ARE FARMERS CHANGING FROM FOOD PRODUCTION TO BIOFUEL PRODUCTION? A CASE STUDY OF THE NORTHERN AGRICULTURAL REGION OF KWAZULU-NATAL

RESEARCH MINI-DISSERTATION

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DECLARATION

This research was carried out under the supervision of Dr Denis Rugege and Co-supervisor of Mr D. Cimhamhiwa who is Senior Lecturer and Programme Director for Land Information Management in the Centre for Environment, Agriculture and Development.

I Fezeka Faith Mbele, declare that the work contained in this Mini-dissertation is entirely my own work with the exception of quotations or references which I have attributed to their authors or sources. Furthermore it has not been submitted for any degree or examination in any university.

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ABSTRACT

A study was conducted to establish whether farmers are changing land use from growing food crops for human consumption to biofuel production to an extent that could significantly affect food security. Following concerns in the recent years about the excessive global demand for fossil fuel that drove prices to very high levels, biofuel alternatives derived mainly from agricultural food crops such as soybean, maize and sugarcane are being pursued in many countries.

This study targeted a sample emerging farmers in the Northern Agricultural Region, one of the four administrative areas for agricultural extension services in the province of KwaZulu-Natal. Bio-physical suitability for change from maize food crop to soybean for biofuel land use was assessed using the locally developed Bio-resource spatial database. A sample of 11 emerging farmers was interviewed regarding land use change of food to biofuel production, farming operations, inputs and yields. Emerging farmers are black African farmers who were previously deprived of land and institutional support in developing into commercial farmers, but who are now recipients of land as well as financial and technical agricultural support services. This group of farmers arguably comes from vulnerable communities who depend on food crops for subsistence and who could influence change in land use with food security implications in their communities. Further information was obtained from an agricultural consultant regarding 7 commercial farms producing soybean biofuel.

The study revealed that the Northern Agricultural Region had adequate suitability for profitable soybean production for biofuel. Furthermore, the majority of farmers interviewed had changed from maize production for human consumption to soybean production for biofuel. All the farmers interviewed applied farming operations with modern technology including land preparation and planting, fertilisation, irrigation, crop protection and harvesting. The majority interviewed farmers reported varied total earnings from soybean derived biofuel ranging from R 50, 000 to R 500, 000. The variability in earnings is consistent with the varied range of ages as attributable to experience and with the varied levels of education which may be related to management skills.

Although the sample of farmers interviewed was too small to provide statistically valid conclusions, they represent an important sector in the farming community that shows future directions of food versus biofuel productions. The farmers indicated that they are fully aware of food production requirements and will endeavour to balance the two through soybean-maize crop rotation, a practice that not only ensures food security but also improves soil quality.

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ACRONYMS

BRU	Bio-Resourse Unit
CASP	Comprehensive Agricultural Support Programme
DoA	Department of Agriculture
DWARF	Department of Water Affairs and Forestry
EIA	Environmental Impact Assessment
EU	European Union
FAO	Food and Agriculture Organization
GHG	Green House Effect
KZN	KwaZulu-Natal
NEPAD	New Partnership for Africa's Development
CAADPI	Comprehensive Africa Agriculture Development Programme Implementation
OECD	Organisation for Economic Co-operation and Development
SADC	Southern African Development Community
SPSS	Statistical Package for the Social Sciences
STATSA	Statistics South Africa
UN	United Nations
US	United States
USA	United States of America
WDR	World Development Report
WWF	World Wide Fund

CHAPTER 1

1. ORIENTATION OF THE STUDY

1.1 Introduction

The use of vegetable oils as alternative fuel has been reported since the beginning of the last century when the inventor of the diesel engine, Rudolph Diesel successfully tested coconut oil as an alternative source of diesel fuel (Shay, 1993; Knothe, 2001; Mittelbach and Remschmidt, 2004; Corrêa and Arbilla, 2006). However, during the 1920s, diesel engine manufacturers altered their engines to utilise the lower viscosity fossil fuel derived petrodiesel due to poor atomisation of the high viscosity vegetable oil fuel in the fuel spray process which often resulted in deposits and "coking" of fuel injectors, combustion chambers and valves (Bona, Mosca and Vamerali, 1998). According to Bona, Mosca and Vamerali (1998), a patent for a procedure for the transformation of vegetable oils for their use as fuels (transesterification) using methanol and ethanol was granted to G. Chavanne of the University of Brussels (Belgium) on August 31, 1937, leading to the production of what is known as 'biodiesel' today.
Only recently have environmental impact concerns and the ever increasing price of fossil fuels lead to more attention being focused on the cheaper biofuel alternatives.

Renewable fuels that can be manufactured from conventional agricultural crops, the so called 'energy crops' or by the conversion of waste vegetable oils and animal fats are now commonly referred to as biofuels (Wilson, Matthew, Austin and von Blottnitz, 2005). Biofuels, unlike fossil fuels are referred to as clean-burning because they produce significantly reduced emission levels of carbon dioxide (CO_2) and other hydrocarbon Green-House Gases (GHG) mainly from internal combustion engines. GHG are currently attributed to the global warming phenomenon which in turn is suspected to be responsible for adverse climate change. Biofuels are envisaged to improve air quality by reduced vehicle emissions and to improve energy security, particularly in rural areas and in countries with limited reserves of fossil hydrocarbons, as well as creating employment in the agricultural sector.

According to Bona, Mosca and Vamerali (1998), an Austrian company, Gaskoks, obtained the technology from the South African agricultural engineers and proceeded to install the first biodiesel pilot plant in November 1987 and the first industrial-scale plant in April 1989 with a capacity to use 30,000 tons of rapeseed per annum.

However, according to Kupta, Lemmer and Makenete (2007), biofuel production has raised a debate in South Africa and across the globe surrounding the long term impacts of using of food crops for biofuel production on food prices and food security as well as competition for land between food crops and biofuel crops. A more detailed discussion of the research problem is provided in the next section.

1.2 Definition of key concepts

1.2.1 Introduction

In order to understand this research, it is important to understand the terms used to describe it. In this regard, the next paragraph is describing the definitions of the key concept. Concepts provide the general representation of the phenomena to be studied and are the building blocks that determine the whole course of the study (Veal, 1997).

- Biofuel is a renewable fuel that can be manufactured from conventional agricultural crops.
- Feedstock is a raw material supplied to a machine or processing plant from which other products can be made.

- Biodiesel is a renewable fuel that can be produced from crops such as soybean, canola, sunflower and groundnut.
- Bioethanol is a renewable fuel that can be produced from crops such as maize, sugarcane, sorghum and wheat.

(Source: Mittelbach and Tritthart, 1988).

1.3 Problem Statement

As mentioned in the introduction, biofuel is manufactured from the agricultural crops that are traditionally used mostly for food. These crops are respectively converted to produce ethanol or biodiesel according to the type of feedstock. In this regard, plans to use food crops to produce biofuel have raised concerns due to the assumption that they might be overexploited thus jeopardising food security (Naylor et al., 2007). The concern is mainly based on the argument that if these crops are diverted into fuel production, people might end up starving as there will not be enough food produced for human consumption. To the extent that the largest area of farmland in South Africa is planted with maize, followed by wheat and, to a lesser extent, sugarcane and sunflowers, the concern appears to be real.

Furthermore, it is recognised that the debate surrounding biofuels worldwide (Sugrue, 2007) with respect to productive adequacy as an alternative to fossil fuels without threatening food security on the one hand and effectiveness in mitigating CO_2 emissions on the other. It is thus important to analyse this issue in detail so as to understand what the sustainable path may be.

1.4 Justification

Ever since the term biofuel was introduced, there has been a lot of unsettling questions asked by various stakeholders such as farmers, communities and various government and private departments (Hart, Raswant & Romano, 2008) regarding policies meant to promote affordable, alternative energy sources capable of maintaining current energy consumption levels, supporting further economic growth and reducing fossil oil dependency.

It should be noted that concerns have not yet been comprehensively clarified or answered as to whether biofuel production will be beneficial or cost efficient to all the stakeholders involved. Hence, there is still a lot of debate as to whether food should be turned into oil for fuel and if this has already taken place, to what extent will it impact positively or negatively to the decisions taken by the officials to address food security and other concerns discussed in the previous sections (World Development Report - WDR, 2008).

The aim of this research, in this regard, is to identify and understand whether there is a change from growing food crops for human consumption to biofuel production and whether the change is sustainable with respect to biophysical suitability and profitability. A conceptual framework for the research was formulated as described in the next section to establish whether there is a developing trend of change of land use from human consumption food crops to biofuel production.

Emerging farmers are those that belong to the group of mainly black African people who, during the apartheid regimes were forcibly removed from land and/or excluded from state and other agency support of farming activities and who therefore could not participate in the agricultural economy, but who are now receiving land and support and are being encouraged to produce commercially (Hart, Raswant and Romano, 2008).

An area in the KwaZulu-Natal province was selected where there were preliminary indications that traditional maize producing small-scale and emerging farmers were now growing soybean for biodiesel production. The soybean crop was selected for the study due to its potential expansion in areas of high rainfall such as KwaZulu-Natal as suggested in the New Partnership for Africa's Development-Comprehensive Africa Agriculture Development Programme Implementation (NEPAD-CAAPDI, 2007).

Moreover, some producers blame low food production in South Africa on the lack of local markets (Kupka, Lemmer & Makenete, 2007). In this regard, soybean meal for instance is the world's most important protein feed, accounting for nearly 65% of world protein (World Bank, 2007). Soybean is therefore a vital part of the human food chain and therefore key to enhancing food security. In addition, when it comes to land use change, soybean can easily adapt when being rotated with crops such as maize, dry beans, sunflower, and groundnuts.

It is therefore likely that changes in land use favouring biofuel production would involve soybean as preliminary indications in the study can be shown. The research hypothesis, objectives and methods are described in the next sections.

1.5 Hypothesis

Below is an assumption that this dissertation is based upon.

There is no change from maize based land use systems for food to soybean based systems for biofuel production among emerging farmers of the KwaZulu-Natal Northern Agricultural Region.

1.6 Research questions:

The following questions provide the researcher with the ability to identify and understand the purpose of the study.

- Is the biophysical environment of the KwaZulu-Natal Northern Agricultural Region suitable for the changes to soybean land use systems?
- Is there evidence of farmers changing from maize crop production for human consumption to soybean production for biodiesel supply?

1.7 Objectives:

Below are the objectives that provide the researcher with the ability to identify the intention, idea and goal of the study.

- To assess the biophysical suitability for the soybean land use systems in selected areas cultivated by emerging farmers.
- To assess whether emerging farmers in the Northern Agricultural Region of KwaZulu-Natal are changing from maize production for human consumption to soybean as a biofuel.

1.8 Conclusion

Given the fact that agriculture is an important aspect to poverty alleviation strategies in urban and rural poor households it has been important to assess the biophysical suiability land use of biofuel producing crops in particular farms. Biofule production has emerged at the intersection of a number of debates such as poverty alleviation, economic empowerment, household food security and conservation of the natural environment (Hart, Raswant and Romano, 2008). This suggests that attention is urgently required to understand the local and national food security and nutrition contribution of biofuel prodcution.

CHAPTER 2

2. BIOFUEL VERSUS FOOD PRODUCTION

2.1 Introduction

This chapter reviews international and national literature primarily relevant to biofuel production. This chapter further reviews the suitability of crops in different environment. The different views of how various authors distinguish the sustainability and implications of biofuel are reviewed. Biofuel production is reviewed in detail with reference to its impact to food and human consumption.

2.2 Suitable crops for biofuel production

The selection of an appropriate crop or mix of crops for the production of feedstock for biofuel is a critical factor in developing sustainable production systems. In South Africa, soybean, sunflower, groundnut and canola are the most suitable and favoured crops for biodiesel production, whereas sugarcane, molasses, sugar beet and sweet sorghum are most suitable and preferred for bioethanol production (Farrell et al. 2006).

Soybean, sunflower, groundnut and canola are mainly grown in the warm climatic high rainfall regions found in the provinces of KwaZulu-Natal, Free State, North West and Mpumalanga (Blottnitz and Curran, 2007). Table 1 shows the crops suitable for biodiesel in South Africa and their respective requirement.

Table 1 Crops suitable and preferred for bio-diesel

Crop	Temperature requirements	Water requirements	Soil requirements	Average yield per ha	Oil content	Production levels (tons p.a.)
Soybean	Annual summer crop. Minimum of 25℃ for all growth stages	An annual rainfall above 600mm. Constant supply through out the growing season.	Variety of soils. Heavy clay soils, arcadia types, or even sandy soils	1.5–2 tons dry land	18–22%	200,000–300,000
Sunflower	Annual summer crop. Short grower. 26℃ up to 34℃ optimum for growth.	Normally under dry land of 550 mm per annum.	Variety of soils from sands to clays. Best in sandy loam to clay soil types. Good drainage.	1.2–1.8 tons dry land	39–50%	500,000–700,000
Groundnut	Annual summer crop. Ideal maximum temperature of 25℃	Rainfall of 500mm per annum under dry land.	Light coloured, light textured with good drainage & low organic matter. Sandy type that is loose and friable.	1.1–1.8 tons dry land	42–52%	60,000–70,000
Canola	Cool–season crop. Winter annual crop. Optimum temperature between 5℃ and 10℃	Minimum annual rainfall of 400 mm water through growing season. Irrigation very important in summer rainfall areas.	Medium textured well–drained soils. Clay loam soils	1–1.5 tons dry land	42–45%	30,000–45,000

Source: NEPAD-CAADPI (2007)

Soybean and sunflower are assumed to hold the most potential as biodiesel feedstock in South Africa in comparison to groundnut and canola (NEPAD–CAADP, 2007). Table 1 also shows sunflower and soybean as the most produced at almost double the quantity. It is suggested in NEPAD-CAADP (2007) that although soybean produces almost 20% less oil than other feedstock, it has potential for expansion in the wetter provinces of South Africa.

The most suitable crops for bioethanol production in the South African are those that are sugar-rich such as maize, sugarcane, sugar beet and sorghum. Sorghum with its very high starch content of about 75 percent (Food and Agriculture Organization - FAO, 2007) is considered healthier and requires fewer inputs such as water and fertilizer than sugarcane. In addition, sorghum and maize are the more widely used crops for human consumption as staple foods and as animal stock feeds as there is a good base of knowledge and experience for growing these crops in South Africa.

Maize is regarded as the largest locally produced field crop with up to 10 million ton/ha (Table 2), and the most important source of carbohydrates in the Southern African Development Community (SADC) region.

Sugar cane (80% starch) is the second largest production with up to 3 million ton/ha and sorghum (72% starch) the list with less than 0.5 million ton/ha. Although wheat (60% starch) is the third largest in production and included in Table 2, it is not considered a candidate for bioethanol production probably because of its wide range of value-added food products which are on high demand including bread as a staple diet for the urban population as an important section of the population (Farrell et al. 2006).

Table 2: Crops suitable for bioethanol

Crop	Temperature requirements	Water requirements	Soil requirements	Average yield per ha	Production levels	Ethanol/sugar content
Maize/corn	Annual summer Crop 140 days frost–free period.	550–750 mm rain per annum. Irrigation enhances yield per unit area.	Sandy loam to loamy soils types.	2.5–3 tons under dry land 5 tons irrigated.	8–10 million tons p.a.	75% starch (sugar content).
Sugar cane	Perennial subtropical crop. Annual mean temperature of between 26 to 32oC	750–1200 mm per annum Irrigation is necessary where rainfall is lower.	Sandy loam soils with pH between 6.0 to 7.7	66.5 tons (average of last five years)	2–3 million tons p.a. of sugar.	80% starch (sugar content)
Sorghum	Annual summer Crop. Entire season frost free (20–30oC	400–750 mm per annum. Irrigation enhances Yield	Variety from sands to cracking black clays. Good drainage with 5–8.5 pH levels	2.1 tons under dry land 3.5 tons Irrigated.	200,000–450,000 tons p.a.	72% starch (sugar content)
Wheat	Annual winter crop Cool moist season for growth.	600 mm per annum. Irrigation is necessary in summer rainfall areas.	Loamy to sandy loam Avoid acidic soils with high Al+ content.	2–2.5 tons under dry land 5 tons irrigated.	1.5–3 million tons p.a.	60% starch (sugar content).

Source: NEPAD-CAADPI (2007)

However, it is important to note that in South Africa, unlike developed and industrialised countries such as the United States of America (USA) and the European Union (EU), biofuel production is driven predominantly by the need for rural development. This statement is also noted by Kupka, Lemmer & Makenete (2007), to enhance food security and eradicate poverty by creating sustainable income earning opportunities. The choice of crops is therefore determined by different economic, social and environmental demands policies and regulations. In this regard, the need to attain environmental goals and achieve energy security as in the case of the USA and EU, does not seem to be the priority in developing countries including South Africa with regards to the farmers changing from maize for human consumption to biofuel production.

On the one hand, considerable effort has been invested in research for high potential but non-food crops that provide sustainable biofuel alternative sources (Austin, Matthew, Wilson and von Blottnitz, 2005). The main candidate alternatives to using food crops for biofuels as proposed by Fairless (2007), WWF (2006) and Kartha (2006) include Jatropha and Pongamia, with the former being the preferred crop. Data from Austin, Matthew, Wilson and von Blottnitz (2005) featured in Appendix 2 show biofuel candidate crops with their respective oil yields. The data show that Jatropha (*Jatropha curcas sp)* seeds can produce 1, 892 l oil/ha, almost twice as much as produced by sunflower and about 4 times as much as produced by soybean. Moreover, Jatropha has other important agroforestry benefits including nitrogen fixation as it is a legume and soil erosion mitigation properties. The plant, originating in Central America, is mainly grown in Asia and in Africa, where it is known as Pourghère (World Agroforestry, 2007). Cultivation is uncomplicated as it can grow in wastelands and grows almost anywhere, even on gravelly, sandy and saline soils. According to World Agroforestry (2007), *Jatropha curcas* can thrive on the poorest stony soils and grows in the crevices of rocks. It can be grown in arid lands that are not normally suitable for food crops on a mere 250 mm of rain a year and only during its first two years does it need to be watered, in the closing days of the dry season. It is reported that the national department is pushing Jatropha use for bio-diesel, linking this to poverty alleviation particularly for the benefits of job creation for both the farmers and the rural community.

2.3 Jatropha as a sustainable source of biofuel production

Jatropha is a crop originated in Central America mainly grown in Asia and Africa, where it is known as pourghére. Cultivation of this crop has been reported by World Agroforestry (2007) as uncomplicated as it can grow in wastelands and grows almost anywhere, even on gravelly, sandy and saline soils and can thrive on the poorest stony soil and grow in the fractures of rocks as it can be grown in arid lands that are not normally suitable for food crops on a mere 250 mm of rain a year and only during its first two years does it need to be watered in the closing days of the dry season. However, according to Marvey (2002), the National Department of Agriculture is reluctant to support the adoption of jatropha as a sustainable alternative for biofuel production. Figure 1 shows a picture of a healthy jatropha tree growing in a Zululand (northern KwaZulu-Natal) homestead.

One concern, however, is that the seeds of jatropha are highly flammable and therefore the process should not be located near to any sugar or paper producing operations (two of the major industries currently operating in KZN). Furthermore, there are environmental concerns over its widespread agricultural use in terms of its potential to become a pest species and to disrupt the ecology of insects, some of which are critical for sustaining agricultural production. Therefore, precautionary principles are underway using the Environmental Impact Assessment (EIA) procedure with regards to the assessment of the biophysical suitability for the soyabeans in local communities.

Figure 1 **Jatropha tree in a rural KwaZulu-Natal homestead**

Nevertheless, it has been reported by Austin, Matthew, Wilson and von Blottnitz (2005) that cultivation of jatropha can help to improve soil fertility whilst reducing erosion in large-scale plantations. Furthermore, it has the potential to create a new agricultural industry to provide low-cost biodiesel feedstock for both the developing world and exports to markets. As mentioned earlier, introduction of this crop could create thousands of job opportunities especially in the poor local communities in activities including planting, organic compost preparation from residues and gathering of seeds at harvest.

In this regard, it must be noted that biofuel production using appropriate non-food crops presents valuable opportunities for sub-Saharan Africa to attract significant investments into rural areas thereby promoting agricultural development at an unprecedented scale and contributing to food security (Wood, 2005). Biofuels also provide an import substitution for fossil oil with savings in the national finances and are currently the safest alternative to paraffin that is used as a household fuel for the low-cost or low-income households. As much as the debate is still unresolved, some of these crops can be balanced with regard to food and biofuel.

2.4 Positive impacts of biofuel production

Hazell (2007) proposes that because biofuel production is labour intensive, investor or producer incentives should only be allocated to projects that ensure job creation, expand agricultural supply and increase food supply whilst reducing rural-urban migration. In this regard, the issue of most concern is job creation, particularly within the agricultural sector in rural areas through the promotion of biofuel production. Dekeiser & Hongo (2005) project that the promotion of biofuel production in rural agriculture through government departments and independent commercial farmers would add an estimated 9 million job opportunities in China, 1 million in Venezuela and 1.1 million in sub-Saharan Africa by 2012.

Many poor South Africans still use wood for heating and cooking which means that there is still high reliance on bioenergy which places the natural resource base under significant pressure. This means that fuel wood is usually their primary household energy source, although its harvesting is usually unsustainable and contributes to deforestation (Slater, 2007). In some communities where there is a shortage of fuel wood, cow dung is used and is known to cause from the noxious smoke it produces. Hart, Raswant and Romano (2008) suggest that besides job opportunities for the communities, farmers could benefit by potentially replacing their fuel needs with biodiesel made on their farms whilst rotating different crops within the same field to suit what it produces and contributes best in biofuel production and further bringing agricultural communities closer to ecological and economic sustainability.

Farmers are encouraged to produce large quantities of oil, thereby reducing the Green House Effect (GHE) and increasing job opportunities to local communities. The GHE is reduced when growing crops absorb and release only the amount of carbon emission they absorbed when harvested (Hazell, 2007 and Lazarus, 2000). However, results will vary depending on the type of feedstock, cultivation methods, conversion technologies and energy efficiency. Furthermore, when these crops are well managed, they also offer large new markets for higher prices for agricultural producers that could stimulate rural growth and farm incomes. In this regard, this process could be sustainable should the crops be cultivated in a suitable land use system.

It is believed that this process will be achieved by targeting existing agricultural support programmes such as the Comprehensive Agricultural Support Programme (CASP) of the South African Department of Agriculture (DoA) to assist biofuels investments. Demand for the biofuel will enable emerging farmers to grow into commercial farmers enabling them to progress and improve in their farming, management and development skills. The desired end result would be to alleviate poverty and to improve economic growth of the country.

2.5 Negative impacts of biofuel production

As mentioned earlier in this dissertation, the adoption of biofuel production has raised a lot of concerns (Greiler, 2007) especially with regard to the effects on vulnerable people that consist of the landless, the unemployed and the powerless. In this regard, maize is particularly the main concern in the debate as it is one of the greatest produced sources of food. Lederer (2007) and Ogg (2007) stated that the United Nations (UN) expert Jean Ziegler, referred to the growing practice of turning crops into biofuel as a crime against humanity because it has created food shortages and sent food prices soaring, thereby leaving millions of poor people hungry. Some nutrition studies show that the number of food-insecure people in the world rises by more than 16 million for every percentage increase in the real prices of staple foods. They further suggest that 1.2 billion people could be chronically hungry by 2025 which is 600 more than previously predicted (Slater, 2007). The main concern is the threat to food production for human consumption, especially for the already poor.

It has been speculated that changing food producing crops to biofuel production will threaten food to an extent that farmers will not be able to grow or balance enough food for both food and fuel and therefore leading people to starvation (Runge et al., 2007). It must be noted that South Africa has a large population and does not grow enough food as it imports supplementary food from other countries (NEPAD-CAAPDI, 2007). If there is not enough food available, demand will exceed supply which will result in food inflation with soaring prices that the poor cannot afford as already experienced in many countries including South Africa today (Schmidhuber, 2006). In this manner, it is important for farmers to plan effectively with regards to diverting food producing crop into biofuel.

Furthermore, the development of the biofuel industry requires intensified crop production. In poor developing countries where for a number of reasons there may not be adequate environmental management, especially with respect to soil erosion control measures and crop rotation programmes, intensification may lead to land degradation, the most common of which is increased soil erosion (Kartha, 2006).

2.6 Land access implications of biofuel production

Runge et al (2007) argue that the change to biofuel will result in an increase in the amount of arable land that will be earmarked for biofuel rather than for food production with a possible result in tenure insecurity for small farmers. According to the Organization for Economic Co-operation and Development (OECD) - FAO

(2007), estimates of the amount of land that would be used for biofuel development is at present 1 percent of the world's arable land in which by 2030 could increase up to 3 percent and as much as 20 percent by 2050. FAOSTAT (2005) estimates South Africa's total land area at 121.4 million ha while Schoeman and Van der Walt (2006) estimate that South Africa has a maximum of 25 million hactares of arable land (only 20% of total land area).

Furthermore, preparing land from its natural state for biofuel crops may bring harmful effects to the environment with regard to land clearing, tilling, fertilisation and crop protection (Abbasian, 2007). Furthermore, Slater (2007) argues that the expansion of biofuel crops can displace other crops and threaten ecosystem integrity by shifting from bio-diverse ecosystem and farming systems to industrial monocultures.

The poor who often farm under difficult conditions in remote and fragile areas may according to Hart, Raswant and Romano (2008), be tempted to sell their land at low prices (but which may appear high in their local economic circumstances) to the state as they usually have little negotiating powers and skills. Hence, the demand and supply for food production will not be the same as the demand for fuel from industrial companies.

In this regard, Fairless (2007) suggests that in order to protect land rights of the small farmers, the poor, the disadvantaged and indigenous peoples, appropriate policies for biofuel land use systems should be developed and integrated to ensure that they retain ownership rights to their land. Furthermore, prioritising improvement of land policies and land administration systems is important to protect them in terms of maximizing their benefits particularly those with insecure, usually customary tenure.

2.7 International trends in biofuel production

There is generally a great deal of interest in issues surrounding the introduction of cleaner fuels in the transport sector because it touches on a range of social, economic and environmental issues that are high on the international agenda. However, biofuel has been produced for decades with Brazil leading as the most competitive producer with the longest history of bioethanol production (Hart, Raswant & Romana, 2008; Zarrilli, 2006). Furthermore, Hawaii is reported to have the potential to completely replace its petroleum fuel requirements with biodiesel in the near future because of such large areas of agricultural lands, unique favorable climate, fertile volcanic soils, and suitable topographic conditions (Leary, et al., 2006). The United States (USA) mainly in the great plains region, is also among the countries that have been producing biofuel for a while using crops such as wheat as the dominant crop (50% of harvested land), followed by hay (20%), maize (15%), and cotton (4%) with other important crops that include barley (3%), sorghum (2%), and sugar beet (1%) (Gutmann, Ojima and Parton, 2007). This as a result confirms that in other countries, farmers have changed or diverted crps from producing fro food to biouel and are doing well.

Siregar and Thompson (2007) and Cassman and Liska (2007) have linked price increases in sugar, maize, rapeseed oil, palm oil, and soybean to their value as feedstock for biofuel rather than their value as human food or livestock feed. A study by the United States Centre for Agriculture and Rural Development concluded that maize-to-ethanol production would increase food retail prices in the United States by 10% and hence also world prices (Foreman and Livezey, 2002). According to Sugrue (2007) and World Bank (2008), the global maize price increases and the shortage of basic food stuffs in countries such as Mexico which were directly linked to biofuels investments, have influenced South Africa to exclude maize use in its initial stages of biofuels development.

However, it should be noted that although price increases are blamed on increased biofuel production, Prakash (2007) validly argues that price increases in commodities is also affected by issues such as levels of stock exchange movements and weather as well as intangible factors such as speculation especially in countries that employ intensive farming practices. Therefore, either way, the farmers can change or divert their crops and not be blamed for the threatening food insecurity for production.

2.8 Local trends in biofuel production

Growth in energy consumption in South Africa has been steady, increasing overall by about 19 percent between 1990 and 1997 whilst biofuel supplies require low-cost, high-yield and surplus agricultural production which is generally not destined for food consumption, as well as government support (Austin, Matthew, Wilson, and von Blottnitz, 2005). A recent study conducted by the South African Department of Agriculture estimated that at least 12.5 percent of the final energy demand in South Africa came from the agricultural sector and its backward and forward linkages (Department of Agriculture and Environmental Affairs, 2007). In South Africa, crops such as soybean, canola, and sunflower have been selected for biofuel development whereas sugarcane and sugarbeet are selected for bioethanol (NEPAD-CAAPDI, 2007).

However, according to Mthembu (2007), there are 3 million hectares of under utilized, high potential land, mainly in the former homelands. Mthembu (2007) further suggests that it is important to understand that biofuel production such as protein oilcake from sources such as soybeans which are currently imported will also contribute to food security by increasing the availability of byproducts that can be used for animal feed. Furthermore, water is raised as an important concern in as far as the impact of biofuel production is concerned. In terms of climate change, scientists believe that intense dry spells will become more frequent over the next century which will lead to shortages of water in many regions which in turn will make it more difficult to grow enough food (Gutmann, Ojima and Parton, 2007). This may in future put constraints on the environment as people would be exploiting the already limited resources. Whereas some crops such as sugarcane require considerable quantities of water while others such as jatropha and sorghum require less (WWF, 2006 and Openshaw, 2000).

The Department of Water Affairs and Forestry (DWAF), however, notes that impacts on water quality by soil erosion and siltation as well as fertilizer and pesticide loaded runoff are as important a concern as impacts on available volumes (DWAF, 2007). It further recognizes that means to alleviate such problems should therefore be applied to all biofuel cropping, both irrigated and dry land. FAO (2007), states that South Africa's shortage of food has been linked to political and social issues such as poverty, government corruption, and inefficient distribution. Further, Gundidza (2008) and Borchardt (2006) further argue that biofuel production is not necessarily a problem but many people do not have the finances or resources to purchase or grow food as hunger is caused primarily by governments that have not made it a priority to make sure all people have access to food.

2.9 Conclusion

This chapter revealed even though there are negative impacts, it is important to note that positive impacts of biofuel production outweigh the negative impacts. Negative impacts can be classified as potential impacts that can be curbed through mitigatory measures. Government departments have often responded to negative food production impacts by enforcing by-laws that prohibit the practice of biofulel production activities that have often resulted in farmers' reluctance to start-up biofuel farming activities.

CHAPTER 3

3. METHODOLOGY

3.1 Introduction

This chapter describes the methodology followed in identifying the study area, the design of data sampling scheme. It further describes the study area, its historical background and justifies its selection by describing criteria used.

3.2 Conceptual Framework

The null hypothesis that there is no change from food to biofuel production can be tested by direct observation of current land use systems for the presence of biofuel feedstock crops in the study area and asking farmers whether these are a result of such a change. Current land use information can also be obtained from existing land use maps and associated ancillary information such as the biophysical environment, management practices and yields may be obtained from extension officers and/or farmers.

Information and data sourced by interview questions was directly asked to a sample of key informants in the form of personal communication or in the form of direct interviews whereby a researcher administers a structured or unstructured questionnaire. Sampling design and methods for interview data collection have been extensively published in educational books, examples of which include Kumar (1999) and Kaewsothi and Harding (1992). The sampling method may depend on the research objective and/or questions accuracy of levels required or achievable and the logistical circumstances of the target population. The Simple Random Sampling method and its variations according to (Kitchin and Tate, 2000) is the most recommended to avoid bias as a major source of interview survey error as every member of the sampling frame or target population has an equal chance of being selected. Other common methods include snow-balling and purposive sampling.

Purposive sampling may be used where Simple Random Sampling may not yield a desired sample, for example in a case where a researcher is targeting a particular group of people in a community (Burton, 2000). Snow-balling may be used when, for example, only a few of the targeted group of people can be identified and a sufficient sample can only be reached by referral from the initial few. The number then increases rapidly as each identified person with the required characteristics refers to others of the same characteristics (Kitchin and Tate, 2000).

Indirect interviews may also be arranged whereby either type of questionnaire is circulated to targeted informants by ordinary mail or e-mail. In the case of indirect interviews, prior arrangements with target informants are made to provide the required background information on the research and to secure consent. In this dissertation a targeted informant was consultant and provided required information.

3.3 Method of data collection

The first step in data collection involved the identification of emerging and commercial farmers growing biofuel feedstock crops through talking to the key informant. As there was no information available in the literature regarding the identitification of such farmers in the province of KwaZulu-Natal, a snowball sampling approach was adopted for the study.

A local farmer, who is also an associate of the University of KwaZulu-Natal and former colleague of the supervisor of this researcher Dr Edwin Ngidi, was consulted to assist in locating of biofuel feedstock farmers in the province. He was introduced to the research topic and asked to advice on the identification of a suitable study area where emerging farmers as well as commercial farmers were likely to be growing biofuel feedstock crops and soybean in particular, in order to study whether there is an unfolding change from food to biofuel crop production. Emerging farmers are those that belong to the group of mainly black African people previously removed from land and/or excluded from state and other agency support of farming activities and who therefore could not participate in the agricultural economy, but are now receiving land and support and are being encouraged to produce commercially (Cassman, Dobermann and Walters, 2002). Furthermore, traditionally, commercial farmers are those, mainly white people, who operate large scale high input mechanised agricultural production. It is these two groups of farmers who are likely to drive the change from food to biofuel production (Cassman, Dobermann and Walters, 2002).

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Dr Ngidi introduced an *iNkosi* (Dr R. Zondo) (Chief in a traditional community) and prominent biofuel feedstock farmer in the North Agricultural Region as managed by the KwaZulu-Natal Provincial Department of Agriculture. The Department organises agricultural development and support in the province by geographic regions (North, South, East and West). The North Agricultural Region as one of the areas that is home to both categories of farmers was selected as the study area. However, most of the emerging farmers come from communities with a strong cultural background organised under a Traditional Authority. Following the introduction, the *iNkosi* made several referrals of biofuel feedstock farmers.

The referred farmers by the key informant could not be visited on their farms as they were located across the large study area with vast distances between them. However, the *iNkosi* was able to arrange contact with the farmers during a farmers meeting where 11 emerging farmers were interviewed. During the meeting, a consulting extension officer (Mr C, Anthony) for commercial soybean farmers was introduced to the researcher and interviewed regarding commercial production of soybean as a biofuel feedstock. The extension consultant provided maps of 7 commercially-producing soybean fields and provided an estimate of the average yield in tons/ha. Appendix 1 features the questionnaire administered by the researcher during the interviews of farmers.

3.4 Method of data analysis

Interview data was entered and analysed using the Statistical Package for the Social Sciences (SPSS). Frequency tables were generated to explore and describe the data and interpret the responses to the interview questions. Response data was described according to the interviewed farmer's profile with respect to age, gender and levels of education; land use systems including crop use, soil quality, cultivation practice (sequence operations) and yields.
Biophysical data were obtained from the Bio-resource Unit (BRU) programme Version 6.012 spatial database developed locally by the KwaZulu-Natal Provincial Department of Agriculture and Environmental Affairs. This data was used as ancillary information to interview data.

The BRU, as defined by Camp (2003), is an ecological unit within which factors such as soil type, climate, altitude, terrain and vegetation display sufficient degree of homogeneity. The BRU provides a good indication of potential yield for a range of crops, including soybeans. However, the custodians (KwaZulu-Natal Provincial Department of Agriculture and Environmental Affairs) of the BRU database recommend that for accurate production potentials, detailed soil surveys are necessary to confirm soil characteristics such as depth, type, clay content, drainage class and rockiness. In this current research, the BRUs of the studied farms were used to make comparisons between production potentials of soybean and actual yields obtained from farmers' interviews in order to have a rough indication of the suitability of large scale soybean production as a biodiesel feedstock. A BRU is identified by code based on rainfall and altitude and a name. In the example Wc4-Vriscgewaagd, Wc4 is the BRU and Vriscgewaagd is the farm name. The uppercase letters in the code denote the annual rainfall range (W) of 801-850mm and the lower case letter (c) the altitude range from

901-1400 above sea level and the number 4 indicates the BRU is the 4th occurrence code in KwaZulu-Natal (Camp, 2003). Coding (Table 3 and 4) is used to explain the BRUs occurring in the study area of Vryheid. The first letter in upper case (Table 3) indicates the rainfall zone in which the BRU falls; a lower case letter indicating the physiographic zone in which it falls and which is an indication of temperature zone.

Table 3: Symbols and codes of the Bio-Resource Units

Rainfall description	
Symbol	Rainfall (mm)
R	<600
S	601-650
T	651-700
U	701-750
V	751-800
W	801-850
X	851-900
Y	901-1100
Z	1100

Altitude description		
Code	Name	Altitude range (m)
a	Coast	<450
b	Lowlands	451-900
c	Uplands	901-1400
d	Highland	1401-1800
e	Montane	1801-2000
f	Escarpment	>2000

Each BRU contains subclasses referred to as soil ecotopes (Table 4) describing dominant soil characteristics in terms of soil form, texture, depth, wetness, slope and surface characteristics (for example, rockiness).

Table 4: Ecotope definition coding as described in Bio-Resource Units

Soils	
A	Humid soils
B	Well and moderately drained soils
C	Alluvial soils
D	Mottled and moderately drained soils
E	Mottled and poorly drained soils
F	Black (Margalitic) soils
G	Black (Margalitic) poorly drained soils
H	Young soils
I	Other poorly drained soils
J	Duplex soils
K	Organic soils and wetlands

Clay (percent)	
1	>35
2	15-35
3	<15
Depth (mm)	
1	>800
2	500-800
3	300-500
4	200-300
Slope (percent)	
f	<12
s	12-40
x	>40
Surface characteristics	
n	Not rocky
r	Rocky

An example of ecotope B.1.2.f.r would indicate well and moderately drained soils; clay>35 percent; depth 500-800mm; slope <12 percent and rocky surface.

Table 5: Shows studied farms and respective planted areas

BRU	Farm Name	Soybean planted area	Local areas
Vc4a, Wd3, Yd3	Goedgeleof	209.1 ha	Osizweni
Wc4	Vriscgewaagd	101.0 ha	Swart Mfolozi
WXc2	Bethel	32.2 ha	Scheepershek
Vc4a, TUc1	Spartelspruit	80.8 ha	Kingsley
Vc4a	Lynspruit	118.7 ha	Osizweni
Wd3	Holkrans	390.1 ha	Zungwini
Vc4a	Orlandia	90.6 ha	Osizweni

All farmers selected were identified using BRU. The majority of the farmers interviewed are the owners of these farms with an average size of 146 ha. A total of 11 farmers were interviewed.

3.5 The Study Area

The North Agricultural Region is located in the north of the province as indicated by the name. The region is serviced by the N2 and N11 national roads in the north-east and west, respectively. The N2 passed through the rural towns of Mkuze and Pongola whereas the N11 passes through the town of Newcastle. The towns of commercial farming towns of Utrecht and Vryheid are closest to the studied farms. Figure 2 below shows the location of the studied farms within the North Agricultural Region.

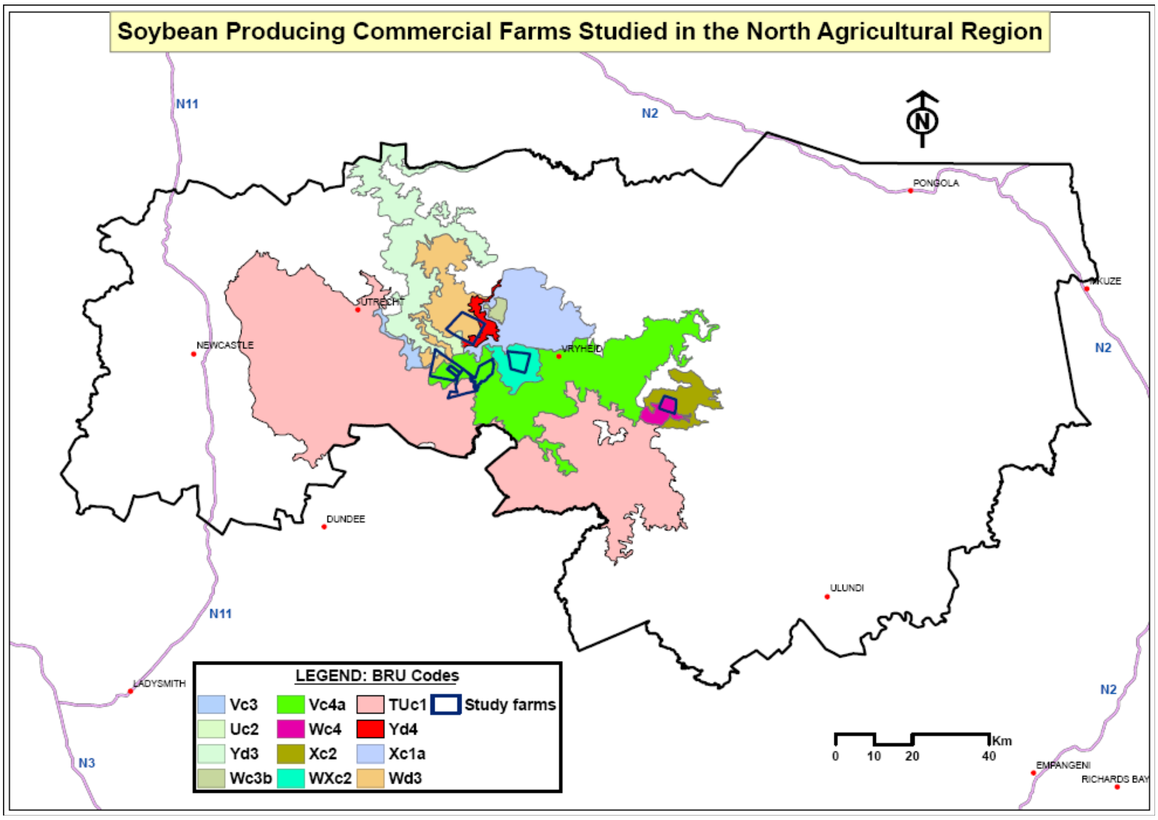

Figure 2: Map showing study area

3.6 Description of Biophysical properties of the studied farms

(a) Geodgeleof

BRUs occurring in the Geodgeleof farm are Vc4a and Wd3 with a small portion of Vd3. The Vc4a unit represents biophysical characteristics of annual rainfall that ranges from 751-800mm and upland altitude of 901-1400m with dominant soil types being well and moderately drained as well as some mottled and moderately drained soils (B.2.1, B.2.2, D.2.1, D.3.1 and E.3.2). The soil types are estimated to have yield potentials of between 1 and 2.3 tons /ha for mottled and poorly drained soils and well drained soils respectively for dryland soybean, and 2.8 to 4.2 tons/ha for irrigated soybean.

The Wd3 unit represents annual rainfall and altitude classes of 801-850mm and highlands of 1401-1800m respectively. Dominant soils include well and moderately drained and young soils (B.1.1, B.2.1, B.2.2, H.3.4.x.r) with yield potentials of between 1.7 and 2.0 ton/ha for dryland soybeans and 3.0 and 3.3 ton/ha for irrigated soybean.

The Yd3 unit represent annual rainfall an altitude classes of 901-1100mm and highlands of 1401-1800m respectively. Dominant soils include well and moderately drained soils (B.1.1) with yield potentials of 2.4 ton/ha for dryland soybean and 3.0 ton/ha for irrigated soybean.

(b) Vriscwaagd

The Wc4 unit is dominated in the Vriscwaagd farm. This BRU represents annual rainfall and altitude classes of 801-850mm and upland of 901-1400m respectively. Dominant soils include mottled and moderately drained and young soils (D.2.1, D.2.2., H.3.4.s.r, H.3.4.x.r) with yield potentials of between 1.5-2.3 ton/ha for dryland soybean and 3.9-4.2 ton/ha for irrigated soybean.

(c) Bethel

Bethel is dominated by a BRU unit of WXc2. this BRU represent annual rainfall and altitude classes of 801-850mm to 851-900mm and upland of 901-1400m respectively. Dominant soils include well and moderate drained and mottled and moderately drained soils (B.11. B.2.1, D.2.1, D.3.1, D.3.2) with yield potentials of between 1.6-2.7 ton/ha fro dryland soybean and 3.1-4.2 ton/ha for irrigated soybean.

(d) Spartelspruit

BRUs occurring in Spartelspruit are TUc1 and Vc4a in almost equal sizes. The TUc1 and Vc4a units represent annual rainfall of 651-700mm and 701-750mm and upland altitude classes of 901-1400m respectively. Dominant soils include mottled and poorly drained soils, young soils and duplex soils (E.3.2,.H.3.4.r, J.3.3) with yield potentials of 1.7 ton/ha for dryland soybean and 4.2 ton/ha for irrigated soybean. The Vc4a unit has already been described under the Geodgeleof farm above.

(e) Lynsptruit, Holkrans and Orlandia

These farms are dominated by the Vc4a and Wd3 units which are described above under the Geodgeleof farm.

3.7 Conclusion

This chapter has summarised the study area selection and its background. The background of the study will help in understanding the behaviour pattern and explaining the reason for some indigenous practices. The criteria for study area selection will ensure that there is no biasness from the results as BRUs are homogenous units.

CHAPTER 4

4. DATA ANALYSIS AND RESULTS

4.1 Introduction

The purpose of this chapter is to discuss the results of the survey by analyzing the data collected in the field. The purpose of the data analysis is to reconcile the results of the study with the aims and objectives of the study. Data analysis is an important component of the research project. It provides an outline of whether the researcher was able to achieve the objectives set out. The result of the data analysis justifies or refutes the theory that is provided by the literature review.

4.2 Profile of interviewed farmers

All 11 farmers interviewed were male with ages ranging from 26 to 65 years. 8 of the 11 farmers interviewed have completed secondary education, with only 3 of them having a tertiary qualification. The results show that farmers interviewed fall within the range of young adults and pre-retirement ages defined as economically active (25-65 years) by Statistics South Africa (STATSSA, 2007). This result also confirms gender inequality and low levels of post-secondary education as seen in all sectors of South African rural life.

4.3 Land use system

Below is the land use systems used to get the results envisaged by the researcher.

4.3.1 Crop Use

Most farmers (80%) interviewed indicated that they grew soybean for both biofuel production and human consumption. Results in Table 6 shows that 64% used soybean for food and biofuel production while less than 27% used their soybean for biofuel and less than 9% for food only.

Table 6: Crop Usage

Crop Usage		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Food only	1	9.1	9.1	9.1
	Biofuel only	3	27.3	27.3	36.4
	Biofuel and Food	7	63.6	63.6	100.0
	Total	11	100.0	100.0	

4.3.2 Crop rotation

Interviewed farmers (100%) indicated that they are not using maize to produce for biofuel as a result of government excluding it from being used as one of the crops suitable for producing biofuel. However, the farmers also stated that with this issue of maize being excluded, they are going to rotate maize fields with soybean. A photo of a vigorously growing soybean crop is shown in figure 3.

Figure 3: A healthy soybean crop at a vegetative state.

4.3.3 Soil Quality

Farmers generally perceived the soils on which they were growing soybean to be of high quality, with 73% of the farmers rating the soil very good and 27% good as shown in Table 7.

Table: 7 Farmers perception of soil quality

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	good	3	27.3	27.3	27.3
	very good	8	72.7	72.7	100.0
	Total	11	100.0	100.0	

4.3.4 Change to Biofuel

The majority of farmers (91%) indicated that they have changed from food usage of soybean to biofuel. Only one farmer, as indicated in Table 8, did not change from food crop to biofuel use of the soybean crop. However, interviewed farmers indicated that they are sensitised about the need of ensuring food security and still grow maize for the purpose of human consumption as a rotation crop.

The soybean is an excellent rotation crop for maize. Samali (2008) suggests that apart from the beneficial effects in reducing disease incidence, soybean carries 30-50 kg/ha of available nitrogen to the proceeding crop, which represents a significant saving in nitrogen fertilization.

Table: 8 If Farmers had changed to biofuel

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Changed to biofuel	1	9.1	9.1	9.1
	Did not change	10	90.9	90.9	100.0
	Total	11	100.0	100.0	

4.4. Cultivation Practices

The following describes the cultivation practices used in the study.

4.4.1 Land Preparation and Planting

Soybeans require a well-prepared, fine, weed-free seedbed for good germination. Large clods, furrows or ridges must be avoided in order to ease the planting operation and ensure a good stand. Herbicides are also more effective in a fine well-prepared seedbed.

Interviewed farmers indicated different land preparation methods for land preparation. The majority of the farmers interviewed (45%) indicated that used the no-till method of land preparation. About 27% used the disc plough themselves or through a service provider while another 27% used the disc plough with herbicide treatment, *Round-up®* to get rid of weeds as shown in Table 9. Farmers also indicated that mineral fertilizer (NPK – Nitrogen: Phosphorous: Potassium) or farm-yard manure may be applied in unspecified amounts while planting.

Table 9: Land preparation

		Frequency	Percent	Cumulative Percent
Valid	No Till	5	45.5	45.5
	Disc plough with herbicide	3	27.3	72.7
	Disc plough	3	27.2	100.0
	Total	11	100.0	

Farmers also indicated that the may use planting implements such as the one shown in Figure 4.

Figure 4: Planting machine.

4.4.2 Planting time

According to Samali (2008), early planting does not have the same beneficial effect on yield as it does in crops such as maize. In very hot areas with a high number of daily heat units it is important not to plant too early as this will merely stimulate excessive vegetative growth which will later lead to lodging problems without any yield advantage.

Samali (2008) further suggests that very late plantings on the other hand will result in insufficient vegetative growth, a low pod height and lower yields. Therefore, planting in rows 60-75 centimeters wide and 5-6 centimeters between plants in each row at a depth of 1-2 centimeters is recommended. Smith (1998) recommends mid-November to mid-December for the study area (northern KwaZulu-Natal). 100 percent of the farmers are very much aware of the planting season and have indicated that mid-November to mid-December is the best time for them to plant soybeans. As a result, Soybean grows best if planted alone and not overshadowed by other plants such as with maize.

4.4.3 Fertilizer Application

Two types of fertilizers are used in the study area, farm yard manure (FYM) and mineral (NPK) fertilizers. Six of the interviewed farmers (55%) used unspecified amounts of NPK fertilizer and FYM while the remaining five used different NPK fertilizers individually in unspecified amounts. Furthermore, the farmers revealed that the cost amount of fertilizer ranges from R200 to R680 per ha as shown in Table 10.

Table 10: Cost NPK of fertilizer per ha

Amount (Rand/ha)		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	R200.00	2	18.2	18.2	18.2
	R300.00	3	27.3	27.3	45.5
	R500.00	4	36.4	36.4	81.8
	R550.00	1	9.1	9.1	90.9
	R680.00	1	9.1	9.1	100.0
	Total	11	100.0	100.0	

Table 10 shows that 2 interviewed farmers (18%) indicated that their input in terms of fertilizers started from R200, while 3 farmers (27%) spent R300 and 4 farmers (36%) R500. The remaining indicated R550 and R680, respectively. This result indicates that farmers apply different management decisions according to their individual circumstances.

4.4.4 Irrigation

Pannar Seed (2006) and Samali (2008) suggest that the most critical moisture requirements of the soybean plant are during germination, flowering and pod-filling. The soybean seedling needs adequate moisture to germinate and is very sensitive to breaking its "neck". Irrigation at planting or 3 to 4 days later will encourage rapid germination and prevent possible crust formation. The flowering stage is not critical as soybeans flower over a relatively long period. However, adequate moisture at flowering will ensure that the maximum number of flowers will be fertilized and produce pods.

Figure 5: Irrigation machine.

The most critical stage is the pod-filling stage as stress during this stage can reduce yields by as much as 30% (Smith, 1998). Adequate moisture is necessary to avoid pods being aborted and to maximize the number of seeds per plant as well as the size of seeds. Stress during late grain-fill can reduce yields by as much as 30%. The majority of interviewed farmers (91%) applied spray irrigation to their soybean crop as shown in Figure 5. Only one farmer (9%) indicated that he uses a borehole in addition to spray irrigation.

4.4.5 Weed control

All farmers in the study area indicated that they use four-wheel mechanized herbicide sprayers to kill weed as shown in Figure 6 as well as mechanized 2-wheel weed removers as shown in Figure 7.

Figure 6: Four-wheel weed spraying tractor.

Furthermore, the rand value (shown in Tale 11) in terms of weeding ranges from R200 to R1, 200 depending on the production of the farm.

Figure 7: Two-wheel weeding tractors.

Table 11 shows those 4 farmers interviewed (36%) used R500/ha in weeding operations with 3 farmers (27%) using R300 and the remaining 4 farmers using from R200-300 individually.

Table 11: Cost of weeding operations per ha

Amount (Rand/ha)		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	200	1	9.1	9.1	9.1
	300	3	27.3	27.3	36.4
	500	4	36.4	36.4	72.7
	700	1	9.1	9.1	81.8
	1000	1	9.1	9.1	90.9
	1200	1	9.1	9.1	100.0
	Total	11	100.0	100.0	

Samali (2008) suggests that at the correct plant spacing, an effective canopy may be obtained 5-6 weeks after planting. Weed problems after this period are unlikely if a good plant population is maintained. Effective weed control is necessary shortly after planting to protect the seedlings. Good seedbed preparation and the use of a rotary cultivator 3-4 days after planting will control young germinating weeds and at the same time prevent a soil crust. A rotary cultivator may be used until seedlings are approximately 15 cm. This implement should be used during the warmest period of the day to avoid damaging the crop.

Pannar Seeds (2006) recommends a wide range of pre- and post-emergence herbicides are registered for use with soybeans. Roundup Ready Plus® (L 7966) may be applied post-emergence to soybeans from the ground cracking stage through to flowering. A minimum pre-harvest interval of 14 days is prescribed.

The registered maximum allowable Roundup Ready Plus® application volumes as indicated on commercially available products are:

- Combined total per year for all applications 6.7 ℓ/ha
- Pre-plant, pre-emergent applications 2 ℓ/ha
- Total in-crop applications from cracking through to flowering 4.7 ℓ/ha
- Maximum pre-harvest application rate 1.3 ℓ/ha

(source: Pannar Seeds, 2006)

Dosage rates are 1.3-1.7 ℓ/ha depending on the type of weed species targeted and the growth stage of the weed species. Certain weed species require follow-up applications. Other prescriptions for Roundup Ready Plus® use is that a minimum of 1.5% Roundup Ready® spray solution must be adhered to and that the maximum water volume for application must not exceed 125 ℓ/ha.

4.4.6 Harvesting

Harvesting data from the interviewed farmers revealed that the farmers use both hand and machine methods due to the different sizes of their fields. An example of harvesting machines that farmers in the study area use is shown in Figure 8. Samali (2008) recommends that harvesting must commence when most of the leaves have been shed, but while the stems are still pliable as this will results in pods shattering and kernels breaking.

Figure 8: Harvesting machine.

4.5 Yield

Interviewed farmers did not reveal their soybean yield in tons/ha, but were able to estimate the accrued income from the proceed oil for biofuel as shown in Table 12. However, personal communication with the agricultural consultant in the study area region indicated that the emerging farmers obtained an average yield of 1.2 ton/ha in the study area. Table 12 reveals that the majority (5) of interviewed farmers, representing 46%, indicated that they made a total income per year of between R 50, 000 and R 100, 000 from their processed soybean crop oil, while 4 of the farmers (36%) made between R 100, 000 and R 500, 000. The remaining 2 farmers (18%) made between R 10, 000 and R 50, 000 and R 1, 000 and R 10, 000 individually.

This result shows variability in the earnings from soybean derived biofuel. This is to be expected since the different farmers will have different levels of managerial capabilities according to their individual circumstances. The farmers' profiles show a variation in age that may be related to the experience of individuals as well as variations in levels of education that may relate to management skills.

Table 12: Earnings from biofuel (Rand Value per year)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	R1000-R10 000	1	9.1	9.1	9.1
	R10 000-R50 000	1	9.1	9.1	18.2
	R50 000-R100 000	5	45.5	45.5	63.6
	R100 000-R500 000	4	36.4	36.4	100.0
	Total	11	100.0	100.0	

4.6 Conclusion

The findings of this study suggest that most of the farmers who partake in biofuel production and agricultural activities do so because of its potential to provide cheap, readily available oil whilst at the same time providing fresh food to poor urban households. The findings also suggest that the majority of farmers that are engaged in farming activities are men. The results provided a basis on which the study would be undertaken and has explained the problem statement and the need for this research. The literature review of previous studies has revealed that biofuel production practices have a positive impact on the nearest communities by improving the economy through job creation, expansion of agricultural and food supply and generating alternative sources of income whilst reducing rural-urban migration. The required data and their sources have been identified and data collection and data analysis methods explained.

CHAPTER 5

5. CONCLUSION

This research study was embarked on with the objectives to assess the biophysical suitability for soybean land use systems in selected areas cultivated by emerging farmers in the Northern Agricultural Region of KwaZulu-Natal and to establish whether farmers are changing land use from growing food crops for human consumption to biofuel production. The study revealed that the Northern Agricultural Region had adequate suitability for profitable soybean production for biofuel. Furthermore, the majority of farmers interviewed indicated that they had changed from growing only maize as a food crop to a rotation system of the latter with soybean for biofuel production.

Most of the farmers interviewed applied farming operations with modern technology including land preparation and planting, fertilizer application, irrigation, crop protection and harvesting. The majority interviewed farmers reported varied total earnings per year from soybean derived biofuel ranging from R 50, 000 to R 500, 000. The variability in earnings is consistent with the varied range of ages as attributable to experience and with the varied levels of education which may be related to management skills.

The data obtained from the sample of 11 farmers was too small for statistical inference. It would probably have taken a sampling scheme covering the entire province in order to obtain a sufficiently large sample for statistical inference. Time and resource constraints for this academic exercise could not allow a more elaborate survey. It is however, noted that although the sample of farmers interviewed is too small to provide statistically valid conclusions, the obtained results represent an important sector in the farming community that shows future directions of food versus biofuel production.

The study has indicated that there is a clear interest among emerging farmers in producing biofuel from soybean. This is consistent with the global interest in such crop commodities (Prakash, 2007) which have predominantly been used for food but are now being grown as feedstock for producing biofuels due to the increasing demand for substitutes highly priced fossil fuels. Runge (2007) argues that using food for biofuel will push food prices up to make the situation worse, especially for countries that import both food and fuel. However, Hart, Raswant and Romano (2008) argue that higher food prices can be beneficial to food producers, including smallholders of farms and in rural areas through additional capital inflows, which can also create demand for goods and services as well as related employment opportunities. However, they further suggest that this will occur only if institutional mechanisms can be put into place to ensure that small scale farmers and rural communities are partners in the process.

On the other hand, Hedegaard (2008) suggests that not all biofuels are good for the environment and the focus should be on biofuels produced from the by-products of food crops such as sugarcane, rather than crops grown purely for biofuels production. South Africa should explore this concept in this food versus fuel debate as competing land uses. In this case, Jatropha and soybeans should be considered in terms of producing for both food and oil, respectively.

In terms of sustainability, the main alternatives to using food crops for biofuels as proposed by Fairless (2007), WWF (2006) and Kartha (2006) include Jatropha and Pongamia, with the former being the most favored. Jatropha has the ability to grow on marginal lands, is resistant to frost and common diseases and has potential to improve soil fertility and reduce erosion. Jatropha has the potential to produce up to twice the amount of oil as soybean and up to 4 times as sunflower per hectare, with minimum rainfall conditions. In fact, it is suggested by Slater (2007) that in dry areas, the competition between food and fuel crops may become the overriding issue in land use planning, an area in which further research should be encouraged.

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APPENDICES

Appendix 1: Questionnaire

Questionnaires for farmers growing crops producing biofuel

A. Respondent's Personal Details

1. Gender

Male	1
Female	2

2. Age of Respondents

1. <25yrs	2. 26-35yrs	3.36-45 yrs	4.46-55yrs	5.56-65yrs	6.> 65yrs

3. Education

None	1
Level 1 (preschool, ABET)	2
Level 2 (std 6, trade certificate)	3
Level 3 (std 8, professional trade qualifications)	4
Level 4 (std 10)	5
Level 5 (diploma/degree)	6
Other (specify)	7

B. The farmer and the Biofuel crop production

4. Do you grow crops?

Yes	1
No	2

5. If yes, what kind of crops do you grow?

Safflower	1	Oil Palm	9	Linseed	17	Sunflower	25
Sesame	2	Jatropha	10	Coffee	18	Rice	26
Camelina	3	Jojoba	11	Soybean	19	Tung oil tree	27
Mustard	4	Groundnuts	12	Hemp	20	Oats	28
Coriander	5	Olives	13	Cotton	21	Cashew	29
Pumpkin	6	Rapeseed	14	Calendula	22	Maize	30
Euphorbia	7	Pecan Nuts	15	Kenaf	23	Other (Specify)	31
Hazelnuts	8	Castor Beans	16	Lupine	24		

6. What are you growing these crops for?

		Area/size (ha/acres) of a plot	Since when (Year)
For food production/ home consumption	1		
For Biofuel production	2		
Both	3		
Other (specify)	4		

7. What type of soil are you growing your crops in 1 hectare?

Loamy	1
Sandy	2
Clay	3
Local soil name (specify)	4

8. What type of soil are you growing your crops in 2 hectares?

Loamy	1
Sandy	2
Clay	3
Local soil name (specify)	4

9. What type of soil are you growing your crops in 3 and more hectares?

Loamy	1
Sandy	2
Clay	3
Local soil name (specify)	4

10. How good is soil for this crop? How would you rate it ranging from a 5 scale?

11. Have you changed the production for food to biofuel production?

Yes	1
No	2

11.1 If yes why?

12. Do you grow and process crops producing biofuel?

Yes	1
No	2

C. The farm and the economic impacts of producing biodiesel

15. Farming Operations Description

Land preparation

Planting

Fertilizing

Harvesting

Irrigation

16. What are the inputs in? And Rand value?

Weed control

Fertilizer

Labour

17. What are the costs of producing biodiesel?

18. How much income do you generate by producing biodiesel per year?

0-R1000	1
R1000-R10 000	2
R10 000-R50 000	3
R50 000-R100 000	4
R100 000-R500 000	5
Other (specify)	6

Appendix 2: Estimated oil yields in kg oil/ha and litres oil/ha (Wilson, Matthew, Austin & von Blottnitz, 2005)

Crop	kg oil/ha	litres oil/ha
corn (maize)	145	172
cashew nut	148	176
oats	183	217
lupine	195	232
kenaf	230	273
calendula	256	305
cotton	273	325
hemp	305	363
soybean	375	446
coffee	386	459
linseed (flax)	402	478
hazelnuts	405	482
euphorbia	440	524
pumpkin seed	449	534
coriander	450	536
mustard seed	481	572
camelina	490	583
sesame	585	696
safflower	655	779
rice	696	828
tung oil tree	790	940
sunflowers	800	952
cocoa (cacao)	863	1,026
peanuts	890	1,059
opium poppy	978	1,163
rapeseed (Canola)	1,000	1,190
olives	1,019	1,212
castor beans	1,188	1,413
pecan nuts	1,505	1,791
jojoba	1,528	1,818
jatropha	1,590	1,892
macadamia nuts	1,887	2,246
Brazil nuts	2,010	2,392
avocado	2,217	2,638
coconut	2,260	2,689
oil palm	5,000	5,950
Chinese tallow	5,500	6,545
Algae (actual yield)*	6,894	7,660
Algae (theoretical yield)	39,916	47,500