example, feedstock may be measured in purchase price per ton delivered or direct cost per litre of biofuel produced. The higher these costs are above the costs of a biofuel manufacturer's competitors, the more competitively vulnerable it becomes (Thomson *et al.* 2005:98-99).

A biofuel manufacturer's cost competitiveness can be revealed by a value chain analysis and benchmarking. There are three main areas in the value chain where cost differences between a biofuel manufacturer and its competitors can occur. These areas include the biofuel supply chain, the activities a biofuel manufacturer performs and the biofuel distribution channel. The costs of performing each activity should be benchmarked or compared against competitors' costs, if these are available. Furthermore, the costs should also be benchmarked against non-competitors' costs if they perform those activities efficiently and effectively (Thompson *et al.* 2005:103-107).

Cost disadvantages within biofuel manufacturers' value chain activities should be rectified through the implementation of best practices. Best practices are the techniques employed by competitors and other companies who perform certain activities more efficiently and effectively than a given biofuel manufacturer. Biofuel manufacturers should also eliminate or outsource low-value adding and cost-producing activities, such as cleaning or security services, in order to reduce expenses. Further cost reductions can also be achieved by relocating activities with high fixed costs to less expensive areas. For example, a biofuel manufacturing plant and offices should be located near the feedstock producers in the rural areas. This will result in a smaller investment in property or less rent and levies per month. (Refer to Section 3.3 for a discussion of the location of biofuel manufacturing plants.) Furthermore, biofuel manufacturers should invest in productivity improvement and cost-saving technology, as discussed in Section 6.3.2.2.

One of the competitive weaknesses a biofuel manufacturer may experience in its supply chain is the cost of feedstock compared to the cost of extracted crude oil to oil companies. Grain is also consumed by humans and animals and the relatively high demand for this use may increase the price of grain. Biofuel manufacturers should therefore negotiate favourable prices with feedstock producers by offering long-term contracts, production finance and/or biofuel at discounted prices in return. Furthermore, biofuel manufacturers should work with seed companies and feedstock producers to develop and produce feedstock that offers higher biofuel yields. For instance, crops with higher digestible starch content yield higher quantities of biofuel in the fermentation process. (Refer to Section 3.4 for a discussion of the various biofuel manufacturing processes.)

The main costs in the distribution channel may be the government levies on fuel and rival manufacturers' mark-ups. Biofuel manufacturers may enjoy an advantage over petroleum fuel if the government levy on biofuel is less than that on petroleum fuel. Both these costs are set and may prove difficult for a biofuel manufacturer to change.

6.3.3.3 Opportunities

The opportunities available to a biofuel manufacturer should match its resource strengths. In other words, a biofuel manufacturer should be confident that it has the required capabilities to take full advantage of its opportunities. Furthermore, opportunities worth exploring should offer sustainable profits and growth, and give the biofuel manufacturer a competitive advantage over its rivals. For example, a biofuel manufacturer may identify an opportunity to research and develop a particular feedstock that yields more biofuel per ton of feedstock than the norm. The biofuel manufacturer should have the financial resources, skilled researchers and time available to engage in such an endeavour. Another example may be an opportunity to integrate forward or backward in the value chain. This should only be attempted if a biofuel manufacturer has the specialised business know-how, sufficient financial resources and staff capacity.

6.3.3.4 Threats

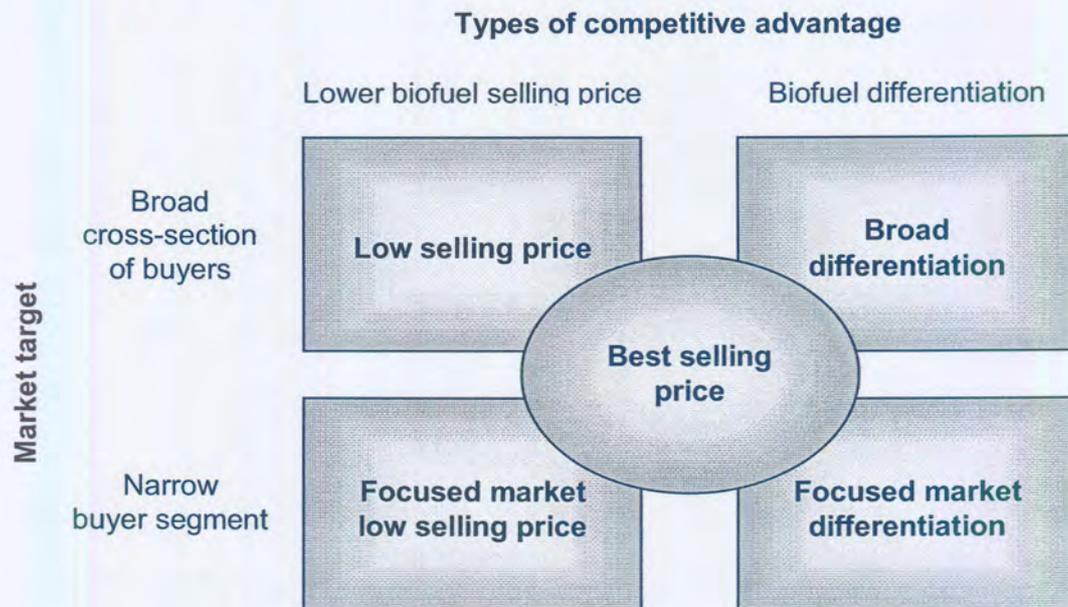
A biofuel manufacturer should be prepared for external threats that may emerge and impact negatively on its profitability. For example, new regulations, emerging competitors, accidents, an increase in the cost of feedstock, or a decrease in the price of oil, should be planned for as far as possible. A proper risk management plan should be implemented and revised periodically. A risk management plan generally consists of a description of the risk, the probability of its occurrence, and the impact on the biofuel manufacturer's profitability if the risk materialises. Strategic actions should be taken by a biofuel manufacturer to minimise the probability of the occurrence of those threats; and disaster recovery plans should be in place to minimise the impact of those threats if they do occur.

In conclusion, a biofuel manufacturer's strategic approach should be tailored to fit its objectives and circumstances, according to the key success factors and information obtained from the SWOT analysis.

6.3.4 Generic competitive strategic approaches

Basically, a biofuel manufacturer's strategic approach will target either a broad or a narrow market, and focus on either a low selling price or product differentiation; or a biofuel manufacturer may decide to take a middle-of-the-road approach, namely best selling price. The five generic competitive strategic approaches that are available to a biofuel manufacturer are represented in Figure 6.3 (Thompson *et al.* 2005:116).

Figure 6.3 – The five generic competitive strategies



Source: Adapted from Thompson *et al.* (2005:116)

A biofuel manufacturer should stake out one of the five positions in the marketplace indicated in Figure 6.3. The market target can be broad or narrow. The type of competitive advantage pursued can be a low biofuel selling price or biofuel differentiation. Best selling price strategies aim at a larger market, although the number of competitors is higher. Each of these approaches is briefly discussed below.

6.3.4.1 Low selling price strategy

When a biofuel manufacturer decides on a low selling price strategy, it aims to sell high volumes of biofuel to a broad cross-section of customers. However, the high cost of feedstock compared to the cost to petroleum fuel producers of crude oil can put pressure on a biofuel manufacturer's sustainable profitability. The limited availability of feedstock locally also has negative impact on the profitability of this option.

6.3.4.2 Broad differentiation strategy

Broad differentiation is a strategy followed by businesses that sell a large variety of products to the general public. Broad differentiation is difficult to achieve for a biofuel manufacturer, since it only produces biofuel and its by-products, glycerine or animal feed.

6.3.4.3 Focused market, low selling price strategy

The focused market, low selling price strategy aims to sell high volumes of a product at a relatively low price to a specific market. A biofuel manufacturer may opt for this approach if it manufactures bio-ethanol as a blend for an oil company. Quality requirements by the oil company and the availability of sufficient quantities of local feedstock may affect the biofuel manufacturer's profitability negatively when this strategy is pursued.

6.3.4.4 Focused market, differentiation strategy

A focused market with strategy product differentiation aims to sell a few highly differentiated products to a target market. Biofuel is a generic consumable product and customers are generally not prepared to pay excessive amounts for it, even if the biofuel has differentiating attributes.

6.3.4.5 Best selling price strategy

Best selling price strategies give a biofuel manufacturer's customers more value for money. The goal is to deliver superior value to customers by fulfilling their expectations on biofuel quality, features and performance. The selling price of biofuel should be lower than the customer is expecting to pay. The downside associated with best selling price strategies is that a biofuel manufacturer may experience competitive pressures from all other fuel providers. Prices below the going market rates could also reflect negatively on the perceived quality of the biofuel.

6.3.4.6 Closing remarks on strategic approaches

Biofuel manufacturers should know who their main customers are and what their expectations are regarding the attributes and price of biofuel. These factors will determine which strategic approach will fit a particular biofuel manufacturer best, bearing in mind that each strategic approach has certain benefits and disadvantages. This report therefore does not attempt to prescribe which strategic approach biofuel manufacturers should adopt. However, if a proper SWOT analysis has been done, the competitive strategy or strategies a biofuel manufacturer should follow will become clearer.

A biofuel manufacturer should also develop and improve a second set of strategies to complement its chosen generic strategic approach.

6.3.5 Complementary strategies

A biofuel manufacturer should develop complementary strategies that enhance its basic strategic approach to increase its profitability. These complementary strategies may include strategic alliances, mergers and acquisitions, backward or forward integration, outsourcing, offensive moves and defensive moves (Thompson *et al.* 2005:141-160).

6.3.5.1 Strategic alliances

Biofuel manufacturers should realise that the quest for current market leadership and technological advances for future market leadership sometimes requires more skills, resources and technological expertise than one manufacturer can or wants to manage. A biofuel manufacturer should therefore form strategic alliances or collaborative partnerships to achieve mutually profitable outcomes. These alliances go beyond normal business-to-business transactions, but fall short of formal mergers and acquisitions. For example, a biofuel manufacturer may form a collaborative partnership with a group of feedstock producers. It can also form an alliance with a seed company or research institution that focuses on improving the efficiency of biofuel manufacturing processes.

6.3.5.2 Mergers and acquisitions

A merger refers to the grouping of two or more biofuel manufacturers as equals. The merger often takes on a new name. An acquisition is one biofuel manufacturer that purchases and absorbs the operations of another enterprise. The biofuel manufacturer may aim to gain more market share in a geographical area and benefit from other synergies by merging with or acquiring other biofuel manufacturers. Mergers or acquisitions are also an option when a biofuel manufacturer aims to gain quick access to new technologies, as opposed to doing its own time-consuming research and development.

6.3.5.3 Backward or forward integration

A biofuel manufacturer should integrate vertically if its competitiveness could be improved by such a move. Backward integration may result in a reliable supply of feedstock at lower costs that may not fluctuate as feedstock prices tend to do. Forward integration may expand a biofuel manufacturer's customer base and therefore increase its profitability. However, both backward and forward integration require special knowledge, skills and resources. Another drawback of vertical integration is the increase in business risk, since the biofuel

manufacturer is then exposed to more risks in the same industry. For example, should the demand for biofuel decrease considerably, then the demand for grain as feedstock may decrease as well, which can result in lower profits.

6.3.5.4 Outsourcing

A biofuel manufacturer should outsource non-crucial value chain activities if they can be performed better by outside specialists or can be bought at a lower cost from outside the enterprise than performing these activities in-house. Furthermore, a biofuel manufacturer should concentrate and spend its resources on its core competencies, that is, the required and inevitable activities which are inherent in biofuel manufacturing. For example, if a biofuel manufacturer does not regard its marketing activities as a core activity that can give it a competitive advantage, marketing should preferably be outsourced to a marketing specialist. Another example is to outsource support services such as security and cleaning, if these services can be rendered more effectively and at a lower cost than by the biofuel manufacturer.

6.3.5.5 Offensive moves

A biofuel manufacturer may gain competitive advantages by initiating offensive moves to obtain cost, differentiation or resource advantages. Offensive moves that a biofuel manufacturer may initiate generally aim to counter its competitors' strengths or benefit from its competitors' weaknesses, as identified in SWOT analyses performed on the biofuel manufacturer and on its main competitors. For example, a biofuel manufacturer may offer low priced or high quality biofuel in order to take away market share from its competitors. This can be done if the biofuel manufacturer can manufacture biofuel at a lower total cost per litre than its competitors.

6.3.5.6 Defensive moves

A biofuel manufacturer may expect offensive attacks from its rivals and should be prepared to defend its market share. A biofuel manufacturer may block challengers by continuously improving its biofuel attributes and giving guarantees to its customers. Furthermore, a biofuel manufacturer may commit itself to match any rival's selling terms or prices.

Biofuel manufacturers' third set of strategic choices is functional area support strategies.

6.3.6 Functional area support strategies

A biofuel manufacturer should decide how the functional segments of areas of the business will support its strategic approach and competitive moves. These functional areas include research and development, production management, human resources management, sales and marketing management and financial management (Thompson *et al.* 2005:166).

For example, if the biofuel manufacturer decides on a low selling price strategy, then production management will focus *inter alia* on economies of scale, high labour productivity, efficient feedstock supply management and automated biofuel manufacturing. If the biofuel manufacturer decides on a differentiating strategy, the focus will most probably be on research and the development of biofuel attributes and the production of quality biofuel. Superior marketing management would emphasise the differentiating biofuel features and advertise a valued brand name.

The fourth strategic choice biofuel manufacturers have is when to launch the various strategies concerned.

6.3.7 Timing strategic moves

Timing is an important variable when one is making strategic moves. A biofuel manufacturer may choose to be a first mover, a fast follower or a late mover. A biofuel manufacturer that is a first mover may strengthen its market position and competitiveness. This may be beneficial to a biofuel manufacturer that is still in the process of establishing its business. Moving first will help build the biofuel manufacturer's image and reputation in the market place. However, the biofuel manufacturer that aims to be a first mover should have adequate financial resources, competitive capabilities and high quality management in order to reap the benefits. Furthermore, the biofuel manufacturer should decide whether the customers are ready for new moves (Thompson *et al.* 2005:167). For example, a new, pioneering biofuel manufacturer should know whether its target customers' motor vehicles are able to run on biofuel and whether the customers are informed of the advantages of using biofuel.

Being a fast follower or late mover may be financially beneficial to a biofuel manufacturer, especially if the first mover's strategies can easily be copied at lower costs. Furthermore, the fast followers and late movers can learn from mistakes made by first movers. For example, a first mover biofuel manufacturer may develop special biofuel attributes at considerable cost and over a long time. The fast followers and late movers may copy these special biofuel

attributes at a fraction of the cost and in a relatively short period of time. The fast followers and late movers may be financially better off in such circumstances.

6.4 CLOSING REMARKS

It is evident that there are several external competitive forces that can exert pressure on a biofuel manufacturer's profitability. Potential new biofuel manufacturers and petroleum fuel producers are the most significant of these competitive forces. A biofuel manufacturer has to counter these pressures by employing competitive strategies.

There are several key success factors which a biofuel manufacturer should bear in mind when developing its strategies. Information on the biofuel manufacturer's position should be obtained from detailed SWOT analyses of the biofuel manufacturer and its competitors. This information will assist the biofuel manufacturer when it decides between the strategic choices open to it. A biofuel manufacturer's strategies include its basic strategic approach, complementary strategies, functional area support strategies and timing strategies to enhance its competitiveness. These strategies aim to give the biofuel manufacturer competitive advantages over its rivals and to increase its profitability.

PART IV

ELEMENTS OF THE MACRO-ENVIRONMENT OF BIOFUEL MANUFACTURERS

CHAPTER 7: GOVERNMENTAL FORCES THAT INFLUENCE BIOFUEL MANUFACTURERS

CHAPTER 7

GOVERNMENTAL FORCES THAT INFLUENCE BIOFUEL MANUFACTURERS

7.1 THE MACRO-ENVIRONMENT IN PERSPECTIVE

The macro-environmental forces faced by a biofuel manufacturer are government (politics), the economy, society, technology, ecology, demography, institutional and international forces, as depicted in Figure 1.1. Global and South African economic conditions have a definite influence on biofuel manufacturers' profitability, for example, interest rates on the amount of finance costs play a role and economic growth influences the demand for fuel. Political forces, for example, political risk in the Middle East, affect the availability and selling price of oil, which is the substitute product for biofuel. Other forces, such as society's pressure on biofuel manufacturers to be socially responsible, the ecology's influence on the availability and cost of feedstock, and technological advances in biofuel manufacturing, affect biofuel manufacturers' profitability. However, the exact impact of these forces in the macro-environment on a biofuel manufacturer's profitability cannot be determined because too little is known about these influences at present. For the purposes of this report, a discussion of South African legislation and regulations as governmental forces will suffice.

7.2 INTRODUCTORY REMARKS ON GOVERNMENTAL FORCES

The Department of Minerals and Energy of the Republic of South Africa published a white paper on renewable energy in November 2003. Government recognises that energy derived from renewable resources has significant potential in the medium and long term. The drive for energy security is a key objective, since a relatively large portion of the Republic of South Africa's energy expenditure is on US dollar-dominated imported fuels, which imposes a heavy burden on the economy. Furthermore, developed countries may implement environmental response measures, which would put coal production, processing and consumption at risk. South Africa currently relies heavily on coal as a source for energy. Sasol's fuel manufacture and Eskom's electricity generation from coal are examples in this regard. The Republic of South Africa's government is therefore targeting an energy contribution of 10 000 Giga-watt-hours of energy to final consumers by 2013 from renewable resources. These renewable resources should mainly be biomass, wind, solar and small scale hydro power. For instance, the objective is to generate four per cent of the projected

electricity demand for 2013 from renewable resources (Department of Minerals and Energy 2003:viii, ix).

The Petroleum Products Act, Act 120 of 1977 as amended (South Africa 1977) provides a basis for the integration of biodiesel and bio-ethanol into the framework regulating the petroleum industry. These regulations have a direct impact on biofuel manufacturers' profitability and are therefore discussed briefly.

7.3 THE PETROLEUM PRODUCTS ACT

Recent amendments to the Petroleum Products Act, Act 120 of 1977 as amended, were published in the *Government Gazette*, number 28958, of 23 June 2006 (Government Gazette 2006). This Act and the amended regulations according to this *Government Gazette* form the main frame of reference for Sections 7.3.1 to 7.3.7 below.

7.3.1 Manufacturing biofuels

Biofuel manufacturers are categorised into three categories namely non-commercial manufacturers, category one commercial manufacturers, and category two commercial manufacturers. The non-commercial manufacturers have to register as manufacturers but do not need to license their premises if they do not manufacture more than 300 000 litres per annum. Furthermore, non-commercial manufacturers are exempt from payment of all duties. Category one commercial manufacturers manufacture more than 300 000 litres per annum but only supply to final consumers in the Republic of South Africa. Registration and licensing of their premises is required. Category two commercial manufacturers produce more than 300 000 litres per annum for consumption within the Republic of South Africa, and in Botswana, Lesotho, Namibia and Swaziland, or for export elsewhere. Stringent requirements are applicable for these commercial manufacturers (South African Revenue Services 2006:n.p.).

A biofuel manufacturer should comply with the grading standards discussed in section 7.3.4. It should be noted that these standards do not make any provision whatsoever for additives containing lead in fuel. Furthermore, a biofuel manufacturer may not sell or provide any blend of different petroleum products or other substances that result in the non-payment of any tax, levy or duty.

7.3.2 Price regulation, fuel tax and levies

The selling price of petrol and diesel is, to a large extent, regulated by legislation in South Africa. The pump price of petrol and diesel are reviewed and adjusted on a monthly basis. The elements of the Gauteng pump price of 93 octane petrol on 6 September 2006 are given in Figure 7.1.

Table 7.1 – The elements of the Gauteng pump price of 93 octane petrol, 6 September 2006

Cost element	Cent per litre	Percentage	Percentage
Basic fuel price	390.632	59.5	75.3
Retail margin	43.900	6.7	
Wholesale margin	39.268	6.0	
Zone differentials	13.700	2.1	
Service and cost recovery	7.000	1.1	
Fuel tax	116.000	17.7	24.7
Road accident fund levy	36.500	5.6	
Customs and excise levy	4.000	0.6	
Slate levy	5.000	0.8	
Equalisation fund	0.000	0.0	
Total pump price	656.000	100.0	100.0

Source: Adapted from Department of Minerals and Energy (2006a:n.p.)

Table 7.1 indicates the various elements that added up to the pump price of 93 octane petrol in Gauteng on 6 September 2006. The main cost elements are the basic fuel price (59.5 per cent) and the fuel tax (17.7 per cent). The elements that relate to the cost of fuel and value added services amounts to 75.3 per cent of the pump price. Government taxes and levies collectively make up 24.7 per cent of the pump price. (See the discussion of the various elements in Section 4.2.5.) All these cost elements are set and adjusted through regulation. A seller of fuel has no control over these policies and prices. On 6 September 2006, for example, a bio-ethanol manufacturer who sold its bio-ethanol as petrol directly to the final consumer would have had to charge the pump price of R6.56 per litre and pay the various levies and taxes to the relevant authorities.

The elements of the pump price of low-sulphur diesel on 6 September 2006 are indicated in Table 7.2.

Table 7.2 – The elements of the pump price of low-sulphur diesel, 6 September 2006

Cost element	Cent per litre	Percentage	Percentage
Basic fuel price	428.030	67.6	77.0
Wholesale margin	39.260	6.2	
Delivery cost	7.000	1.1	
Transportation cost	13.700	2.2	
Fuel tax	100.000	15.8	23.0
Road accident fund levy	36.500	5.8	
Customs and excise levy	4.000	0.6	
Slate levy	5.000	0.8	
Equalisation fund	0.000	0.0	
IP marker	0.010	0.0	
Total pump price excluding retail margin	633.500	100.0	100.0

Source: Adapted from Department of Minerals and Energy (2006b:n.p.)

Table 7.2 reveals the cost elements that made up the pump price of low-sulphur diesel, excluding the retailer's margin on 6 September 2006. Again, the basic fuel price is the largest cost element at 67.6 per cent. Fuel tax is the second largest cost, at 15.8 per cent. The cost of fuel and value added services amounts to 77 per cent of the total pump price, excluding the retail margin, while taxes and levies make up the balance of 23 per cent. The retail margin is not regulated by government and is determined by the individual fuel station.

It should be noted that the fuel tax for biodiesel is equal to the fuel tax of petroleum diesel less 40 per cent. The fuel tax is, therefore, 60.0 cents per litre for biodiesel, compared to petroleum diesel's 100.0 cents per litre, as shown in Table 7.2. The selling price of biodiesel is therefore 593.500 cents per litre (633.5 cents per litre less 40.0 cents per litre), excluding the retail margin.

The intended compulsory use of biofuels will have an impact on various aspects of the profitability of biofuel manufacturers. It should, for example, have a major influence on the market size and ways of distribution of biofuel. Some remarks on the intended compulsory use of biofuel are therefore necessary.

7.3.3 Intended compulsory use of biofuels

Although the compulsory use of bio-ethanol is not regulated yet, it is expected that petrol may in the foreseeable future contain 10 per cent bio-ethanol (graded as E10 petrol). The use of E10 or E85 (85 per cent ethanol in petrol) is practised by some developed countries where research has proven that these two percentages provide optimum performance (US Department of Energy 2006). The compulsory use of biodiesel in its pure form or as a blend in petroleum diesel is also not regulated yet; however, regulation regarding the grading of biodiesel is already in place. This grading and the specifications for petrol and diesel are discussed in Section 7.3.4, below.

7.3.4 Standards for fuel (grading and specifications)

Licensed wholesalers may only sell permitted grades of petrol and diesel to final consumers. Biofuel manufacturers who sell directly to final consumers should be aware of the prevailing specifications and standards for their fuel. A brief discussion of standards (grading and specifications) for petrol and diesel seems appropriate, since they directly influence the manufacturing process of biofuel and ultimately the profitability of enterprises producing biofuel.

7.3.4.1 Standards for petrol

Petrol (or bio-ethanol sold to final fuel consumers in its pure form as petrol) should comply with the South African National Standard, Unleaded petrol, SANS 1598. Petrol's grading can be divided mainly between metal-free and metal containing unleaded petrol, with a research octane number (RON) of 91, 93 or 95. This RON is a measure that indicates the capacity of the petrol to prevent engine knocking at low speeds, combined with low engine revolutions and a high gear operation.

According to these standards for metal-free petrol, the maximum permitted traces of lead contamination may not exceed 13 milligrams per litre. Furthermore, the maximum permitted content of aromatics (a group of hydrocarbons that contain benzene rings in their molecular structure) and benzene are 50 per cent per litre and five per cent pre litre respectively. As for metal-containing petrol, the same specifications apply as for metal-free petrol. Furthermore, only one additive – manganese-based (36 milligrams per litre), potassium-based (10 milligrams per litre) or phosphorus-based (14 milligrams per litre) – may be added to metal-containing petrol.

7.3.4.2 Standards for diesel

Petroleum diesel must conform to the South African National Standard, Automotive diesel fuel, SANS 342. Diesel can be divided into standard grade diesel and low-sulphur grade diesel. Standard grade diesel may not have a sulphur content of more than 500 milligrams per litre of diesel. Low-sulphur grade diesel may not contain more than 50 milligrams of sulphur per litre of diesel. Furthermore, there is the grading of diesel as “Bx” (where the “x” indicates the minimum quantity of biodiesel the diesel contains). For example, B10 indicates a minimum content of 10 per cent biodiesel; B50 contains at least 50 per cent biodiesel. B100 is 100 per cent biodiesel and contains no petroleum diesel.

7.3.5 Labelling specifications

A biofuel manufacturer who sells to the final consumer should be aware that its fuel should be labelled according to the specifications set out in the Petroleum Products Act. The label should indicate the fuel and its grading and should be in a standard solid Arial type font size of 55 or larger. This label should be placed next to the nozzle of the fuel pump and on the same side of the pump as the information indicating the price of the fuel. A label that indicates metal-free unleaded petrol must be lettered in white on a green background and state “95, 93 or 91 Metal-free”, as the case may be. Metal-containing unleaded petrol must be lettered in white on a red background stating “95, 93 or 91 Metal-containing”, as the case may be. Metal-containing unleaded petrol that is sold as a replacement for leaded petrol should have the additional indication “LRP” or “AVSR additive”.

Diesel should be indicated by white letters on a black background and state “Standard diesel 500ppm” for standard grade diesel; “Low-Sulphur diesel 50ppm” for low-sulphur grade diesel; or “Biodiesel B100” for 100 per cent biodiesel, as the case may be. Furthermore, diesel that contains biodiesel should be indicated with an additional “Bx”, where the “x” indicates the percentage of biodiesel it contains. For example, B10 is indicative of 10 per cent biodiesel, B30 means 30 per cent biodiesel, or B50 implies a content of 50 per cent biodiesel.

Any biofuel manufacturer that does not comply with these labelling requirements may face penalties. This can put its profitability under pressure. Under the Act, inspectors may inspect a biofuel manufacturer’s products and operations.

7.3.6 Inspection and testing

Under the Petroleum Products Act, inspectors may enter and search any premises, vehicle or container without warrant and seize a whole batch or sample of any petroleum product if transgression of the Act is suspected. Furthermore, inspection is done in order to monitor or verify compliance with the provisions of the Act, the South African National Standards, Unleaded petrol, SANS 1598, and the South African National Standards, Automotive diesel fuel, SANS 342 regulation. An inspector may also demand any relevant documentation in respect of such petroleum products. These are records that a biofuel manufacturer has to keep and they are important for the undisturbed manufacturing of biofuel. They are discussed briefly below.

7.3.7 Records

A licensed biofuel manufacturer should keep records of the grades and quantities of fuel sold. It should also have records on the results of tests performed on any batch of fuel manufactured, including details of the batch and the date of every test. Additional documentation is required if the biofuel manufacturer imports or purchases other petroleum products for use in a blending process. These records should be retained for a period of five years and must be available for inspection at its registered address. The cost of testing fuel and administration expenses increase a biofuel manufacturer's total cost per litre of biofuel and consequently its profitability.

Taxation has a large influence on a biofuel manufacturer's profitability. A discussion of fuel taxes and levies, income tax and value added tax is therefore relevant to this report.

7.4 TAXATION OF BIOFUEL AND BIOFUEL MANUFACTURERS

7.4.1 Income tax

Biofuel manufacturers are subject to the payment of income tax on their taxable income in accordance with the Income Tax Act, Act 58 of 1962, as amended (South Africa 1962). It is not the purpose of this report to discuss the details of the Income Tax Act in respect of income recognition and deductions. In general, income from the sale of biofuel and by-products is taxable and expenses that were incurred to generate these sales may be deducted. Capital investments may only be deducted according to certain provisions in the Act. However, it should be noted that according to section 12B of the Income Tax Act, a

biofuel manufacturer who manufactures biofuel to generate electricity may deduct the cost of the manufacturing equipment, excluding VAT, on a 50/30/20 basis. A similar practice is used by farmers. This means that 50 per cent of the cost of the biofuel equipment may be deducted from income in the first year of operation, 30 per cent in the second year and 20 per cent in the third. This is a special concession to biofuel manufacturers.

Should a biofuel manufacturer qualify as a small business corporation under section 12E of the Income Tax Act, the cost of manufacturing equipment can be deducted in total in the first year of operation and the costs of its other assets on the 50/30/20 basis. A small business corporation is defined as a close corporation, registered under the Close Corporation Act, Act 69 of 1984, as amended (South Africa 1984) or a private company, registered under the Companies Act, Act 61 of 1973, as amended (South Africa 1973). Its shareholders should at all times be natural persons who do not hold shares in other close corporations or private companies. Furthermore, such a small business corporation's gross annual sales should not exceed R6 million, of which not more than 20 per cent is derived from investment income and personal services rendered. According to section 13 of the Income Tax Act, the cost of buildings used in manufacturing can also be deducted at two per cent per annum.

It should be emphasised that biofuel manufacturers should consult qualified accountants for tax planning and tax calculations, since the impact of income tax on a biofuel manufacturer may be substantial.

Value added tax is another direct tax and also requires a brief discussion.

7.4.2 Value added tax (VAT)

Fuel and animal feed are subject to value added tax at the zero rate, according to the Value Added Tax Act, Act 89 of 1991, as amended (South Africa 1991) section 11(h). This means that a biofuel manufacturer does not pay VAT to the South African Revenue Service (SARS) on the sale of biofuel or animal feed. Moreover, input VAT paid on capital and operational costs can be claimed back according to certain provisions. The provisions include the following: the biofuel manufacturer must be registered as a VAT vendor; and VAT input claims must be made from valid tax invoices. Furthermore, enterprises such as farmers may claim a refund on a portion of the fuel taxes paid if diesel is consumed in their farming operations. This refund can be claimed by the registered farmer on its periodic VAT returns.

7.5 CLOSING REMARKS

It is evident that the South African government promotes the manufacture of biofuel to satisfy the demand for energy. There are several advantages that biofuel manufacturers enjoy over petroleum fuel producers, such as lower fuel tax and some income tax deductions. A commercial biofuel manufacturer is, however, involved in the fuel industry and as such is regulated strictly by government. Biofuel manufacturers have to comply with all the relevant laws and regulations and these are very stringent when a biofuel manufacturer sells biofuel to final consumers. These regulations can have a substantial impact on a biofuel manufacturer's profitability. A farmer who manufactures his/her own biodiesel faces fewer legal requirements, provided he/she produces less than 300 000 litres of biodiesel per annum. This biodiesel is to be consumed in the farming operations by the farmer himself/herself.

Government's impact on biofuel manufacturers can be both beneficial and detrimental. It is therefore a force in biofuel manufacturers' macro-environment which has to be reckoned with, since it has a direct and significant influence on a manufacturer's profitability.

PART V

**RELATED MATTERS THAT INFLUENCE THE PROFITABILITY OF
BIOFUEL MANUFACTURERS**

**CHAPTER 8: FINANCIAL RISK MANAGEMENT BY BIOFUEL
MANUFACTURERS**

CHAPTER 8

FINANCIAL RISK MANAGEMENT BY BIOFUEL MANUFACTURERS

8.1 INTRODUCTION

Commercial biofuel manufacturers have a number of profitability objectives. The most important objective is to obtain a required return on investment. To achieve this objective manufacturers develop operational and financial plans based on certain strategies. However, there are elements of risk that could affect a biofuel manufacturer's profitability. In this report, risk refers to a biofuel manufacturer's exposure to a chance of suffering a financial loss. Biofuel manufacturers therefore have to manage their risk effectively and efficiently. A brief discussion on risk management is therefore relevant to this study.

8.2 RISK MANAGEMENT

A comprehensive risk management plan should be developed, implemented and reviewed periodically by every biofuel manufacturer. This risk management plan sets out a description of all the risks the biofuel manufacturer faces. In a certain sense, this plan describes everything that can go wrong in the business. For example, a biofuel manufacturer may face a risk of an explosion of biofuel in the manufacturing process. This explosion may cause injuries and even death to employees and an interruption in biofuel manufacture. The risk management plan should contain information on every stated risk, giving details of at least four aspects. Firstly, management should know what the probability is of the threat posed by the particular risk. Secondly, what would the financial and operational impact on the business be if that eventuality occurs? Thirdly, management should know what must be done to prevent risks, if possible. Fourthly, the action to be taken should be very clear if the event does occur. Disaster prevention and recovery plans should receive high priority from management and they should be reviewed and updated regularly. This will ensure that financial losses that result from disasters are kept to a minimum.

Not all events can be classified as disasters. However, risks may put pressure on a biofuel manufacturer's profitability and their impact should therefore be minimised as far as possible. For example, the selling price of fuel might decrease or the cost of feedstock might increase more than was anticipated. In these circumstances, a biofuel manufacturer can hedge its risk of undesirable movements in the market to a relatively large extent. Hedging of sales, the cost of feedstock and foreign exchange transactions therefore require further discussion.

8.3 HEDGING AS A RISK MANAGEMENT TOOL

Hedging refers to management's efforts to eliminate the risk component or uncertainty that is associated with a certain type of transaction. For example, the availability and cost per ton of feedstock may change unfavourably due to drought. Some financial instruments, such as futures, forwards, options and swaps may be used by biofuel manufacturers to manage certain risks. (It is not the objective of this report to describe the mechanisms of financial risk management instruments in detail.) Depending on the scope and intensity of risks in the risk environment, futures contracts and forward contracts as hedging alternatives can contribute to the profitability of biofuel manufacturers. Thus a brief discussion of futures and forward contracts seems appropriate.

8.3.1 Futures contracts

A futures contract can be described as an agreement by one party to either buy or sell an item at a certain price at a certain future date (Hull 2005:1). For example, a biodiesel manufacturer's financial risk that the cost of sunflowers as a feedstock may increase considerably in the foreseeable future may be eliminated by entering into a futures contract. According to this futures contract, the biofuel manufacturer will purchase a certain quantity of feedstock and pay a certain price per ton at a specific date in future. A futures contract, such as JUL07 SUNS that was offered on SAFEX at R2 082 on 14 September 2006 may be a suitable hedge for the cost of sunflower feedstock (SAFEX 2006). Should a biofuel manufacturer be in a position to buy sunflower feedstock from another feedstock producer at a lower cost in July 2007, the biofuel manufacturer will be financially worse off. On the other hand, the uncertainty with regard to the cost of sunflower feedstock until July 2007 is eliminated. The actual spot price in July 2007 may also be higher than the current futures price. In that case, the biofuel manufacturer will be financially better off.

A biofuel manufacturer may also enter into private contracts with particular feedstock producers in his neighbourhood to supply a specific quantity of feedstock at a certain price per ton at a specific future date. Biofuel and by-product sales can also be hedged by entering into agreements with customers to buy certain quantities of biofuel at certain prices at certain future dates. Currently, no fuel futures contracts are traded on SAFEX. These private agreements have basically the same objective as futures contracts on the buying side. The main differences are that these agreements are made with known feedstock producers or customers, and these agreements are not tradable financial instruments.

Forward contracts as financial instruments for hedging are discussed briefly in the following paragraph.

8.3.2 Forward contracts

Forward contracts function in a similar way to futures contracts. They are also contracts to sell or buy assets at certain prices at certain future dates. Forwards, however, are not traded on exchange markets (Hull 2005:5). Forwards contracts are generally used to hedge transactions where foreign currencies are involved. For example, a biofuel manufacturer may order biofuel manufacturing equipment valued at \$100 000 from an enterprise in the United States of America and be obliged to pay for it within one month. The Rand/US Dollar exchange rate may be expected to increase (more Rand per US dollar) during this period, the value of the Rand thereby decreasing. The biofuel manufacturer may therefore decide to hedge this risk by entering into a forward rate contract with a bank to buy \$100 000 at a fixed rate at the particular future date when payment to the supplier is due. Should the actual exchange rate at payment date be lower than the forward rate, the biofuel manufacturer will be financially worse off. On the other hand, the risk element was removed to a large extent. The biofuel manufacturer may also gain profit when the actual exchange rate is higher than the forward rate.

There are however, other risks which cannot be managed through futures and forward contracts. Events (risks) may occur which can jeopardise a biofuel manufacturer's financial viability. Biofuel manufacturers can protect themselves financially especially when their income-generating assets are lost. Short-term insurance as a risk management tool is therefore discussed briefly.

8.4 SHORT-TERM INSURANCE AS A RISK MANAGEMENT TOOL

Preventative risk management is of the utmost importance, since the cost of short-term insurance can be relatively high. Furthermore, claims sometimes lead to the loss of a no claim bonus. The insurance premium of a biofuel manufacturer may therefore increase after a claim for the theft of a vehicle, for example.

8.4.1 Accidents and theft

The assets of a biofuel manufacturer, such as vehicles, equipment and feedstock, can generally be insured against losses due to accidents or theft. The Republic of South Africa

faces a food security threat. This food security threat increases the risk of theft of edible feedstocks, such as maize and soybeans. (It should be noted that *jatropha curcas* seeds are toxic to humans and animals and therefore pose a relatively small risk of theft.)

8.4.2 Loss of income-generating assets

A biofuel manufacturer can insure its gross profit capability in case some or all its income-generating assets are lost. For example, should an explosion or fire destroy all the biofuel manufacturing equipment, it may take five months to rebuild the plant. The equipment should be insured with the intention that the biofuel manufacturer will not suffer financially when replacing the equipment. Furthermore, the biofuel manufacturer will not be able to generate income during the five month period needed to rebuild the biofuel plant. The loss in income (sales less cost of sales) should therefore be insured in order to pay for all fixed expenses during that period.

A farmer or groups of farmers that market their produce by manufacturing biodiesel may expect unfavourable economic conditions in the foreseeable future. They may decide to suspend biodiesel manufacture for some time, since their capital investment may only consist of biodiesel manufacturing equipment. This option is only available to farmers and not to independent biofuel manufacturers and therefore requires a brief discussion.

8.5 SUSPENDING OPERATIONS IN UNFAVOURABLE ECONOMIC CONDITIONS

Certain economic conditions can cause biodiesel manufacturing not to be profitable for a farmer who manufactures his/her own biodiesel. These conditions may include low fuel prices and high feedstock prices. These risks cannot be managed effectively and efficiently in the long run. A farmer who expects these economic conditions to prevail for the foreseeable future may decide to suspend biodiesel manufacturing temporarily. It should be noted that in this scenario the farmer's main business is farming, while biodiesel manufacturing is an additional value adding activity.

8.6 CLOSING REMARKS

It is clear that unforeseeable changes in a biofuel manufacturer's business environment can have a negative impact on profitability. The risks related to the occurrence of these unwanted events should be managed effectively and efficiently as far as possible. This can be done through a comprehensive risk management plan, hedging sales, cost of sales, and

foreign exchange transactions through financial instruments, contracts, short-term insurance of assets and insurance against a loss of income. In short, a comprehensive risk management plan should be designed in order to prevent loss or to limit the impact of potential and real risks on the profitability of a biofuel manufacturer.

PART VI

CLOSING REMARKS

CHAPTER 9: SUMMARY AND RECOMMENDATIONS

CHAPTER 9

SUMMARY AND RECOMMENDATIONS

9.1 INTRODUCTION

In this research report, several issues regarding the profitability of biofuel manufacturers were discussed. In conclusion, a summary of the research report, a summary of the research findings, recommendations and areas for further research are given.

9.2 SUMMARY OF RESEARCH REPORT

In this study it became evident that, although the biofuel industry is still in its infancy in the Republic of South Africa, it will become a meaningful and significant role player in the broad fuel and energy industries in the foreseeable future. The profitability of biofuel manufacturers will undoubtedly be one of the pivotal points in the establishment, maintenance and growth of these manufacturers in the long term.

This study endeavoured to identify and describe qualitatively and quantitatively some of the main factors and aspects that affect the profitability of biofuel manufacturers. In this regard emphasis was placed on the following:

- biofuel manufacturing in South Africa;
- biofuel manufacturer value chain activities;
- competition in the biofuel industry;
- governmental forces in biofuel manufacturers' macro-environment; and
- related matters that influence the profitability of biofuel manufacturers.

Specific aspects that received attention included biofuel manufacturing processes and capital investment, feedstock for biofuel manufacturing, biofuel sales, other revenues from biofuel by-products and related expenses. The main research results are summarised in the next section.

9.3 SUMMARY OF RESEARCH FINDINGS

In Section 1.4, the objectives of the study were identified. Sections 9.3.1 to 9.3.5 show to what extent these objectives have been achieved. These objectives are grouped under the following headings: introduction to biofuel in South Africa, biofuel manufacturer value chain

activities, competition in the biofuel industry, macro-environmental forces faced by biofuel manufacturers, and related matters that influence biofuel manufacturer profitability.

9.3.1 Introduction to biofuel in South Africa

Biofuel possesses properties similar to petroleum fuel and is manufactured from renewable biological resources. The type of biological resource or feedstock used determines the manufacturing process and the type of biofuel manufactured. Maize, wheat and sugar can generally be used as feedstock for bio-ethanol manufacturing using a fermentation process. Biodiesel is manufactured through the esterification of oil seeds from a feedstock such as sunflowers, soybeans and *jatropha curcas*. The type of manufacturing process choice has a direct impact on the total capital investment. A relatively small biodiesel manufacturer can expect to invest R1 518 000 for a 1 000 litre per day plant (or R1 518 investment per litre capacity) and on a sliding scale up to R2 846 000 for a biodiesel plant with a capacity of 4 000 litres per day (or R712 investment per litre capacity). Economies of scale are clearly illustrated by these figures.

The Republic of South Africa should focus on the local manufacture of biofuel in the interest of national economic and social objectives for three main reasons. Firstly, expensive fuel imports put pressure on the balance of payments. Secondly, global warming poses a threat to the long-term existence of mankind. Although the burning of fuel contributes to global warming through carbon dioxide emissions, the production of the feedstock utilises carbon dioxide. Thus, the net effect of biofuel burning does not contribute significantly to global warming. Thirdly, the agricultural industry in South Africa plays an important role in the national economy. Agriculture in South Africa is performed on roughly 14 million hectares of commercial arable land, and almost one million people are employed in agriculture. Agriculture can benefit substantially from an additional market for farmers' produce created by biofuel manufacture.

The importance of biofuel manufacture in South Africa has been established. The cost of feedstock, biofuel sales, the sale of by-products and related expenses are incurred through the biofuel manufacturer's value chain activities. Findings on these aspects are subsequently discussed.

9.3.2 Biofuel manufacturer value chain activities

The choice of feedstock is one of the most important decisions a biofuel manufacturer has to make. The type and availability of feedstock determines, *inter alia*, the cost of feedstock, the location of the biofuel plant, the manufacturing process, the final product (biodiesel or bio-ethanol), the quantity of biofuel per ton of feedstock and the marketable by-products. A biofuel manufacturer is generally located in a province where the feedstock is available in sufficient and sustainable quantities. For example, maize and sunflowers are primarily produced in the Free State and the North-West province. Soybeans are mainly produced in Mpumalanga, while wheat is produced primarily in the Free State and in the Western Cape.

The cost of feedstock per litre of biofuel produced is influenced by the SAFEX price of the grain used per ton, the import parity price, and the biofuel conversion yield per ton of feedstock. According to SAFEX's June 2006 prices and conversion yields, the cost of maize as feedstock was R2.97 per litre of bio-ethanol manufactured, for sunflowers it was R3.91 per litre of biodiesel manufactured, for soybeans the cost was R6.72 per litre of biodiesel manufactured, and for wheat it was R3.73 per litre of bio-ethanol manufactured. The cost of *jatropha curcas* seeds per ton was not available at the time of investigation.

Biofuel selling prices are affected by the international price of crude oil and the Rand/US Dollar exchange rate. It was found that OPEC production changes and major world events such as wars and new oil field discoveries can have a negative or positive effect on the international price of oil. Currently, global economic growth contributes to a relatively high demand for fuel. This inevitably leads to higher oil prices. The future supply of crude oil is uncertain. This phenomenon further improves the case for biofuel. To a large extent reliable information on the demand for biofuel in South Africa was not available when the research was done. However, the biofuel consumption trends in the United States of America, Germany and Australia are expected to prevail in South Africa. In South Africa, biodiesel sells at the same price as petroleum diesel, which was R4.28 per litre, excluding taxes and levies, on 6 September 2006. Bio-ethanol sold at around R2.80 per litre.

An important source of additional income for biofuel manufacturers is the sale of by-products. The various feedstocks yield different quantities of marketable glycerine and animal feeds per ton. Again, the various animal feeds from the different feedstocks have different selling prices. According to September 2006 retail prices, the income from the sale of animal feed from maize was R0.94 per litre of bio-ethanol manufactured; for sunflowers it was R2.83 per litre of biodiesel manufactured; for soybeans the figure was R7.07 per litre of biodiesel

manufactured; and for wheat it amounted to R0.71 per litre of bio-ethanol manufactured. Revenue from the sale of glycerine was R2.67 per litre for glycerine derived from sunflowers, R7.07 per litre for that from soybeans and R1.04 per litre for that from *jatropha curcas*.

In the biodiesel manufacturing process, methanol (R0.54 per litre), caustic soda (R0.03 per litre) and biodiesel additives (R0.07 per litre) are required. These costs are applicable when sunflowers, soybeans and *jatropha curcas* are used as feedstock.

The net contribution to the gross profit of the biofuel manufacturer at September 2006's prices for the various feedstocks were the following: maize R0.74 per litre, sunflowers R2.79 per litre, soybeans R6.81 per litre, wheat R-0.77 per litre and *jatropha curcas*, excluding the cost of *jatropha curcas* seeds, R4.68. From a by-product perspective, it is evident that certain feedstocks are more profitable than others. However, the cost of the feedstock and consequently the selling price of the animal feed by-product per ton may vary considerably over time.

With the value chain activities in place, biofuel manufacturers have to deal with competition in the biofuel industry. This competition can put significant pressure on a biofuel manufacturer's profitability. The findings regarding competition are discussed in the following section.

9.3.3 Competition in the biofuel industry

It was found that the main competitive forces faced by South African biofuel manufacturers are the threat of potential new biofuel manufacturers, and petroleum petrol and diesel as alternative energy products. The entry barriers to the biofuel industry are relatively low, since there are at present relatively few biofuel manufacturers in a potentially profitable industry with fairly high selling prices. Feedstock producers have considerable bargaining powers, since the biofuel industry is but one of several marketing channels for their produce. Furthermore, feedstock producers may integrate forward in the biofuel value chain and oil companies may enter the biofuel industry in order to comply with the anticipated governmental requirement of compulsory blending of biofuel into their petroleum fuel. Other alternative energy products, especially for electricity generation, include nuclear, hydro, wind and solar power. These products are, however, not regarded as serious competitive threats to biofuel manufacturing.

Biofuel manufacturers should have a sound knowledge of the key success factors required to counter these competitive forces effectively. It was found that biofuel manufacturers should, *inter alia*, be experts in biofuel technology. Biofuel attributes should be improved continuously. Furthermore, biofuel manufacturers should manage their resources in such a way that their productivity and efficiency are optimised. A biofuel manufacturer should have viable marketing channels and significant capabilities to deliver biofuel according to customers' needs. A SWOT analysis is highly recommended. This will determine, *inter alia*, a biofuel manufacturer's resource strengths and weaknesses, and also the possible opportunities and threats that may exist in its business environment.

In view of the required key success factors and the results of a SWOT analysis, a biofuel manufacturer could exercise four sets of strategic choices to improve its competitiveness. Firstly, the biofuel manufacturer should decide which generic competitive strategy to follow. The five generic choices are a low selling price, a focused market low selling price, broad differentiation, a focused market broad differentiation and best selling price strategies. Each of these generic strategies has its own benefits and disadvantages. Each biofuel manufacturer has to decide which strategy suits it best. Secondly, a biofuel manufacturer should employ complementary strategies that enhance its basic or generic strategic approach. These strategies include strategic alliances, mergers and acquisitions, backward or forward integration, outsourcing, offensive moves and defensive moves. Again, the particular biofuel manufacturer has to decide which complementary strategies are available and manageable, in view of its objectives. Thirdly, functional area strategies, such as research and development, should be implemented to support the biofuel manufacturer's generic and complementary strategies. Fourthly, the timing of when to implement a specific strategy is as important as the strategy itself. Being a first mover, fast follower or late mover has unique benefits and disadvantages. Furthermore, these strategies should be tailored to each biofuel manufacturer's specific characteristics and circumstances.

As an element of the macro-environment of such manufacturers, the government of the day can have a direct influence on the profitability of biofuel manufacturers. Findings regarding the government as a macro-environmental force are discussed below.

9.3.4 Government as a macro-environment force affecting biofuel manufacturers

The manufacture, standards and sale of fuel are regulated by the Petroleum Products Act, Act 120 of 1977 as amended. Although all biofuel manufacturers have to register as manufacturers, different reporting and fuel taxation rules apply for different sized

manufacturers. A biofuel manufacturer that produces less than 300 000 litres per annum and uses the fuel in other operations, such as farming, is exempt from most report duties and the payment of fuel taxes and levies. The sale of biofuel or consumption of more than 300 000 litres of biofuel per annum impose stringent reporting and record keeping duties. Biodiesel is subject to 40 per cent less fuel tax than petroleum diesel. These incentives for biofuel manufacturers prove government's desire to stimulate the local production of biofuel.

Another impact government has on biofuel manufacturers' profitability is income tax according to the Income Tax Act, Act 58 of 1962 as amended. Qualifying biofuel manufacturers may benefit from certain wear and tear allowances. Biofuel manufacturers also benefit from certain value added tax (VAT) provisions, according to the Value Added Tax Act, Act 89 of 1991. Fuel and animal feed are subject to VAT at the zero rate. Biofuel manufacturers can therefore claim input VAT on qualifying purchases, but should not charge VAT on the sale of biofuel or animal feed by-products.

Other macro-environment forces such as economic conditions, political risks, technological advances, ecological forces and societal demands have a definite impact on biofuel manufacturers' profitability. (Quantifying the impact from these forces on the profitability of biofuel manufacturers falls beyond the scope of this study.)

In an attempt to limit various variable costs and risks, biofuel manufacturers should endeavour to manage their financial risks. Findings on related matters are discussed in the section below.

9.3.5 Related matters that influence biofuel manufacturer profitability

Biofuel manufacturers should develop and implement a comprehensive risk management plan detailing all the possible risks, the probability of occurrence, their financial impact if they do occur, and what preventative and recovery actions can be taken.

Hedging, by means of financial instruments such as futures and forward contracts can be used to minimise uncertainty resulting from the financial impact of future transactions. SAFEX futures contracts can be used effectively as a hedge for unforeseen changes in the future price and quantity of grain feedstocks.

Short-term insurance is a mechanism available to biofuel manufacturers to insure their assets against accidents and theft. Furthermore, biofuel manufacturers can insure their

expected gross profit for a certain period, should all or most of their income-generating assets be lost.

Suspension of biofuel manufacturing as a strategy is also an option for farmers who manufacture their own biofuel. This can, for instance, be considered when the farmer can market his/her produce more profitably through other channels.

Recommendations based on the above findings of this study are made below.

9.4 RECOMMENDATIONS

This study has found that there are a large number of potential new biofuel manufacturers in South Africa. As a matter of fact, a number of biofuel manufacturers are in the process of commencing business already. The question is how a potential biofuel manufacturer should enter the biofuel industry. Naturally, there are many options in this regard. Due to the numerous variables and forces involved, and based on the findings of this study, a two-step strategy is recommended for a biofuel manufacturer (a new entrant and/or an existing one): first, design, develop, implement and maintain a comprehensive business plan. Second, implement a comprehensive business audit on the execution of the business plan. Aspects of a business plan for a biofuel manufacturer and of an applicable business audit are discussed below.

9.4.1 Business plan for potential new biofuel manufacturers

The importance of a well-developed business plan cannot be overstated. This business plan is the primary document used to obtain finance for all the required fixed assets, the intellectual property assets and working capital. Furthermore, the business plan sets out the initial strategies and actions the potential new biofuel manufacturer should take, as well as the budgeted financial statements for the first financial period. Some important aspects of the business plan, namely a description of the proposed business, the target market, and the financial planning deserve attention.

9.4.1.1 Description of the proposed biofuel manufacturing business

Kipling, quoted by Reynders (1975), once said: "I had six stalwart men. They told me all I know. Their names are what, where, why, when, who, and how." A comprehensive business plan should answer these questions. The questions asked by financiers (and what the

managers of the enterprise will be held accountable for), include the following: What does the proposed enterprise intend to do and what is required to achieve this objective? Where does it intend to be located and where will it acquire its feedstock and other supplies from? When does it intend to recruit people, build a plant, acquire supplies, operate, sell products and receive cash? Who will manage, supply feedstock, perform value chain activities, and distribute? How will every aspect be managed to achieve the objectives? The overall question that must be answered for every aspect is: why? It should be stated why every strategy or action is chosen above other options. These detailed descriptions of the proposed business are incomplete unless the enterprise's market is described in detail.

9.4.1.2 The biofuel manufacturer's target market

Sales of biofuel and by-products are among the most important aspects of a biofuel manufacturer's business. It is recommended that a potential new biofuel manufacturer perform a well-developed market survey with the assistance of qualified business research organisations such as Business Enterprises at University of Pretoria (Pty) Ltd. The manufacturer should know the answers to the questions of what, where, why, when, who, and how, about its target market. A new biofuel manufacturer should have answers for the following questions: Who is the target market? Where do the customers want to acquire or use the biofuel? How much biofuel will they buy? When will they buy biofuel? How much are the customers prepared to pay? What other requirements do customers have? A proper marketing strategy should be developed based on this information.

A potential new biofuel manufacturer should use the information from the market survey, its production capacity, total capital investment, and expected operating expenses in order to compile a financial plan.

9.4.1.3 The biofuel manufacturer's financial plan

The financial plan is an important tool to manage the generally limited funds of an enterprise. The amounts reflected in the projected income, expenses and cash flow should be used as a guideline by managers on how much money to spend on what and when. These projected figures should be used as comparative figures for actual financial results. Managers are held accountable by shareholders and must achieve the projected figures. Any discrepancies should be explained.

After the business plan has been implemented, the biofuel manufacturer should conduct periodic business audits. They are a powerful tool to determine whether the biofuel manufacturer is still on course towards achieving its objectives.

9.4.2 Business audit for existing biofuel manufacturers

A business audit is a comprehensive and structured re-evaluation of a biofuel manufacturer's total business. The business audit is directly linked to the biofuel manufacturer's functional areas, field of business and macro-environment. During the business audit, an assessment should be made of the current situation the biofuel manufacturer finds itself in and management's performance. The biofuel manufacturer should examine its internal, market and macro-environment to identify possible opportunities and threats. A SWOT analysis, as described in Section 6.3.2, is useful to determine the enterprise's strengths, weaknesses, opportunities and threats. Checklists provide systematic and step-by-step answers to a series of questions. This information may lead to adjustments to the biofuel manufacturer's current strategies, as discussed in Section 6.3.

In conclusion it may be stated that in this study a number of obstacles and areas for further research were identified. These obstacles and areas are discussed below.

9.5 LIMITATIONS AND AREAS FOR FURTHER RESEARCH

During the course of the study areas were identified where no information is available, areas where limited information is available and aspects which were unclear or doubtful. Enterprises intending to venture into biofuel manufacturing are unwilling to disclose detailed information on their capital investments, markets and certain other aspects that influence their profitability. It is recommended that these and other aspects should be researched. Three of these areas, namely a biofuel market survey, the cost of *jatropha curcas* as feedstock, and the total capital investment in a biofuel plant, require further attention.

9.5.1 Biofuel market survey

Currently the selling price of biodiesel is equal to that of petroleum diesel. Bio-ethanol is sold at the prevailing market price of ethanol, a substance that can be chemically processed into various products. However, the benefits society gains from the use of biofuel (biodiesel and bio-ethanol), as opposed to generally imported petroleum fuel, are significant. It can therefore be argued that the final consumer should pay a premium for biofuel. This premium

can be compared to social responsibility investments in the community at large. The final consumers' awareness and perception of biofuel, including the expected price per litre, should therefore be determined through a comprehensive market survey.

9.5.2 Cost of *Jatropha curcas* as a feedstock in biodiesel manufacturing

Jatropha curcas possesses attractive properties as a feedstock in biodiesel manufacturing. However, there is currently not an open market for *Jatropha curcas* seeds. Biodiesel manufacturers have to produce *Jatropha curcas* seeds themselves. No detailed information on the production costs of *Jatropha curcas* seeds is available, at present. Further research should be done to determine the total production cost per ton of *Jatropha curcas* seeds produced. This should be done in order to determine the gross contribution of biodiesel manufactured from *Jatropha curcas*, compared with the other feedstocks such as sunflowers or soybeans.

9.5.3 Total capital investment in a biofuel plant

The capital investment in the manufacturing equipment can be determined if a turn key plant is bought from an engineering enterprise. However, this capital investment in equipment may be only a relatively small portion of the total capital investment a biofuel manufacturer has to make. The cost of other assets such as land, buildings, storage facilities, vehicles and working capital vary from one location to another and from one enterprise's managerial preferences to another. Research should be done to determine an average total capital investment for a biofuel manufacturing plant with a certain capacity. This information can be of assistance to potential new biofuel manufacturers conducting economic feasibility studies.

9.6 CLOSING REMARKS

This research project was undertaken to investigate some aspects that influence the profitability of biofuel manufacturers, to a lesser or greater extent. It is obvious that this industry is still very young in South Africa, but it is very dynamic.

In conclusion, biofuel manufacturers should perhaps take note of the words of Daniel Burnham: "Make no little plans; they have no magic to stir men's blood!"

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