Producing food staples in South Africa: The competition for arable land

by

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DECLARATION

I, Divan van der Westhuizen, declare that the dissertation, which I hereby submit for the degree M.Com Agricultural Economics at the University of Pretoria, is my own work and has not been submitted for a degree at any other tertiary institution.

SIGNATURE: …………………….………………   DATE: January 2013

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Abstract

The agricultural and food production systems in South Africa have experienced renewed volatility and changing market conditions during the past five years, with both macro-economic as well as climatic conditions playing a vital role in the direction of agricultural markets. These changing market conditions included various macro-economic drivers, natural conditions, changing consumer behaviour, input inflation, energy related drivers and the continuous impact of global role-players in both the demand and supply side of agricultural goods.

These volatile drivers have a relentless effect on the primary production of agricultural goods and more specifically on strategic decision-making at farm level. The decision-making environment of a farm business has thus become a delicate space due to simultaneous interactions of a range of volatile drivers. Yet, this study clearly illustrates that despite all of these simultaneous interactions, a few basic principles still determine the future of a farming operation.

Like in other developing countries in the world, the demand for food in South Africa is increasing rapidly and putting greater pressure on South African farmers to produce more food. However, it is not only the rate of increase in food demand that is a cause for concern, but also the changing nature of consumption patterns as people's income increases. For example, meat consumption experienced the highest rate of increase over the past decade and in future this trend is expected to continue. The rate of increase in the consumption of bread, rice and potatoes is outpacing the increase in maize meal consumption and South Africa is already a net importer of wheat and rice.

The problem statement identified for this study is grounded in the basic principle of overlaying production and consumption trends. Although this old principle has been applied by researchers at BFAP for many years, it has only been applied within a sector-wide application, and more specifically the sector model. The sector model uses aggregate elasticities to project the long term shift in area under production. Although these supply response elasticities have been statistically estimated, they present an aggregate view of the total area under production for a specific crop and not a detailed for a specific region. Hence, this study set out to test whether the long term shifts in the areas under production of the various grains and oilseeds are in fact economically sustainable at farm-level taking the range of drivers into consideration that influence the farmers decision. This study can thus be viewed as a disaggregate approach to understanding plausible long term supply response in South Africa.

Thus, the need exists to conduct a stock-take of the current position of farm businesses in South Africa and to evaluate the respective impacts of changing agricultural drivers and macro-economic factors. The objectives stipulates that it is necessary to identify representative farm businesses in the key summer producing regions in South Africa and to determine the current production and financial environment of these typical farm businesses. Furthermore, it is necessary to determine whether long-term projections are plausible from a production perspective and whether land utilisation patterns might change in the intermediate and/or long term. By evaluating the current position and impact of long-term projections at farm level, one can determine and revise the various drivers of the farm business's decision-making environment.

The study is introduced in Chapter One, which briefly explains the background behind the study, the problem and purpose statements, the research objectives, context and unit of analysis and delimitation or study assumptions. Chapter Two presents a detailed literature review in order to demonstrate the current resource availability in South Africa, the fundamentals that drive balance sheets for the key grain and oilseed commodities, the demand for animal feed, consumer trends and analysis and other drivers that impact the decision-making environment of farm businesses in South Africa. Chapter Three clearly identifies the study approach and stipulates the methodology behind modelling resources and the integration of these models. In Chapter Four, a detailed analysis is conducted on representative farm businesses in the North West province, northern and western Free State, eastern Free State and Mpumalanga producing regions. This demonstrates the historic, current and projected financial position given a set of macro-economic assumptions and other decision-making drivers that could influence the farm business structure and land utilisation trends. Chapter Five addresses various macro-economic and production scenarios, which include the concept of farm-level risk management and their respective impact on farm businesses. The key findings of the study are interpreted in Chapter Six.

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CHAPTER 1

INTRODUCTION TO THE STUDY

1.1 BACKGROUND

Similar to global trends, the agricultural and food production systems in South Africa have experienced extreme volatility during the past five years, with both macro-economic as well as climatic conditions playing a major part in the direction of the markets. More recently, supply and demand as basic characteristics of an economy tightened the balance sheets in the most important summer cereals produced internationally and resulted in commodity price increases in 2011 (BFAP, 2011). The depleted global stock levels in especially coarse grains and oilseed markets were mainly caused by adverse weather conditions in key producing regions. Stronger economic recovery and growth in Latin America, Asia and Eastern Europe further boosted demand and caused even more relentless pressure on the stock equilibrium levels.

Severe weather conditions play a critical role in the formation of commodity prices as they directly influence commodity stock levels. The linkage between agricultural commodities and energy markets through inputs such as fuel and fertiliser further increased the spread of volatility during the past two years. This means that world economic growth and volatility not only drive agricultural markets through food demand, but correspondingly through energy demand (BFAP, 2011).

These macroeconomic drivers have a challenging impact on the primary production of food in South Africa and the question therefore arises how these drivers could impact the farming environment over both the intermediate and long term. Secondly, what are required changes that farming businesses will need to make on a consistent basis in order to keep up with the growing demand for food and limited natural resources. A more specific question to ask is whether a relative shift in total hectares planted as well as the relative share of crops could be expected in the long run.

Land and water resources are a binding constraint; therefore the competition for arable land will clearly become more intense in the intermediate and long term.

The cost, risk and barriers of breaking new agricultural land and producing on a sustainable but competitive basis are increasing globally as production has to expand beyond the traditionally well-developed production areas (BFAP, 2011). In terms of its main staple, maize, South Africa is a food secure country, producing a surplus in most of the years through the optimal utilisation of scares resources. South Africa has a total of 16 million hectares of arable land, of which 13 million hectares are currently under production, with most of the land only having a medium to low potential for producing crops. Production risks have to some extent been overcome by much improved cultivation practices and seed technology over the past decade (Collet, 2008:vi). A key question that arises is whether these improved production practices will be enough to keep up with the future demand for food arising from an increasing population and income levels.

North-American farmers are eminent for their share in feeding the world for decades by seeding their versatile croplands each year and adjusting production annually in order to replenish crops with low stock levels and to supply the changing demand of the increasing global population (Gillam, 2008).

According to Gillam (2008), the price of almost every major crop was at or near record highs in 2008, which further encouraged agricultural production, especially maize, soybean, wheat and sunflower production. The macro-economic factors that contributed to spikes in commodity and food price in 2008 are currently being repeated in agricultural commodity markets, but a new set of altered factors has emerged which causes even more volatile markets and agricultural production conditions (Farm Foundation, 2011). These changing drivers include continual demand shocks, market inelasticity, weather and grain shocks, China's policies and other macro-economic exogenous drivers such as exchange rates. The report from the Farm Foundation (2011) further argues that the persistent demand shocks specifically refer to two major drivers; the biofuels industry, particularly maize production and the rising demand for soybeans from China due to growth in disposable income and stocks building.

Different utilisation of key commodities has also changed the meaning of agricultural production. Food and feed as the only major absorption of crop production has changed with the introduced of other consumption trends such as the use of maize and soybeans for the purpose of ethanol production for bio-fuels. The escalating demand for cereals has placed major concerns on food security and the ability of countries to meet the necessary demand. A report compiled by the Food and Agricultural Organization (FAO) stated that the world's population will reach 9.1 billion people in 2050, which is 34 % higher than the population in 2009. The FAO also indicated that the majority of this population growth will occur in developing countries and that urbanisation will persist at an accelerated pace (FAO, 2009). The implication of growing demand means that the competition for land becomes more intense between selected crops as the expansion of hectares is a binding constraint.

In a report compiled by Haldenwang (2011), it is stated that the Institute for Futures Research (IFR) projects the South African population to reach 53.3 million people by 2040, despite the impact of HIV – almost 2.8 million more than the population in 2010.

The annual Bureau for Food and Agricultural Policy (BFAP) Baseline report published a graph in 2012 which illustrates what the most likely effect on hectare utilisation might be, given a certain set of macro-economic and exogenous drivers. The projected South African crop area is illustrated in Figure 1. According to these simulations, the total area under white maize production will decline from 2012 to 2020 (BFAP, 2012). The figure further indicates a relative shift in the crop mix with the total soybean area increasing significantly towards 2020, mainly due to the demand for soybean oilcake and existing opportunities in the soybean crushing industry.

The question arises whether the anticipated shift in the area that is driven by macro-economic factors is realistic from a producer's perspective. Stated differently, can a relative shift in hectares of the various field crops be expected over the intermediate or long term in South Africa, based on an in-depth farm analysis?

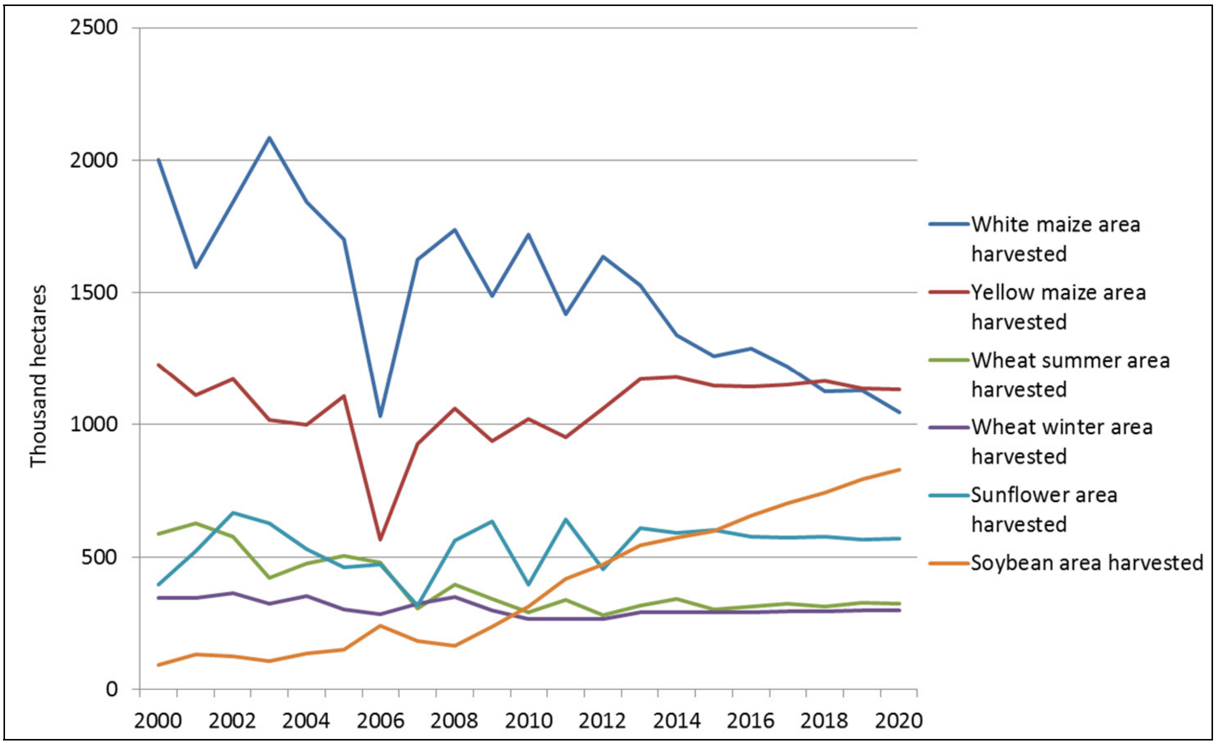


Figure 1: South African crop area (2000–2020)
Source: Bureau for Food and Agricultural Policy (BFAP), 2011

1.2 PROBLEM STATEMENT

Meyer (2006) has developed a regime-switching model within a partial equilibrium framework which generates estimates and projections of endogenous variables under market-switching regimes. In this regime-switching model, the only determinants for area production projections for a specific production season are the various commodity prices, yield projections based on assumptions on rainfall trends and relative cost of inputs and the rainfall expected at the time of planting.

As these four drivers of relative hectares planted in a specific year are to large extent macro driven, it is important to understand the state of the farm business as a whole, taking into consideration not only aggregate drivers, but rather a more detailed, micro approach to understanding their financial impact on a specific farm from a financial perspective.

The research gap for this study is defined as follows: The study unpacks the decision-making environment of farmers from a financial perspective in order to anticipate relative shifts in future cropping patterns in South Africa. The decision-making environment of the South African farmer is extremely volatile and uncertain and the commercial farming sector has to adapt in order to be financially sustainable. Adaption over time may impact land use patterns, and if a majority of farmers undertake certain shifts, then the relative crop mix in South Africa will change, which in its turn again will affect the country's food security status.

The outlook generated by the BFAP sector model provides long-term projections until 2020, based on several drivers and assumptions about a range of economic, technological, political, environmental, institutional and social factors that are incorporated in the model through a set of estimated supply response elasticities. The 2011 projections take the latest trends, policies and market information into consideration and are constructed in such a way that decision makers can create an overview of plausible future demand and supply trends given a certain set of assumptions. The question to be asked is whether primary production will be able to adapt to these long term projections.

It is important to note that following the additions that were included by Gebrehiwet in 2010, the BFAP sector model does take input cost into consideration. However, the additions were made on aggregate level, meaning that the South Africa agricultural input and production environment was considered as a whole. Gebrehiwet (2010) extended the study in order to combine gross income, input expenditure, gross value added and net farming income to evaluate the financial and economic position of the agricultural sector at large (Gebrehiwet, 2010:v). In reality, one should consider each commodity independently, as cost structures and physical inputs could differ significantly. Gebrehiwet (2010:182) suggested that a study of variable input cost composition focusing on each commodity level could be of remarkable value. In other words, the switch between maize and soybean hectares is driven by the relative input and output prices but not by application rates or more selective issues, for example, the effect of nitrogen fixation by soybeans that also has a monetary value for the farmer.

Hence, this study will use a farm-level approach to determine whether the BFAP sector model's general long term projections for cropping patterns in South Africa are in fact economically viable from a farm business perspective and if not, what structural changes might take place for farmers to adapt to the underlying macro supply and demand trends.

1.3 PURPOSE STATEMENT

Given the research gap outlined in the problem statement, the purpose of this study is to focus more intensively on the decision-making environment of farmers and the corresponding drivers that will influence or change this environment. This specifically refers to area utilisation in any specific year and whether a plausible future scenario is realistic at farm level. Furthermore, the purpose entails the development of a qualitative interface between macro-economic analysis and farm-level models such as the BFAP sector and farm-level (Financial Simulation Model or Finsim) models focusing on macro-economic impacts, cost structures on farm-level and typical farm businesses in the summer rainfall region of South Africa.

1.4 RESEARCH OBJECTIVES

The following specific objectives will guide the study:

- To conduct on-farm validations by identifying typical farm businesses in the summer rainfall area of South Africa, focusing on summer produced crops such as maize, sunflowers and soybeans;
- To evaluate the profitability and sustainability of the typical farm business by using Agribenchmark data, the BFAP farm-level model and the BFAP sector model in order to determine the long run sustainability given a certain set of assumptions and projections influenced by both domestic and international drivers;
- To validate whether the projections made by the BFAP sector model are economically viable from a farm business perspective;
- To identify the pertinent drivers that could influence decision making of farm businesses in the long term and to determine whether long term balance sheet projections based on the BFAP sector model output will be plausible from a micro farm-level perspective or primary production aspect;

- To determine what the relative shift in hectares in the summer rainfall area could be in the long term, considering macro-economic analysis, cost structures on typical farms and changing consumer demands and markets in the different summer rainfall regions of South Africa;
- To create macroeconomic and production scenarios and determine the long term impact at farm level.

1.5 CONTEXT AND UNITS OF ANALYSIS

The study will be conducted in selective regions in the summer rainfall area of South Africa. These selective regions can be identified as the northern and western Free State, which takes into consideration dryland production of maize and sunflowers, the North West province, with dryland maize and sunflower production, the eastern Free State, where the focus falls on dryland maize and soybean production, and finally, the Mpumalanga Highland areas, focusing on maize and soybean production.

Within the identified areas, typical farm businesses will be included in the analysis as representative farms for that region. The unit of analysis will be on the financial interpretation of each representative farm and the respective cost structures of each enterprise and will further focus on financial ratios such as net farm income (NFI), which measures farm profitability, and ending cash surplus/deficit, which indicates the cash flow (CF) position of farm businesses. The linkages between the BFAP sector model and the BFAP farm-level model will be able to determine the long term outcomes at farm level and possible shortfalls.

Finally, the relationships between different farm enterprises and their respective cost structures, operations, net margins and sustainability could determine to what extent the relative shift in hectares ought to be based on certain macro-economic assumptions and the relative impact of these assumptions on representative farms in the summer rainfall area of South Africa.

1.6 DELIMITATIONS

Several issues fall beyond the scope of this study.

Firstly, it is important to note that the study will be limited to the summer rainfall area of South Africa where the main focus will be on production in the central and eastern regions of the country.

Secondly, the central and eastern regions of South Africa can be further divided into specific provinces. The focus will be in the northern and western Free State, the eastern Free State, Mpumalanga and the North West provinces, as these provinces are responsible for the proportion of the total production of maize, sunflower and soybeans in South Africa.

Thirdly, the study will include both dryland and irrigation production of selective crops, but the focus will be on the production of dryland commodities as this is the main agricultural practice in the central and eastern regions of the country.

Fourthly, the food staples under discussion will focus only on the production of maize, sunflowers and soybeans.

Finally, the sample space of the farm dataset will be limited by identifying and selecting only representative farms within the selected regions and provinces. The methodology and criteria behind the selection of these representative farms will be discussed later in study.

1.7 DEFINITION OF KEY TERMS AND ABBREVIATIONS

A list of definitions is provided in Table 1 in order to define some of the important terms used in the study.

Table 1 Definition of key terms

Key Term	Meaning
The Bureau for Food and Agricultural Policy (BFAP)	The BFAP is a network linking individuals with multi-disciplinary backgrounds to a coordinated research system that informs decision making within food and agricultural systems (BFAP, 2011).
Partial equilibrium models	The most widely used model in order to assess the effect of various policy interventions on the agricultural sector and the fundamental assumption is that the balance between consumption and production in the economy is maintained by consumers and producers maximising utility and profits respectively (Garford and Rehman, 2006 quoted in Gebrehiwet, 2010).
Typical farms	Typical farms are simply representative farms according to a certain set of criteria, which are outlined in Chapter 3.
Net Farm Income (NFI)	NFI is equal to all farm receipts minus all on-farm costs, which further can be divided into direct allocated and overhead costs.
Cash Flow (CF)	The CF position of a farm is simply the available cash flow positions (either positive or negative) at the end of a certain period or production year.
Genetically Modified (GM)	Indicating that the DNA of an organism has been manipulated in order for improvement or correction of defects (Dictionary.com, 2011).
Living Standard Measure (LSM)	LSM divides the population into ten groups according to their socio-economic status and income (SAARF, 2011).
Profit maximisation	The process that a business will pursue in order to generate maximum returns subject to a combination of factors such as cost minimisation and economies of scale.
Risk	From a financial perspective, risk refers to the chance that an investment's actual return will be different than what was expected due to unknown probabilities and drivers. Risk is usually determined by the standard deviation of that variable from its mean value (Investopedia, 2012).
Sustainability	The ability of a firm to remain profitable and continue operations in the intermediate and long term.
Sensitivity analysis	A technique that is used by farm businesses to determine how different values of an independent variable could impact a particular dependent variable under a given set of assumptions (Investopedia, 2012).
Stochastic model	A stochastic model contains the random nature of most likely impacts, meaning that the random variables and relationships in the model will allow the output to enclose random elements or probability distributions (Strauss, 2005:15). Stochastic models and the random nature thereof incorporate risk by conveying probability distributions to specific exogenous and endogenous variables or key output variables (KOVs).
Gross margin (GM)	From an enterprise perspective, GM refers to the respective farm gate price multiple by yield minus all direct allocated expenses.
Farm gate price	The price that will be realised on the farm. Thus, the market price minus all costs involved in order to market or transport the commodity.
Overhead structure	The overhead structure refers to all expenditures that cannot be allocated to a specific enterprise. It normally includes all overhead expenses, finance costs, depreciation and asset replacement expenditure.

Table 2: List of abbreviations

Abbreviation	Meaning
AGIS	Agricultural Geo-referenced Information System
ARC	Agricultural Research Council
BFAP	Bureau for Food and Agricultural Policy
CF	Cash Flow
CUSDs	Correlated Uniform Standard Deviations
DAFF	Department of Agriculture, Forestry and Fisheries, South Africa
FAO	Food and Agricultural Organisation
FINSIM	Financial Simulation Modelling
GDP	Gross Domestic Product
GM	Genetically Modified
GTI	GeoTerraImage
ISNDs	Independent Standard Normal Deviates
Km^2	Square Kilometres
KOVs	Key Output Variables
LSM	Living Standard Measurement
NFI	Net Farm Income
T	Ton
SOP	Standard Operating Procedure

Chapter 2 will include a detailed literature review on the key aspects and drivers of the study. Firstly, an overview is provided on the South African agricultural land use and potential. Secondly, an overview is provided on the current production trends and demand of selective cereals in South Africa. This is supported by providing long-term projections of the same cereals identified. Finally, the model capacity in the South African agricultural context is interpreted.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

The South African demographics and agricultural environment are considered very complex and uncertain in nature due to extremes such as topographic, climatic, social, political and economic characteristics (Strauss, 2005:1). Uncertainties are further stressed by factors such as the availability of cropland and the changing demand trends of South African consumers and other industries. When combining these uncertainties and extremes, decision making for farmers becomes a very complex exercise and regular adaptation is necessary in order to be sustainable and still competitive in the long run.

Adaptation over time may impact land use patterns, and if a majority of farmers undertake certain shifts, then the relative crop mix in South Africa changes, which on its turn will again affect the food security status of the country. In recent years, the switch between crops as farmers adapt to a changing agricultural and consumer environment has been referred to as the competition for arable land. A summary of the main drivers behind the competition for arable land is illustrated in Figure 2.

For the purpose of this study, the three main drivers that influence the competition for land use are global and local demand patterns, macro-economic conditions and the farmer’s decision-making environment.

The demand for grains and oilseeds can be further divided into the demand for bio-fuels as alternative energy, the demand for animal feed and the demand for food. This is further impacted by urbanisation, consumer trends and preferences, increasing population and disposable income. Fundamentally, the balance between demand and supply drives global and local prices.

The macro-economic drivers can mainly be characterised by 1) the gross domestic product (GDP) which determines a country's relative economic performance, 2) the exchange rate (mainly Rand/US dollar) which is a key driver of parity prices, 3) disposable income, which impacts on consumer trends and per capita consumption, and 4) trade policies that have a major impact on the international trade flow of grains and oilseeds.

The core of the study will focus on the decision-making environment of farm businesses in the summer rainfall area of South Africa and how it could cause a relative shift in the hectares currently under production. This also refers to whether the BFAP sector model projections of numerous summer crops (which are largely impacted by the above stated macro-economic drivers) are plausible from an "on-farm" perspective or, stated differently, will it be economically viable from a farm perspective to track these macro projections? Farm-level drivers include the environment which impacts the decision making of farming businesses and farmers.

The main characteristics of farmers' decision-making environment are illustrated in Figure 2 and can be summarised as follows:

- Profit maximisation is a basic principal of production economics where returns are maximized. Farm businesses will continually strive to maximize the net return of the farm business. It is also closely integrated with sustainability and continuity of a farm business, which largely impacts the decision-making process of land utilisation. Secondly, cost minimisation goes hand in hand with profit maximisation. An example is that a farmer will not continue to produce a specific commodity if there are no profit incentives. Additionally, farm businesses will shift to the production of other crops if profitability levels are not sufficient. For the purpose of this dissertation, the assumption is made that the management of farm businesses will pursue both profit maximisation and cost minimisation approaches given the available resources on the particular farm.

- Cost structure or input expenditure plays a vital role in the decision-making process of a farm business. A relevant macroeconomic linkage is the oil price, which impacts all agricultural input related expenses, especially fuel and fertilisers. As mentioned in the previous paragraph, cost minimisation approaches are a common practise in a typical farm business in South Africa. Cost structures are integrated with profit maximisation principles as increased input expenditure will diminish the business's profit levels. Another important factor to consider is that changing input trends and prices influence farm practice such as crop rotation and the type and amount of inputs utilised.

- Water availability is a critical driver in the decision of land utilisation as certain crops are more dependent on water than others. Technology improvement such as drought resistant maize varieties will impact land utilisation, as these varieties will perform better than others in areas with lower annual precipitation.

- Technology refers to the development of new or improved equipment, mechanisation, chemicals, seed, fertilisers, production techniques and other agricultural inputs due to research and development. Productivity and efficiency are essential for farm sustainability. As stated earlier, new drought resistant seed varieties may decrease production risk in years where inferior rainfall is experienced. New agricultural mechanisation and equipment such as auto-steer tractors fitted with Global Positioning Systems (GPS) allows for more efficient farm practise and operations, which improves crop yields, thus improving the financial position of the farm business.

- Hectare availability is one of the key drivers of this study as it is a natural restriction and thus a binding constraint. In the following section a detailed discussion will follow on South Africa's land availability, quality and potential.

- Production techniques refer to the type of production system a farm business will utilise, which can be further divided into examples such as machinery operations utilisation (minimum tillage, conservation tillage, no-tillage and conventional tilling techniques), rotation systems (e.g. soybean and maize rotations), types of input utilisation (fertiliser applications and chemical usage) and general (farm) production practice.

- The gross margin of a specific commodity can be defined as the income a farm business will obtain per hectare harvested before overhead costs are deducted. The calculation is based on the yield multiplied by the commodity farm gate price minus direct allocated cost, which is the cost that you will have to incur in order for a crop to be planted and to be produced.

- External drivers refer to non-agricultural competition for land such as the expansion of mining activities on agricultural land, degradation of land and residential development.

- All of the above drivers include the risk component such as production risk, market risk, expenditure risk and other external risk.

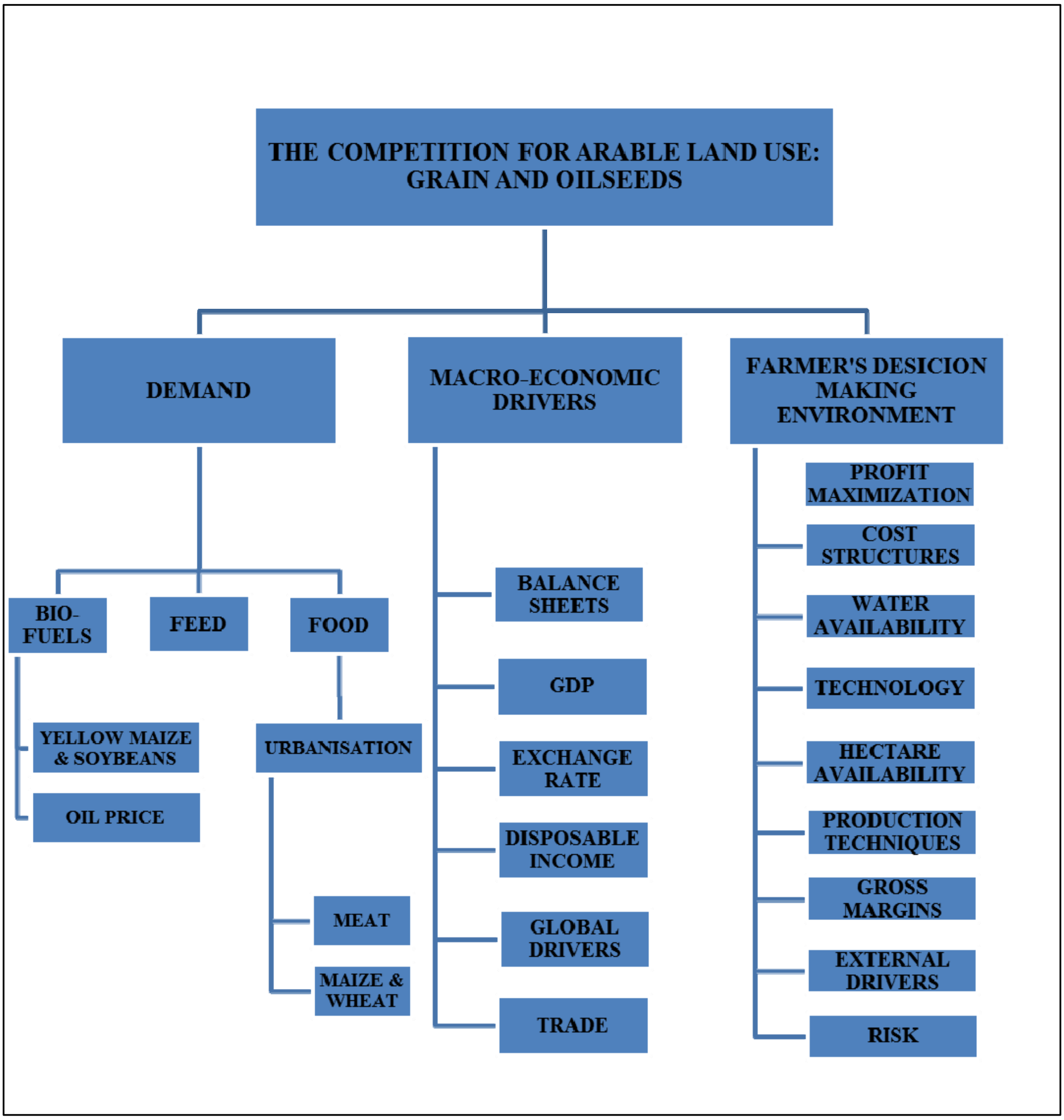


Figure 2: The drivers behind the competition for arable land utilisation

The drivers behind the competition for arable land are influenced by numerous drivers, as was stated in Figure 2 above and the introductory section. Understanding the fundamentals of these drivers will assist the decision-making environment of farm business in South Africa. The next section will focus on the background and formulation of these drivers by means of a literature review on the important factors and subjects that influence the agricultural environment in South Africa.

2.2 SOUTH AFRICAN LAND RESOURCES AND POTENTIAL

2.2.1 Agricultural land use

The Western Cape, Northern Cape, Eastern Cape, Free State, North West, Gauteng, Limpopo, Mpumalanga and KwaZulu-Natal form the nine provinces of South Africa. These nine provinces cover a total area of 1 398 088 km^2. The topographic and climate characteristics consist of deserts, semi-arid areas, tropical regions, coastal flats, escarpments and plateaus (Strauss, 2005:1).

Figure 3 indicates South Africa's land capability per province for very high, high, moderate and marginal arable land. It also provides information on the non-arable land and grazing capacity in the different regions of South Africa.

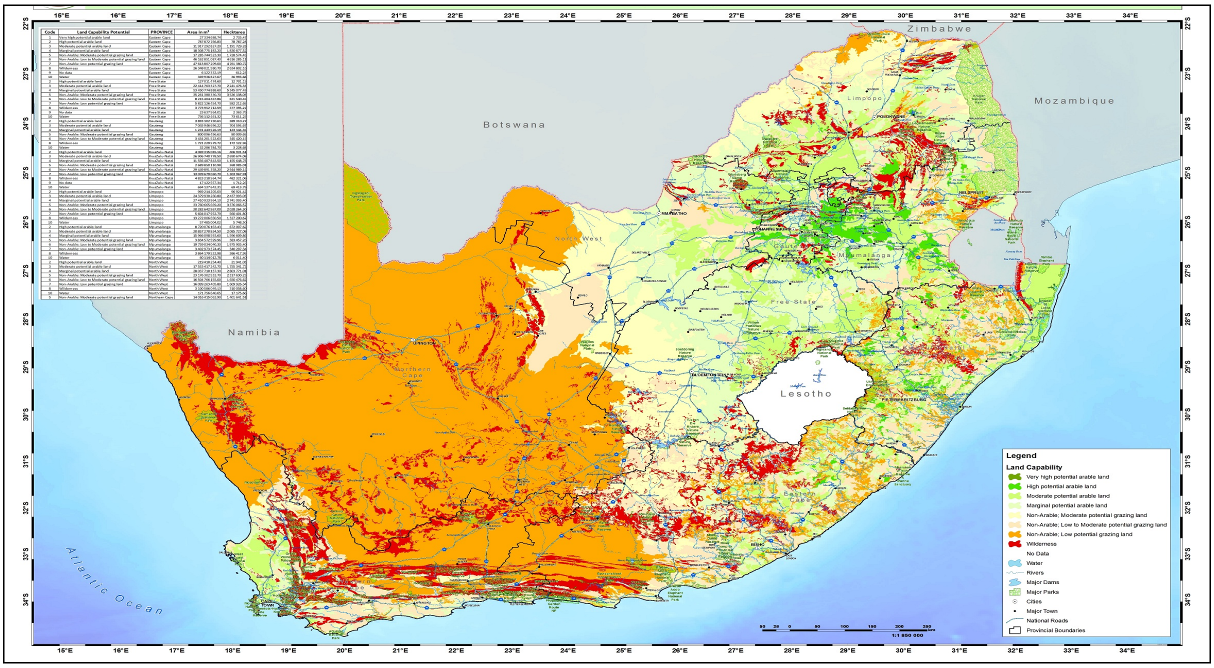


Figure 3: South Africa – Land Capability per Province
Source: Bureau for Food and Agricultural Policy (BFAP), 2011

Figure 3 can be sub-divided into three main categories; High potential arable farming, medium potential arable farming and non-arable farming with specific reference to grazing capacity and land usage. The dark and light green areas are very high and high potential arable land in South Africa. The fog green / turquoise areas can be classified as moderate, marginal arable and grazing land. Finally, the orange areas are non-arable; low potential grazing land.

According to the Agricultural Geo-referenced Information System AGIS (BFAP, 2011:6), out of the 122 million hectares that make up South Africa, 95 million are suitable for agricultural purposes. This is nearly 80 % of the total surface of South Africa. (National Department of Agriculture, 2007:12). Only 22 % of total arable land available is considered to be high potential. About 1.3 million hectares are available for arable production under irrigation. The composition of grazing and cash crop production can be classified as follows: 83 % of agricultural land available is used as grazing or for livestock production and only 13 % of the available agricultural land is used for the production of cash crops.

Cultivation as one of the important land cover classes can be classified as all areas used for agricultural activities, including old fields and subsistence agriculture (Agricultural Research Council (ARC) & GeoTerraImage (GTI), 2010:2). In Table 3 below, a summary is provided of cultivation types in three provinces of South Africa.

Table 3: Provincial cultivation types and areas in South Africa (2008 and 2009)

Provinces and areas in hectares (ha)			
Cultivation type	**Free State**	**Mpumalanga**	**North West**
High cultivation	1064183	159773	936800
Medium cultivation	1738863	579197	641205
Low cultivation	652712	204736	384404
Old fields	170744	0	69218
Pivot irrigation	121540	33298	67865
Small-scale farming	23919	16297	184244
Total	**3771961**	**993301**	**2283736**

Source: Bureau for Food and Agricultural Policy, 2011

According to Table 3, the total area for agricultural activities in the Free State, Mpumalanga and North West is about 3.7, 0.9 and 2.2 million hectares respectively. In the Free State, the high cultivation area is approximately 28.2 % of the total agricultural area. Mpumalanga's high cultivation area is 16.08 % of total agricultural land in the province. Approximately 41 % of available agricultural land in the North West can be assigned to high cultivation production. The total sum of pivot irrigation for the Free State, Mpumalanga and North West is 222 703 hectares, only 3.15 % of total agricultural cultivation area. Non-availability of water is one of the major constraints that limit agricultural production in the mentioned provinces. According to the Department of Agriculture, Forestry and Fisheries (DAFF) (2010:46), production under irrigation is the biggest single user of run-of water in South Africa. The expansion of irrigation areas has been identified by DAFF, which aims to increase irrigation by 50 % by using water more efficiently, revitalising underutilised irrigation schemes and by promoting mini-scale irrigated agriculture (DAFF, 2010).

2.2.2 Agricultural potential

High potential agricultural land as a scarce resource has been recognised for an extended period in the agricultural industry and context (Collet, 2008:228). Collet (2008) further states that the role between agricultural production and land with its associated characteristics cannot function independently. Thus, the dependence between agricultural potential and the status of production and land under the associated weather conditions are important to ensure continuous production of food. Figure 4 below indicates the high, medium and low cultivation areas in South Africa.

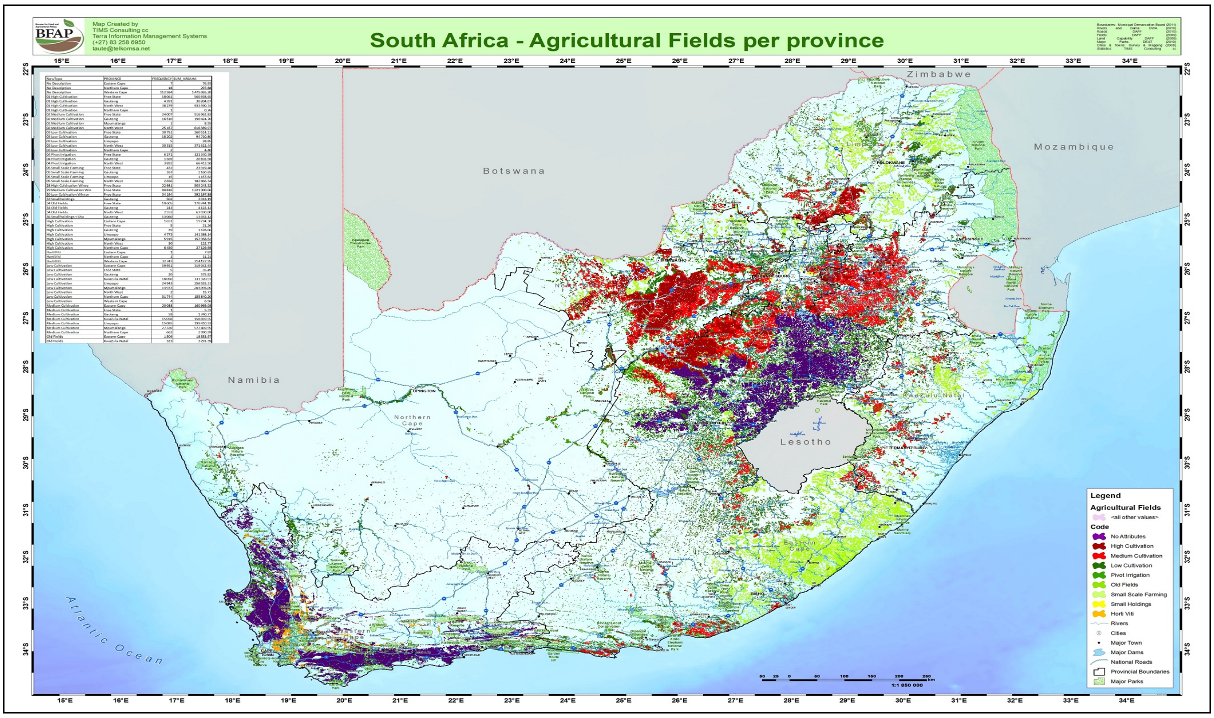


Figure 4: South Africa – Agricultural field potential
Source: The Bureau for Food and Agricultural Policy, 2011

The maroon areas in Figure 4 represent high cultivation areas, which emphasises the scarcity of high potential land in South Africa. The red areas indicate medium cultivated lands. The dark green areas can be classified as low potential cultivation. Figure 4 further highlights a very important image, the distribution and density of arable land potential over the central/eastern parts of South Africa, which can be classified as the summer rainfall area of South Africa. In the last mentioned area (dark green), the production of white and yellow maize, sunflowers and soybeans are common enterprises.

In 2008, AGIS (BFAP, 2011) updated the land potential for agriculture in South Africa. The update provides information on future land potential areas and farm portions per province. This update is shown in Table 4 below.

Table 4: Land potential for agriculture 2008

Area in hectares, percentages and number of farm portions				
Province	**Province area (ha)**	**Agricultural land (ha)**	**% Agricultural land**	**Farm portions per province**
Eastern Cape	16 896 596	11 631 053	69	41 845
Free State	12 982 514	12 279 665	95	48 012
Gauteng	1 654 778	887 107	54	21 670
KwaZulu-Natal	9 436 132	5 159 644	55	41 328
Limpopo	12 575 297	7 347 712	58	26 256
Mpumalanga	7 649 464	4 998 979	65	26 542
Northern Cape	37 288 942	33 100 713	89	23 245
North West	10 651 210	7 141 869	67	36 665
Western Cape	12 946 217	11 996 550	93	45 294
National total	**122 081 150**	**94 543 292**	**77**	**310 857**

Source: Bureau for Food and Agricultural Policy (BFAP), 2011

According to Table 4, out of the total land of 122 million hectares in South Africa, 94 million hectares are regarded as suitable for all agricultural activities. This is 77 % of the total land in South Africa. The total number of farm portions in South Africa adds up to 310 857 ha. The Free State, North West and the Mpumalanga's agriculture potential is 25.83 % of the total land available for agricultural activities and production. It is important to note that potential land for agriculture includes all agricultural activities, such as livestock and cash crop production.

2.3 AN OVERVIEW OF CURRENT PRODUCTION TRENDS AND DEMAND FOR SELECTIVE CEREALS IN SOUTH AFRICA

About 8.5 million people are either directly or indirectly dependent on the agricultural economy for employment and income (DAFF, 2010). From 2002 to 2008, the contribution of agriculture towards total nominal gross domestic product (GDP) increased from R38 billion to R68 billion. The primary agricultural sector contributes roughly 3 % towards total GDP and the agro-industrial sector about 12 % of total GDP. The dual agricultural economy includes a well-developed commercial sector and a subsistence-based sector in the rural areas. South Africa has the ability to be self-sufficient in the traditional food staples like maize, but recent consumption trends are rapidly boosting the demand for wheat and rice consumption, where South Africa's natural resource potential is limited, and it is unlikely that self-sufficiency will be reached in these two commodities in future (BFAP, 2012).

Agricultural institutions, policy makers, the unique labour demography, natural resource factors and technological factors all form part of the unique framework of the South African agricultural industry and economy (Meyer, 2002:9).

The diverse agricultural economy as a whole is a complex environment to explain. In the next section, a more detailed discussion will follow on maize, sunflower and soybean production in South Africa as this could provide more information on the structure and building blocks of the South African cereal and oilseed industries.

2.3.1 Maize balance sheet

Maize as a staple food is the most important grain crop produced in South Africa. Not only is it a major food source for humans and animals but it also provides employment for thousands of citizens and is an earner of foreign exchange (van Zyl, 2010:1). The maize industry is thus an important industry for the sustainability of South Africa's agricultural economy.

Before the 1990s, the maize industry was regulated by the Maize Marketing Board, which was established in 1935 after the promulgation of the Maize Control Act (Act 89 of 1931). The purpose of this board was to eliminate price uncertainty for producers by means of a single-channel fixed-pricing scheme. During the 1990s, marketing boards in South Africa were deregulated, which forced price formation of commodities to operate on a free market system. As a result of the free market system, price volatility increased and producers were continuously exposed to a high level of price and market risk on both input expenditure and output prices (van Zyl, 2010:1).

In Table 5, an overview of total maize production in South Africa illustrates current and historic production trends and consumption patterns. The table includes trends on area harvested, average yield level, total production, human and feed consumption, domestic utilisation and maize ending stocks for the preceding years.

Table 5: Maize production and demand trends

Total maize production and demand ('000)									
Description	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Area harvested (ha)	3100	2843	2810	1600	2552	2799	2427	2742	2435
Production (tons)	9514	9482	10055	6707	7125	11891	11629	12815	11034
Feed consumption (tons)	3719	3745	4011	4047	4158	4284	4627	4765	4999
Human consumption (tons)	3932	4028	3989	4008	3809	4743	4621	4795	4674
Domestic use (tons)	8734	8345	8148	8139	8729	9116	9341	10305	10145
Ending stocks (tons)	2624	3148	3169	2070	1057	1585	2165	2685	2105

Source: The Bureau for Food and Agricultural Policy (BFAP) 2011

A total of 12.81 million tons of maize was produced in 2010 on an area of 2.74 million hectares. The domestic use for the same period was 10.30 million tons, which can be further divided into two main categories, feed and human consumption. A total of 4.76 million tons was utilised for animal feed and 4.79 million tons for human consumption. The ending stock for maize amounted to 2.68 million tons.

Furthermore, total maize production can be divided into white and yellow maize production. The majority of yellow maize is utilised as animal feed and the majority of white maize production is utilised for human consumption. South Africa is a net exporter of maize and during 2010 a total amount of 1.99 million tons was exported (BFAP, 2011). The average producer price for white and yellow maize in 2010 was R1300 and R1379 per ton respectively.

Figure 5 illustrates the historic and current trends for maize area harvested and yield per hectare for the period from 1994 to 2011.

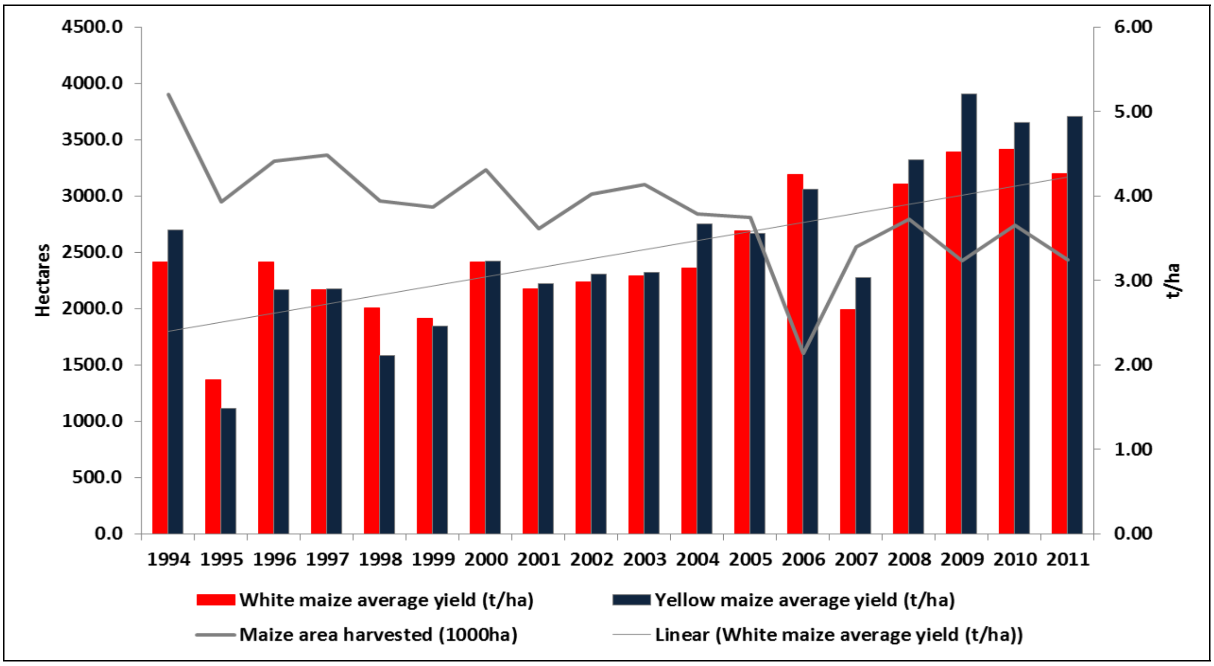


Figure 5: Maize area and yields (1994–2011)
Source: The Bureau for Food and Agricultural Policy (BFAP), 2011

It can be observed from Figure 5 that there was a definite decrease in the maize production area from 1994 to 2011 and an increase in productivity and yields over the same period. In 1994, the total area for maize production was 3.90 million hectares. In 2011, however, the total area was 2.43 million hectares, 37.6 % lower than in 1994. This phenomenon can be ascribed to several factors such as price volatility discouraging farmers from producing maize, rising input expenditure, and political factors that caused farmers to quit production and the profitability of farms to decrease. On the other hand, the average yield and productivity of maize due to a lower area harvested increased for the period 1994 to 2011. The grey line (trend-line) for white maize yield provides proof for the statement that yields have increased during the past decade. The same can be assumed for the yield for yellow maize. This increasing yield can be largely ascribed to technology. Cultivar improvement, genetically modified (GM) maize, better production techniques and implement and machinery development have improved yield levels over the past decade for white and yellow maize.

2.3.2 Sunflower balance sheet

South Africa is the world's 12th largest producer of sunflower seeds (DAFF, 2010). The production of sunflowers accounts for 60 % of all oilseeds produced in South

Africa and is considered the most important locally produced oilseed commodity (van Zyl, 2010:iv). Sunflower seed crushing produces primary by-products that are important ingredients in the food and animal feed sector in the form of edible oils and protein meal.

Before 1996, the sunflower market was controlled by the Oilseed Board, which functioned in the same way as the maize price regulation during the 1990s. The Oilseed Board operated on a single-channel pool scheme and the marketing and regulation of oilseeds and by-products was one of the main functions of the board. After the deregulation of the marketing boards, farmers were exposed to price risks and international competition.

Sunflower area harvested, production, crushing, domestic use, ending stock, net imports and producer prices are presented in Table 6 below.

Table 6: Sunflower production and demand trends

Total Sunflower seed production and demand ('000)									
Description	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Area harvested (ha)	628	530	460	472	316	564	635	397	642
Production (tons)	656	651	614	517	296	872	801	490	809
Crush (tons)	798	656	638	456	369	637	816	771	721
Domestic use (tons)	815	674	639	458	372	653	840	772	737
Ending stocks (tons)	125	120	100	161	95	236	266	46	146

Source: The Bureau for Food and Agricultural Policy (BFAP), 2011

The average production of sunflower for the past nine years was approximately 634 100 tons per year. During 2010, production was significantly lower at 490 000 tons. From 2003, sunflower production on average utilised 516 300 hectares per year. During 2010, only 397 700 hectares of land was under sunflower production. Over the past ten years the average yield for sunflower production was 1.27 t/ha (BFAP, 2011). The domestic use for sunflower production is mainly supplied to and utilised by the crushing industry where oils are manufactured. In 2010, out of the total domestic use of 772 000 tons, 771 000 tons were used by crushing factories. For the same period, the average price that was realised for producers was R3812 per ton of sunflower seed.

2.3.3 Soybean balance sheet

During the 1990s, soybean production was severely undervalued and this is directly reflected in terms of area harvested and production in tons (BFAP, 2011), as can be seen in Figure 6. However, over the past decade the picture has changed dramatically and soybean production in South Africa is currently highly rated and valued, not only because of its importance in the animal feed industry, but also the significant value that it contributes towards crop rotation systems and the value of nitrogen fixation in the soil.

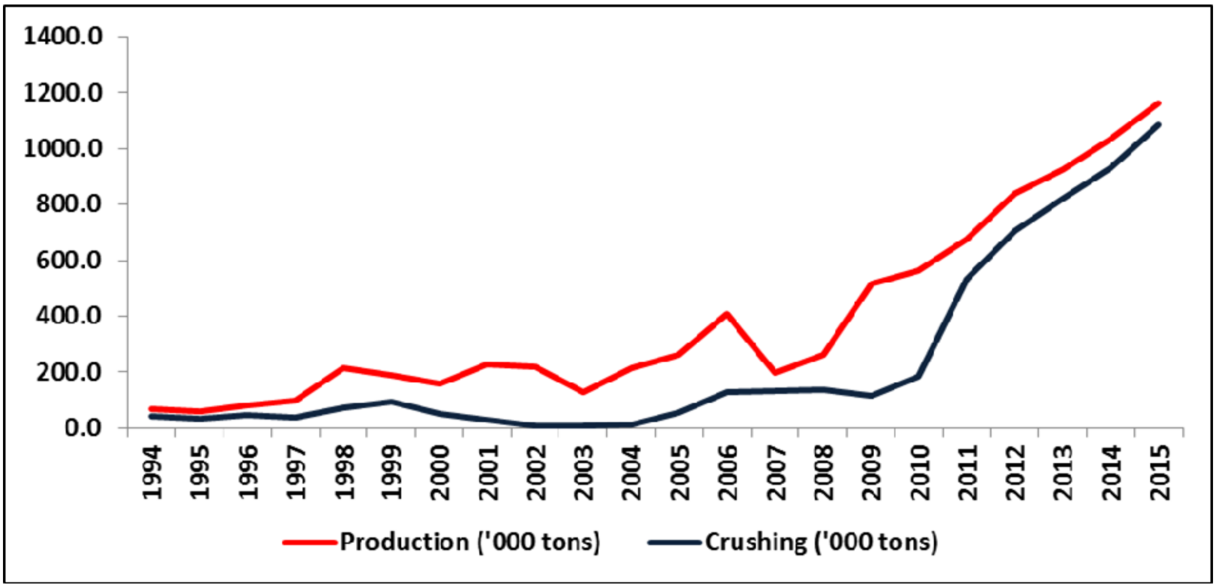


Figure 6: Soybean production and crushing (1994–2015)
Source: The Bureau for Food and Agricultural Policy, 2011

During the marketing year of 2010/2011, for the first time in South African agricultural history, soybean production overtook sunflower production, mainly due to the importance and benefits of a legume crop in a maize cropping rotation. It is projected that the growing demand for animal protein and the importance of cropping rotation could triple production by 2020, to reach a total of 1.8 million tons of soybeans produced locally, according to BFAP (2011). Currently, South Africa is a net importer of soybean oilcake due to insufficient crushing capacity. However, in the medium term the scenario could change due to current investments in the crushing industry.

The total area under soybean production rose to 472 000 ha from a mere 183 000 ha less than five years previously. Total production increased to more than 700 000 tons in 2011. Soybean crushing and feed consumption (full fat) are the two most important contributors to total domestic use. During 2010, 185 000 tons were crushed and 203 000 tons were consumed by the feed industry. The average producer price for 2010 was R2910 per ton and yield was slightly lower than in 2009 at an average of 1.82 tons per hectare.

2.4 OTHER PRODUCTION DRIVERS, DEMAND TRENDS AND PROJECTIONS

In order to evaluate the profitability and sustainability of farming businesses, to validate projections based on the BFAP sector model, to identify and review new or existing decision-making drivers of farming units and to determine whether a shift will occur in land utilisation, it is important to consider other production drivers, demand trends and new directions that may influence the farm business structure and decision-making drivers in South Africa. If one could understand the combined impact of these drivers and projections, the assumption could prevail that farmers will strategically align their businesses according to these drivers and trends and systematic adjustments together with structural changes will occur in the future.

Firstly, technological advances in the manufacturing of biofuels such as ethanol and biodiesel have created new international markets by stimulating the demand for agricultural commodities (Biofuels and Agriculture, 2001). However, increasing biofuels production either due to pure market forces and/or policy has had significant impacts on agricultural markets, including international trade of agricultural raw materials. Linkages between food and energy production include the competition for agricultural production inputs, but also the competition for arable land. During the past two years, several models which focused on agriculture and food processing indicated that a shift in the demand for agricultural commodities as a consequence of increasing biofuels demand leads to substantially increased agricultural commodity prices and an increase in land use (Banse, van Meijl & Woltjer, 2010).

Figure 7 illustrates the United States' ethanol demand and percentage of total production.

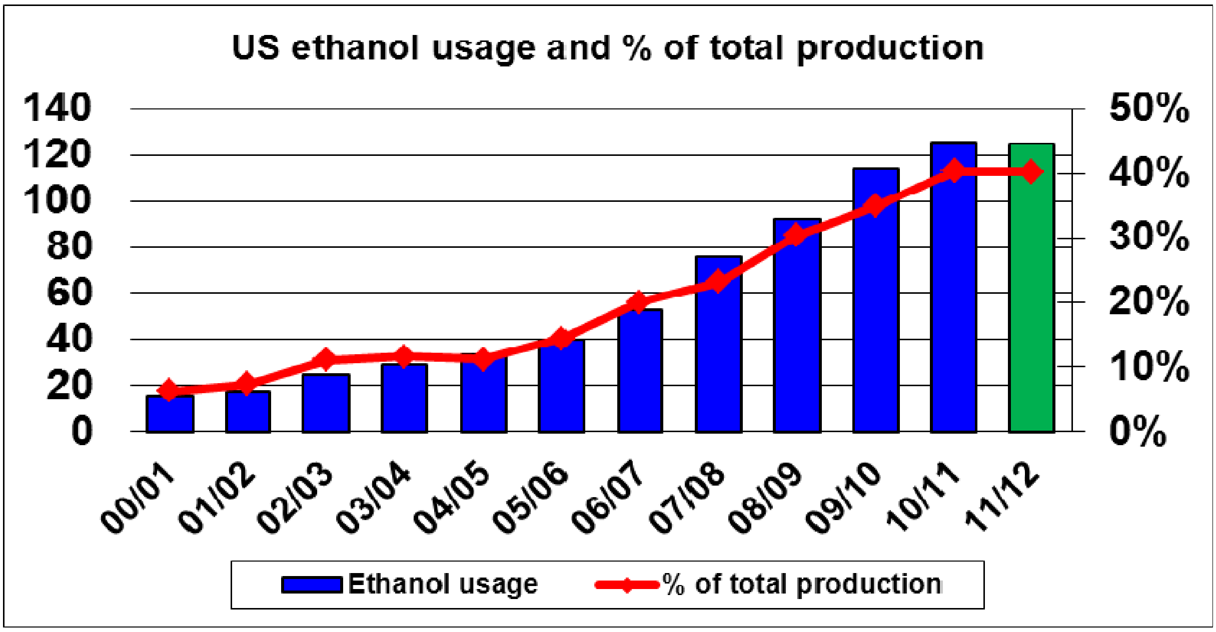


Figure 7: United States (US) ethanol usage and percentage of total production

Source: van der Vyver, 2011

The ethanol usage showed a relatively sideways movement from 2000 to 2005. Thereafter, the demand increased sharply towards the end of 2010 where almost 40 % of total yellow maize production was utilised for ethanol manufacturing. Therefore, Figure 7 demonstrates the increased demand of ethanol from agricultural products and one could argue that increased demand for biofuels has placed enormous pressure on global stock levels. These low stock levels further led to extremely volatile market conditions which further encourage high commodity prices.

The demand for and imports of soybeans by China is illustrated in Figure 8. The consumption of soybeans increased from the 2001/2002 production season to the end of 2010. In addition, imports of soybeans by China also show an escalating trend for the same period. It is further projected that consumption and imports will continue to increase towards the end of the 2011/2012 production season.

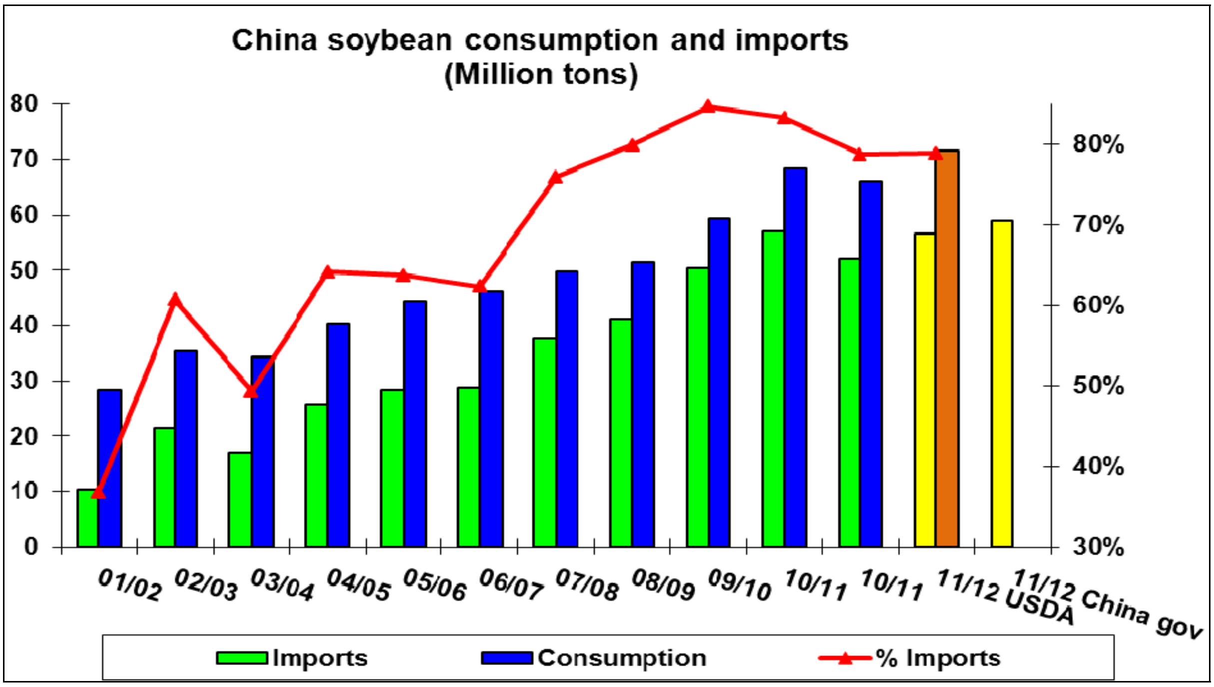


Figure 8: China soybean consumption and imports (2001–2012)
Source: van der Vyver, 2011

Given these two key drivers in the grain and oilseed balance sheets, the key question therefore remains whether the demand for biofuel production and the increasing demand for soybeans from China could cause competition for arable/productive land and therefore establish renewed pressure on the food sector. In addition, the drivers behind the decision-making environment of farm businesses (with a profit maximisation and risk minimisation approach) regarding land utilisation remain unclear. Finally, given the above arguments, a shift in hectares could most likely occur in the medium to long term. This study sets out to explore the drivers at farm level that could cause a shift in area under production in South Africa.

2.4.1 BFAP baseline 2011 projections

Annually, BFAP presents an outlook of the agricultural production, consumption, prices, trade and market conditions in the South African agricultural environment (BFAP, 2011). The outlook generated by the BFAP sector model provides long-term projections until 2020, based on several drivers and assumptions about a range of economic, technological, political, environmental, institutional and social factors. The 2011 projections take the latest trends, policies and market information into consideration and are constructed in such a way that decision makers can create a snapshot of what ought to happen in agricultural environments in the future given a certain set of assumptions. In order to determine whether a plausible future scenario at the farm level is possible, it is important to evaluate what might happen in the long run given a certain set of assumptions and macroeconomic drivers.

Renewed volatility, a changing market environment and stock levels in the past year caused both demand and supply responses, as stated in the background section. Low stock levels forced commodity prices to increase during 2011, thus resulting in an expected supply response in 2012. These low stock levels are mainly caused by severe weather conditions in key production regions in the world (BFAP, 2011). BFAP further states that the sluggish economic recovery of the global economic leaders will affect growth in South Africa negatively, especially the GDP. It is projected that the real GDP will peak at 4.6 % in 2013 and will further gradually decline to reach a real GDP of 2 % in 2020. The oil price is projected to trade within the band of between US $ 110 and US $ 120 towards 2020 and the Rand against the US $ is projected to remain relatively stable. Population growth is one of main drivers of an increase in the demand for food. The total population of South Africa is expected to reach 52.7 million people in 2020. Real commodity prices are expected to remain relatively stagnant over the period 2011 to 2020 (BFAP, 2011). The real net farming income of the South African agricultural industry in 2009 and 2010 declined by 12 % and 15 % respectively. This trend is expected to be the opposite in 2011 and could increase by 29 % due to higher commodity prices. Towards 2020, it is expected that real net farming income could remain stable due to an expected supply response in 2012, the strength of the Rand/US $ exchange rate and finally, increasing agricultural input costs due to sustained high crude oil prices and increasing labour costs. This long-term outlook covers the key macro-economic variables and projections according to BFAP.

In the next paragraph a more in detail discussion will be given on the specific summer grains projections. These projections indicate what the future scenario could look like for farmers and will further assist in the objective to determine whether the on-farm structure is plausible given the long-term projections. This relates to one of the key objectives of this study, and that is to determine whether a shift in hectares could occur in the long term. This is based on the fact that balance sheet projections which refer to basic demand and supply fundamentals will impact commodity price trends, which simultaneously impact the profitability of certain commodities in farming businesses.

Figure 9 below illustrates the projections from 2012 to 2020 for total maize production and total maize demand for human and feed consumption. Total maize production is expected to increase in 2013 due to the supply response in 2012. This is mainly due to better commodity prices that are projected for 2012. From 2013 onwards, total production moves relatively sideways, which could be the result of limited land and water resources that restrict the expansion of production. The blue bar columns, which illustrate the demand for human consumption, provide evidence that production is limited. As the demand for food increase towards 2020, there is almost no supply response, which means that there are concerns regarding the ability of the local industry to produce 13 million tons of maize on a consistent basis. Figure 9 further projects that the demand for feed consumption could remain constant over the baseline period (BFAP, 2011).

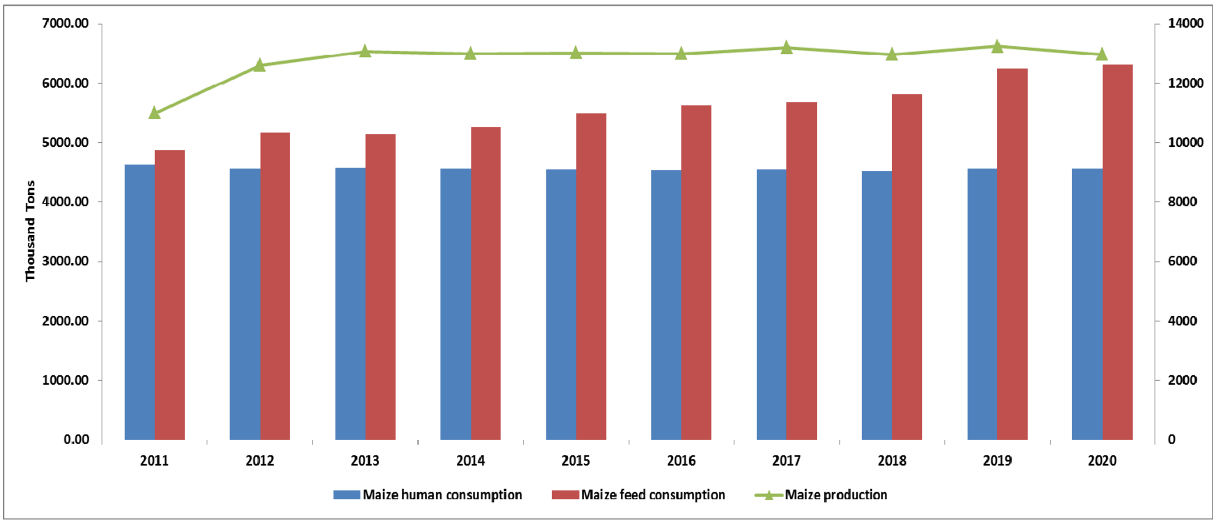


Figure 9: Maize production and demand projections (2012–2020)
Source: The Bureau for Food and Agricultural Policy (BFAP), 2011

Maize is probably considered one of the most important summer crops produced due to its large contribution towards food consumption in South Africa. In addition, the production of soybeans and sunflower also plays a significant role in summer commodities, especially when considering changing consumer trends. Since one of the objectives is to determine what the relative shift in hectares could be, it is important to look at the projections for soybean and sunflower oil and cake demand.

The domestic consumption of soybeans is projected to increase by more than 300 % towards the end of 2020, mainly due to an increase in the soybean crushing industry. The projections for soybean and sunflower production are illustrated in Figure 10. To support the argument, the demand for soybean and sunflower oilcake as key protein feed sources is included in the figure. The green bar columns illustrate sunflower oilcake demand. As can be seen from Figure 10, it is projected that the demand for sunflower oilcake will remain relatively stable towards 2020. It is further projected that the production of sunflowers could increase marginally towards the end of the baseline period. However, the opposite for soybean production and the demand for soybean oilcake can be observed from the figure. By the middle of 2011 and 2012, the total production of soybean exceeds the production of sunflower and further increases significantly towards the end of 2020. It is projected that soybean production could reach more than 1.8 million tons in 2020, approximately 171 % higher than in 2011. This statement is supported when the projected demand for soybean oilcake is considered, which is illustrated by the light blue bars in Figure 10. It is projected that the demand for soybean oilcake could increase by 41 % from 2011 towards 2020 to reach 1.7 million tons in 2020 (BFAP, 2011). During 2010, South Africa imported just under a million tons of soybean oilcake. The assumption and the objective is that South Africa should become more self-sufficient by producing and processing more soybeans locally. The current projection is that soybean cake imports could decline from 2011 to 2020 as domestic production is expected to grow. A total number of 870 000 tons of soybean cake imported is currently projected for 2020 (BFAP, 2011).

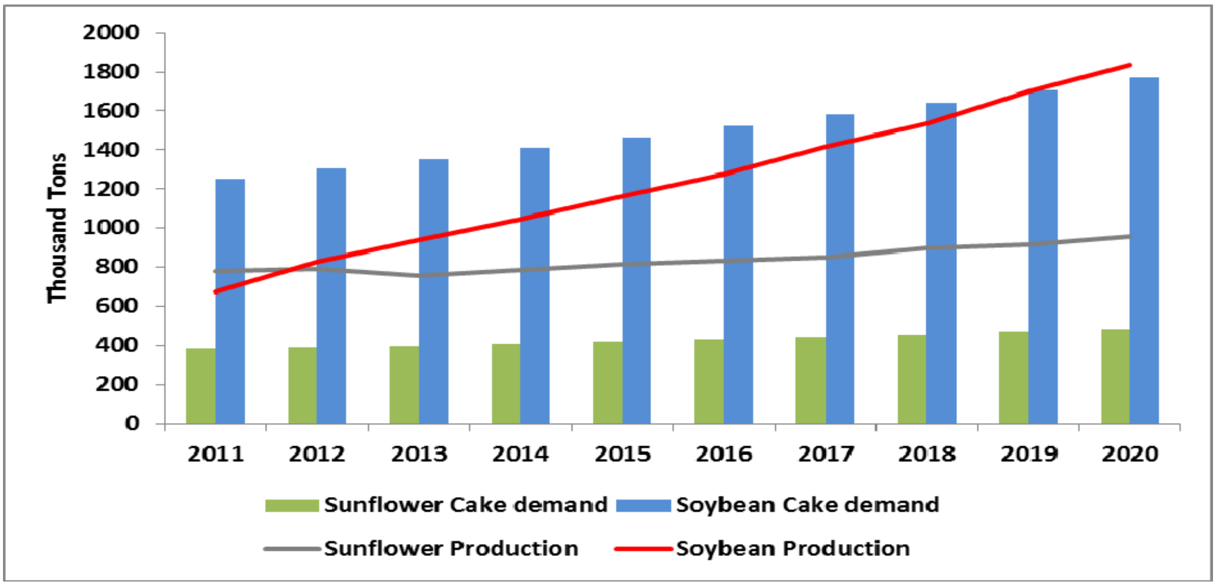


Figure 10: Sunflower and soybean production and demand projections (2011–2020)

Source: The Bureau for Food and Agricultural Policy (BFAP), 2011

Given these projections on the production and imports of sunflower and soybean products, a shift in the number of soybean hectares can be expected, especially when one considers the current limitation on land and labour resources. Secondly, these projections mean that the production of soybean and sunflowers must expand in order to meet demand. Expansion at farm level is possible either by increasing production by expanding the hectares planted or by the use of more efficient technology such as improved seed varieties. Understanding whether this expansion is plausible at farm level is part of the objective of this study.

2.4.2 The demand for animal feed products

The demand for feed is another key driver under the demand category that influences the competition for arable land as shown in Figure 1. The following section provides an overview of the demand for animal feed in South Africa.

Exceptional price volatility was experienced in the domestic meat markets over the past two seasons (BFAP, 2011). Fluctuating price margins, cross-substitution relationships and the outbreak of Rift Valley fever and foot and mouth disease influenced the behaviour of market role-players. As the demand for feed products has a major impact on the production of grain and oilseeds, it remains an important driver that could increase the demand for summer grains and oilseeds and further supports the argument that the competition between hectares could intensify in the medium to long run. It is important to consider what is expected to materialise in domestic meat consumption as this will encourage the production of livestock, and clearly increase the demand for feed products.

Figure 11 represents the consumption of meat in South Africa in 2010 versus consumption in 2020 under the categories beef, chicken meat, sheep meat, pork and eggs. It is projected that over the next decade an increase in the consumption of chicken meat will outrun all other meat groups. It is projected that the consumption of chicken will increase by 41 % over the next 10 years, which implies that the per capita consumption of chicken meat will increase to 43 kilograms in 2020 (BFAP, 2011). The consumption of beef and eggs is expected to increase by 30 % and 28 % respectively in the next decade. Finally, the consumption of mutton and pork products is expected to increase in the next decade by 28 % and 25 % respectively. As chicken consumption increases over the long run, South Africa will remain a net importer, as the relative growth in the production of chicken is outperformed by consumption. Given these expectations in the growing demand for meat products, one can assume that this will further increase the demand for yellow maize and soybean oilcake, as these commodities are important ingredients in the feed industry.

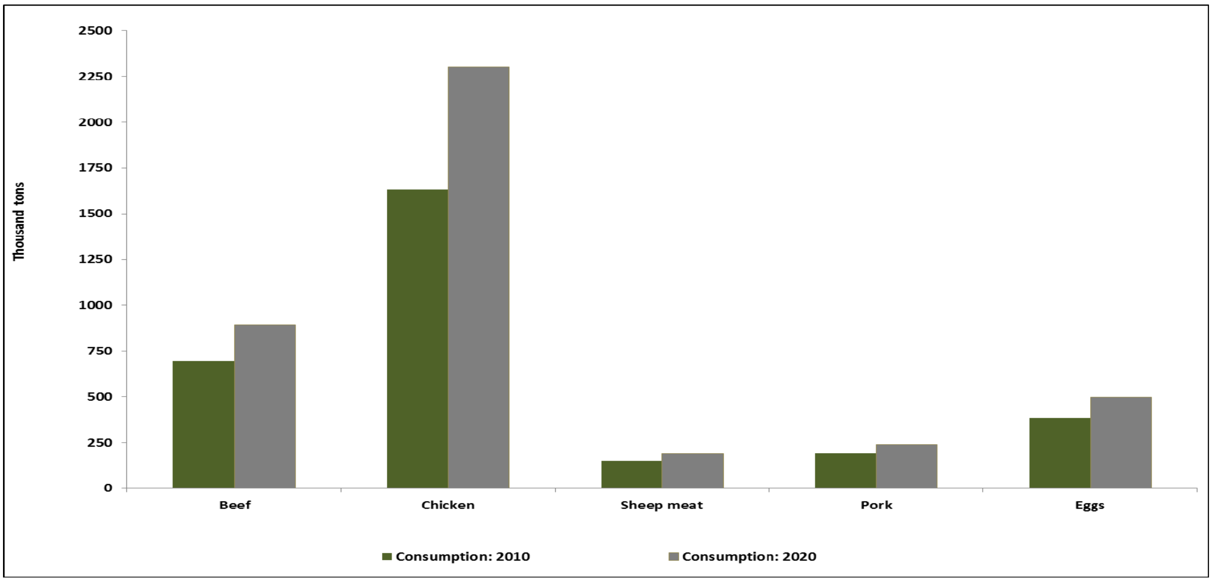


Figure 11: South African meat consumption
Source: The Bureau for Food and Agricultural Policy (BFAP), 2011

2.4.3 Consumer trends and analysis

A shift in consumer trends and disposable income of certain income groups will impact demand trends for certain agricultural goods. A perfect example will be in the case where the disposable income of a certain income group increases, which could cause a shift away from white maize in the form of maize meal to more luxury products such as potatoes, pasta and bread. This impacts the demand for key staples in South Africa, which on the other hand impacts area under production as was seen in Figure 1.

The profile of the South African consumer market and the respective dynamics of it are important drivers of the continuous changing consumer trends and demands (BFAP, 2011). These two drivers are supported by current consumer food trends in the global agro-food sector and food trends in South Africa. South Africa is a diverse nation with different income groups and cultural denominations spread over both urban and rural areas. Understanding these circumstances and how they change over time could assist in long term decision making of farmers.

The South African Advertising Research Foundation (SAARF) has introduced a research tool named the Living Standards Measure (LSM), which has become the most widely used advertising tool in South Africa, dividing the population into ten groups according to their socio-economic status (SAARF, 2011). These LSM groups range from one to ten according to their livelihood status where one is the lowest status and ten is the highest. According to BFAP (2011), most consumers in South Africa are situated between SAARF LSM 4 and SAARF LSM 7 and represented 60 % of the total adult population in 2009. The reason for including the SAARF LSM groups is to attempt to understand consumer behaviour and to determine their changing demand, especially in a case where the total population shifts to higher or lower SAARF LSM groups. In the recent global recession, consumer buying power experienced enormous pressure, which resulted in a lack of spending and even shifted certain spending expenses to more affordable levels. This condition was especially experienced in meat markets, where the consumption of meat was dampened by the recession.

It was stated previously that 60 % of the South African adult population range between the SAARF LSM 4 and 7 levels. The assumption could be made that in each group a certain set of products will be affordable and others will be unaffordable. In the scenario that all these population groups shift to a higher income segment and rank up in their different LSM groups or class mobility, their demands could possibly shift from normal to inferior goods. This effect could cause a relative shift from certain products to more expensive consumables, which directly impact farm-level production. Perhaps a good example is when a consumer shifts from maize meal as a staple food to pasta or rice. Given this overview on consumer trends and analysis, several trends can be identified.

The LSM class mobility is illustrated in Figure 12 and represents all adults during the period 2004 to 2010. A substantial decline in the LSM 1 to LSM 3 groups can be observed from 2004 to 2010.

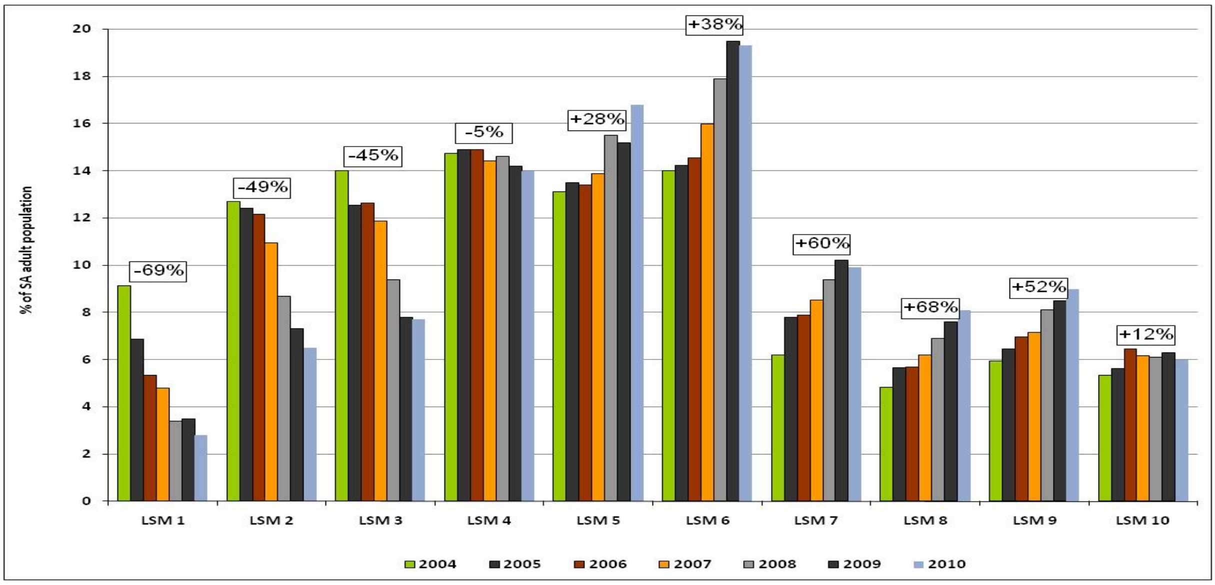


Figure 12: LSM class mobility: All adults during the period 2004 to 2010
Source: The Bureau for Food and Agricultural Policy (BFAP), 2011

The LSM group 4 remained relatively the same during the same period. Finally, the LSM 5–10 groups increased significantly, meaning that the welfare of households has increased during this period. Figure 12 clearly supports the argument of the possibility of a shift in income levels due to several reasons such as economic growth or socio-economic empowerment. This effect is probably one of the main drivers of consumer trends and is critical when evaluating trends that shape the global agro-food environment.

The following list provides a summary of the most prominent food trends in 2011 (BFAP, 2011):

- Health/well-being – Consumers focus more on nutrition, active lifestyles and are more health conscious.
- Convenience – Increased demand for simple and convenient food solutions.
- Naturalness – Increase in consumer need to reduce dissociation with the food that they consume which means, less processed or organic foods.
- Sustainability – Increased focus on the environment and social sustainability such as reduced packaging materials.
- Post-recession trends – Consumers' need for real value, but combined with other benefits.

Chapter 2 thus identified the drivers that could impact the decision-making environment of farm businesses as indicated in Figure 2. The chapter provided an overview of the current availability of land resources. Furthermore, the basic demand and supply fundamentals and projections of South Africa's key grain and oilseeds commodities were discussed as these influence the profitability, sustainability and land utilisation trends of farm businesses in the key producing regions. The chapter concluded by interpreting other production drivers and demand patterns that influence the farm structure of South African farms. The literature review thus creates the base for the subsequent chapters where the decision-making environment of farm business will be analysed and discussed in detail.

CHAPTER 3

RESEARCH DESIGN AND METHODS

In this chapter, a brief explanation will be provided of how the research has been conducted. The research design and methods will be described by focusing on the inquiry strategy and the broad research design, sampling methods, data collection and analysis, assessing and demonstrating the quality and rigour of the proposed design and research ethics. But before these topics are dealt with in detail, it is worth reviewing some of the empirical work, especially related to farm-level decision making that the BFAP group has developed over the past few years that has been used to address some of the objectives in this study.

3.1 MODELLING CAPACITY IN THE BFAP GROUP

Being a conventional farmer in South Africa is a tough and complex profession (Goldblatt, 2010:5). Some of the challenges that can be mentioned are increasing input expenditure depending on external factors beyond the control of farmers, such as macro-economic factors, limited natural resources such as high potential soil, lack of support from government in terms of subsidies, modest market predictability, competition from cheap imports and security on farms. Decision making in farm businesses in South Africa is therefore a complex and risky exercise which could fluctuate almost on a day-to-day basis.

In the thesis of Strauss (2005:3), the problem statement was that decision makers within the agricultural sector have limited knowledge on how changes will affect the agricultural environment. The difficulty in making the right decisions on changing policies and business strategies is a key problem. This led in the conclusion that farmers and decision makers lack a tool to analyse the most likely impact of changes in policies and markets in the agricultural sector (Strauss, 2005:3). The objective of this study is to develop a deterministic farm-level model (BFAP farm level model) with the main purpose of determining and analysing the effect of changes in policy and markets on the financial viability of the farm business.

An econometric regime-switching model within a partial equilibrium framework was developed by Meyer (2006). This econometric model has the ability to generate reliable estimates and projections of endogenous variables under market-switching regimes (Meyer, 2006:iv). The approach of this model (BFAP sector model) was to allow the inclusion of features of regime switching in a multi-sector commodity level model, which has the capability of making more accurate projections of the development of the sector under alternative shocks. The conclusion is that the most important determinants of supply, demand and the relationships between prices are included in the model for various agricultural commodities (van Zyl, 2010). This model shows the relationship, linkages and the integration between various farm indicators such as area under production, commodity yields, total production, direct human consumption, imports, exports and ending stocks of a typical crop in South Africa.

According to van Zyl (2010), the linkage between the BFAP sector model and the BFAP farm-level model are imperative as a number of variables in the sector model are utilised as inputs in the farm-level model developed by Strauss (2005). It is further stated that in order to determine the impact of changes in policies and markets on the key output variables, the results of alternative scenarios can be compared to the baseline results, which means that the baseline serves as a benchmark or reference scenario (van Zyl, 2010). The baseline should not be referred to as a forecast, however, but rather a possible market and policy outlook based on a set of assumptions on exogenous and endogenous variables. Strauss (2005) identified these variables as macro-economic variables, climatic indicators, agricultural policies, economic policies, asset replacement strategies and a combination of farm activities.

The BFAP farm level model developed by Strauss (2005) is a deterministic and stochastic farm-level model, as will be discussed later. The farm-level model is linked to the BFAP sector model as stated earlier and encompasses the grain and livestock industry of South Africa (van Zyl, 2010:81). Two basic approaches exist in farm-level modelling and simulation, a normative and a positive approach. The normative approach can be identified as optimisation of a system or to quantify "what ought to happen" in a system. A positive approach implies the most likely impact of a system and the quantification thereof (Strauss, 2005). Farm-level modelling is further divided into two areas, deterministic and stochastic modelling. A deterministic model is a model where the probabilities of the key output variables are equivalent to one and where the system relationships are constant. The results of the key output variables are thus definite. According to Richardson (quoted in Strauss, 2005), deterministic models do not incorporate the environment of risks due to the fixed nature of the interaction of the variables. Thus, deterministic models simulate a specific outcome given a set of particular inputs (Strauss, 2005).

A stochastic model contains the random nature or most likely impact, meaning that the random variables and relationships in the model will allow the output to enclose random elements or probability distributions (Strauss, 2005:15). Stochastic models and the random nature thereof incorporate risk by conveying probability distributions for specific exogenous and endogenous variables. Probability and cumulative distributions represent the simulation of key output variables in stochastic surroundings, which quantify and compare risks associated with different scenarios and decisions.

The BFAP farm-level model is a total budgeting model capable of simulating a farming business comprising of various enterprises. These enterprises can be classified as the main grain and oilseeds commodities, livestock, fruit production, vegetables, wine and sugar production (BFAP, 2010). The model can be divided into three basic categories, the input block, a calculations block and an output block, which gives information and data on land resources and utilisation, production systems and expenses, the capital structure of the farm and the financial performance and indicators of the farm business. These form the inputs of the model. The integration with the BFAP sector model allows calculations to obtain the key output variables which are the farm gross margin (FGM), net cash farm income, net farm income (NFI), return to family living, ending cash surplus or deficit, total assets and liabilities, net worth of the farm, real net worth and the debt-to-asset ratio. The reason for these selective output variables is the explanation of farm profitability/performance and the operational liquidity of the farm, while the solvency of the farm is represented by the debt-to-asset ratio (van Zyl, 2010). The output block further consists of a set of financial statements such as the income statement, the cash flow statement and a statement of assets and liabilities.

3.2 DESCRIPTION OF INQUIRY STRATEGY AND BROAD RESEARCH DESIGN

According to Kotze (2009:3), an inquiry strategy refers to the general strategy or approach to the study or how a researcher will solve the problem or objectives, or in more general terms, what research approach or strategy will be used in order to accomplish the objectives of the study.

The approach that has been used in this empirical study is a quantitative or numeric approach with a combination of an evaluative multiple-case study and surveys. Both primary and longitudinal data has been used for analytical purposes. In the dissertation of van Zyl (2010:8), an empirical and evaluative multiple-case study was utilised in order to determine the impact of precision farming on the profitability of farmers in the Northern Cape. The reason why this approach was pursued is because general farming conditions require data from a specific or representative farm to allow for comparative analysis.

The broad research design of the study can be explained using the descriptors discussed below:

- **Empirical research**
  The definition of empirical research as stated by Kotze (2009:7) is a study conducted on primary data. The objective to determine the relative shift in hectares and a plausible future scenario of farmers require primary data of representative farms in the selective summer rainfall areas of South Africa. The data includes all macro and micro farm-level data such as input costs, on-farm capital and financial structure and the resource capability of the representative farms.

- **Primary data**

Saunders (2009:598) defined primary data as data that are collected for a specific project. As stated in the empirical research descriptor, it is important to gather primary data from the representative farms in the specific regions in order to meet the objectives which are outlined in the introductory chapter.

- **Descriptive research**

  The objective of descriptive research is to give an accurate profile of a specific event (Kotze, 2009:7). The diverse nature of agriculture causes farmers to adapt to changes on a regular basis and the true profile of these adoptions needs to be captured in order to present a plausible future scenario.

- **Longitudinal research**

  Longitudinal research is a study of a particular phenomenon over an extended period of time using primary and secondary data (Saunders, 2009:155). The Organisation for Economic Co-operation and Development (OECD, 2004) defines longitudinal data as a number of units or data that is observed over an extended or a multiple time period. In this case, the data is usually secondary data. The reason for using a longitudinal secondary data approach is because the BFAP system of linked models contain three key models, which can be identify as the Food and Agricultural Policy Research Institute (FAPRI) model, the BFAP sector model and finally, the BFAP farm-level model (Gebrehiwet, 2011:4). As the BFAP sector and the FAPRI models' equations require historical data and trends, it is important to include data that extend over an extended period of time. The integration and functioning of the different models are further explained in more detail in the data analysis section.

The descriptors of this study are descriptors for an empirical research approach, assisted by a descriptive and evaluative approach and finally, utilises longitudinal and primary data.

Several advantages and disadvantages of a longitudinal research approach can be identified. The advantages of using a longitudinal research approach are that the process of gathering data could be cheaper than collecting primary data (Saunders, 2009:269-272). Saunders further argues that secondary data has a larger dataset capacity. The disadvantage of using longitudinal data is that it could be more time consuming to collect primary data than secondary or longitudinal data, although it also creates the capacity to compare primary and secondary data. However, secondary data could be inconsistent with the objective of the study. Secondly, access to secondary data could be difficult and costly. Finally, control over the quality of the data could be a concern.

Survey research is a research strategies that involves the structured collection of numerical data from a sizable population and could include questionnaires, observation and open discussions. The advantage of conducting a survey research is that more control over the research is possible. When sampling is used, it is possible to generate findings that are true for the entire population at a lower cost. However, on the negative side, this approach could be time consuming and time delays could be expected when depending on others for information. Finally, questionnaires have a limited data capacity due to dependence on other respondents (Saunders, 2009:144).

The above strategy can be identified as the broad research design and inquiry strategy of the study. In the following section, the sampling techniques will be discussed.

3.3 SAMPLING

The target population of the study is all commercial grain and oilseed farmers in selective summer rainfall areas in South Africa. As stated in the delimitation section in Chapter One, the study will be limited to the Eastern and Western Free State, Northern Cape and the North West province. The provinces identified capture the majority of grain and oilseed farmers in South Africa as these farmers contribute the most towards total production of maize, sunflower and soybeans.

However, the target population needs to be narrowed down to a sample size, which in this case is by identifying representative or typical farms in the selective regions or provinces. These representative farms will be selected on strict criteria which will allow the researcher to standardise and compare these representative farms. This criteria and standardisation for representative or typical farms is based on a Standard Operating Procedure (SOP) as defined by Agribenchmark (2011).

According to Agribenchmark (2011:2) the following definition is utilised when using the SOP to identify a typical farm:

> A typical farm is an existing farm or dataset describing a farm, in a specific region which represents a major share of output for the product considered, running the prevailing production system for the product considered, reflecting the prevailing combination of enterprises as well as land and capital resources as well as the prevailing type of labour organisation.

The advantage of using the SOP approach is the ability to create a standardised method of gathering on-farm data that will assist the researcher to determine the relative impact of future scenarios on farmers which produce the selective commodities. The ability to compare farm businesses in different regions can also be considered as a major advantage. Determining whether a future on-farm scenario is plausible given a set of macroeconomic and other drivers will be supported by this approach towards the study and analysis.

The source of the data is primarily obtained from industry specialists such as agricultural economists, agronomists and agricultural specialists within the identified regions. The primary source that has been used to collect data in the Western Free State is Senwes, Ltd, a local co-operative and financial institution who gathers data for their financial and agricultural services. The primary source for data in the Eastern Free State is still unclear, but VKB Ltd (formerly known as Free State Co-operation Limited), also a co-operative in this region, has been identified. The co-operatives that have been used in the Northern Cape and North West province are GWK Ltd (formerly known as Griqualand West Co-operation) and NWK Ltd (formerly known as North West Co-operation).

The target population in this research study is commercial grain and oilseed farmers in the selective summer rainfall areas and the sample space is representative farms within this region. In the next section, the data collection methods and approaches will be discussed.

3.4 DATA COLLECTION

The study will be conducted by means of a quantitative approach where primary and secondary data has been used to analyse typical farms and their respective future state of affairs. The quantitative analysis has been conducted by means of an evaluative multiple-case study approach with surveys.

The specific attributes and characteristics of the representative farms will include several data variables describing the farm. As one of the objectives is to determine the profitability and sustainability of farming businesses, the approach to analyse these representative farms will be from a financial perspective. However, technical on-farm data is crucial to take into account the structure of the farm. The following representative farm data will be required in order to achieve the objectives outlined in Chapter One:

- **Farm and land information**
  This type of data will include general farm data such as land use, land cost, main enterprises, tillage systems utilised, natural conditions and other farm enterprises.

- **Cropping systems**
  The data that are included can be considered as the key information needed for the research. Cropping system data contain information about the specific commodities produced on the farm and their respective input and cost structures. The broad categories can be introduced as rotation systems, crop information and production systems. Monoculture, annual cropping rotation with pastures or double cropping can be included in the rotation system. Crop information includes information on crop hectares, yield and commodity prices. Finally, production systems include all

operations, implements and machinery used and general crop inputs such as seed, fertiliser and crop protection inputs and costs.

- **Machinery and buildings**
  Machinery and building data are simply a stocktake of the capital structure of the farm and includes tractors, towed machinery, self-propelled machinery and on-farm buildings.

- **Prices and overheads**
  In this category, the energy input, labour force, all overhead costs and the finance structure are captured.

These broad categories of farm data will assist the researcher to conduct the study. The most important constraint when following this approach is to identify the representative farms and validate the data. This barrier can be overcome by validating the results on a consistent basis by consulting with industry specialists such as agricultural economists, agronomists and specialists in that specific region. The proposed data analysis concept and techniques will be discussed in the following section.

3.5 DATA ANALYSIS

The main approaches and techniques that has been used to analyse data in this study will be assisted by using Microsoft Excel since Excel has both analytical and storage capacity capabilities. Figure 13 illustrates the BFAP system of linked models, which contains the FAPRI international model, the domestic BFAP sector model and the BFAP farm-level model.

Three models have been used to analyse on-farm data and the expected future situation of farming businesses, however, different analytical approaches were integrated with the BFAP models in order to analyse the drivers of farm-level decision making. As stated in the description of inquiry strategy and broad research design, the three primary models that have been used in this study are the FAPRI international model, the BFAP sector model and the BFAP Finsim farm-level model, which is assisted by the Agribenchmark typical farm approach. The FAPRI model simply assists the BFAP sector model in such a way as to capture the international macroeconomic drivers and trends which impact the domestic drivers and trends. Since the model is updated and maintained by FAPRI in Columbia, United States of America, the model will only be used as secondary data and no analysis will be conducted on the international model.

The second model that has been used to determine the future impact on farmers and the relative shift in hectares is the BFAP sector model. The BFAP sector model is an econometric regime-switching model within a partial equilibrium framework which was developed by Meyer (2006). This econometric model has the ability to generate reliable estimates and projections of endogenous variables under market-switching regimes (Meyer, 2006:iv). The approach of this model (BFAP sector model) was to allow the inclusion of features of regime switching in a multi-sector commodity level model which has the capability of making more accurate projections of the development of the sector under alternative shocks and international drivers (FAPRI model). This model includes the relationships, linkages and the integration between various farm indicators such as area under production, commodity yields, total production, direct human consumption, imports, exports and ending stocks of a typical crop in South Africa. The multi-sector commodity-level model projects possible future outcomes which have a direct impact on the decision-making environment of farmers.

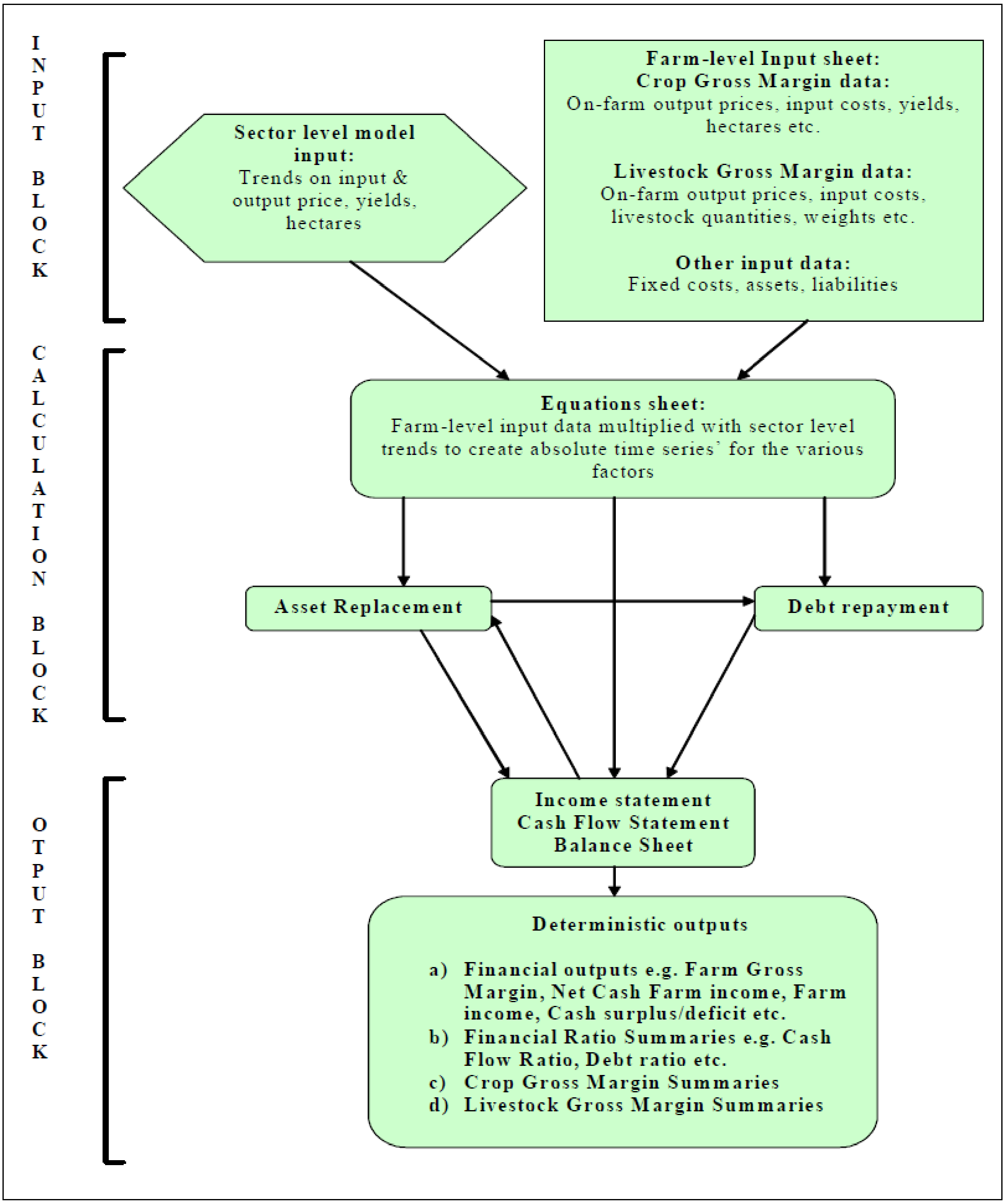


Figure 13: The BFAP system of linked models
Source: Straus *et al.* (2008)

The third model utilised for this study is the BFAP farm-level model developed by Strauss (2005), which is a deterministic and stochastic farm-level model. The farm-level model is linked to the BFAP sector and FAPRI models, which forms the BFAP system of linked models. Two basic approaches exist in farm-level modelling and simulation, a normative and a positive approach. The normative approach can be identified as optimisation of a system or quantification of "what ought to happen" in a system. A positive approach implies the most likely impact of a system and the quantification thereof (Strauss, 2005). The model can be divided into three basic categories, the input block, a calculations block and an output block which is filled by information and data on land resources and utilisation, production systems and expenses, the capital structure of the farm and the financial performance and indicators of the farm business, which outlines the inputs of the model. The integration with the BFAP sector model allows imperative calculations to obtain the key output variables which are the farm gross margin (FGM), net cash farm income, net farm income (NFI), return to family living, ending cash surplus or deficit, total assets and liabilities, net worth of the farm, real net worth and the debt-to-asset ratio. The reason for these selective output variables is the explanation of farm profitability/performance and the operational liquidity of the farm, while the solvency of the farm is represented by the debt-to-asset ratio (van Zyl, 2010). The output block further consists of a set of financial statements such as income statement, cash flow statement and a statement of assets and liabilities.

The integration between these models makes it possible to determine the current South African market and commodity environment by analysing the relationship between local and international macroeconomic drivers and assumptions. The outcome of the integration between the domestic and international models makes it possible to analyse the condition and impacts of farmers in South Africa by inserting the BFAP sector model into the BFAP farm-level model. The integration and functioning of the BFAP system of linked models should assist the researcher to accomplish the objectives of this study.

3.6 ASSESSING AND DEMONSTRATING THE QUALITY AND RIGOUR OF THE PROPOSED RESEARCH DESIGN

One of the major challenges in this empirical study is analysing the decision-making environment of farmers, since there are many exogenous factors which could influence these decision making processes. Included in these exogenous factors is the management ability or skills of farmers which will result in different scenario outcomes. Thus, given a certain set of projections, different outcomes will occur due to different perceptions of farmers. One of the solutions to this constraint is to make certain assumptions about farmers in different scenarios, which are assisted by the functioning mechanism of the BFAP sector model. For example, the assumption can be made that a high maize price will lead to an expansion of maize hectares in the following year due to farmer's reaction to and knowledge of the market environment. These assumptions will contribute to the objective of determining the relative shift in hectares and other objectives of the study.

The second constraint is the accuracy of data. Saunders *et al.* (2009:326) stated that studies or research conducted with the assistance of questionnaires or surveys could lead to a lack of reliability and inconsistency of data due to different interpretations of questionnaires and surveys. However, this constraint can be overcome by consulting with industry specialists such as agricultural economists, agronomists and agricultural specialists in the selective regions as these respondents should have a reasonable knowledge of the agricultural environment. Verification of data on a consistent basis is therefore critical in conducting proper research.

Finally, analysis errors could arise due to human errors, especially when working with several data variables and inputs. Verification and validation of the results should assist in overcoming this constraint.

3.7 RESEARCH ETHICS

Research ethics is described as the manner in which a researcher formulates and clarifies the research topic, the establishment of research objectives, and collection, processing, storage and analysis of data. The actions relating to conducting research should be carried out in a moral and responsible way, taking into account the rights of all the stakeholders in the research process (Saunders *et al.*, 2009:183–184).

Since the study is an empirical and quantitative research, several ethical issues need to be taken into consideration as also stated in Appendix B.

In the following bulleted lists, the most important ethical issues as identified by Kotze (2009:14-16) are outlined:

- **Copyright and plagiarism:** The use of in-text references will be included in the research on continuous basis when secondary data are utilised. In addition, the sources of data will be included in the list of references at the end of the study.

- **The use of financial/non-financial incentives to encourage participation of the study:** The respondents interviewed or approached will not receive any type of incentive (financial or non-financial) in order to participate in the study.

- **Voluntary participation and rights of withdrawal:** The respondents may at any time chose to withdraw from participation of the study without negative consequences, as also stated in Appendix B.

- **Confidentiality and anonymity:** The questionnaires and surveys conducted in this study have an anonymous structure, which means that the name of the respondent (as also stated in the informed consent from in Appendix B) will remain anonymous and results of the study will be treated as strictly confidential and the respondent will not be identified in person based on the answers that the respondent provides.

- **Permission from organisations for the use of secondary data:** In the case where a respondent is not the owner/manager of the organisation, the entity's authorisation of the use of secondary data and analysis is mandatory and must be obtained from the owner or manager of the organisation.

- **Researcher's objectivity and integrity:** Questionnaires and surveys are designed in such a way as to avoid misleading questions and information. Research results will not be influenced or tainted by any industry opinions and the research will be conducted in an objective manner. Reasonability of the results will be compared with available secondary data.

Appendix A contains a questionnaire that has been used to gather data from the selective representative farms in the summer rainfall region. Appendix B contains the informed consent form for the study, which must be signed by respondents and participants of the study.

CHAPTER 4

FARM-LEVEL ANALYSIS AND PROJECTIONS

4.1 INTRODUCTION

The background section in Chapter One stated that during the past year the South African agricultural environment has experienced significant market volatility, changing macroeconomic conditions, rising input expenditure and resource constraints that have considerably influenced the South African agricultural markets and farming sector. These changing conditions place enormous pressure on the already complex decision-making environment of farmers. Farmers have to adapt on a consistent basis in order to be competitive, profitable and sustainable. Given the changing macroeconomic drivers and conditions, the questions arise: What is the current state of farming businesses in South Africa, how did it change from historical trends and how can the long term position be comprehended? Therefore, the current state and the long term projections of the relative performance of farming businesses in selective regions in the summer rainfall regions of South Africa are dependent on a combination and integration of market drivers and market participants in the domestic and international agricultural environment.

On-farm validations in the selective regions are therefore necessary to determine the relative performance of farming businesses in the summer rainfall region in South Africa. In addition, one should evaluate how it might have changed from historical trends. In order to do these evaluations and validations, representative farms in the North West province, northern and western Free State, eastern Free State and Mpumalanga were identified according to a standardised method and definition, as mentioned in Chapter Three. As stated earlier, the identified provinces represent the key production regions in the summer rainfall area. Secondly, the standardised methodology is based on an existing farm or dataset describing a farm which represents a major share of output in a specific region. The different enterprises further represent a specific production system as well as land, capital, labour and other resources (Agribenchmark, 2011).

Furthermore, the financial performance and analysis of the different enterprises will follow after the identification of these representative farms. The long-term projections of the identified farm businesses will be further assisted by the latest BFAP sector model projections of the key market indicators and domestic drivers. The results and analysis should outline the profitability and sustainability of the farming businesses in the summer rainfall region by interpreting and analysing the key financial indicators in the financial structure of the farm business.

Thus, the objective of the study as stated in Chapter One is to validate whether long-term fundamental supply and demand projections as generated in the BFAP sector model are plausible at farm level and whether role-players in the agricultural sector could expect new trends in terms of land utilisation. In other words, is the relative crop mix projected for the next ten years by the sector model economically viable at farm level? Ultimately, this crop mix will determine the food security status of the country.

In order to conduct these validations, one should review historical trends in the identified production regions in terms of farm practice and the decision-making environment of farm businesses. Secondly, the current farm structure, performance and trends should be evaluated in order to determine whether new trends have been adopted by farm businesses. Thereafter an attempt should be made to explain these trends along the line of changing global and domestic drivers. The requirement for this evaluation is to conduct an in-depth study of how specific drivers could have impacted the farm environment and determining what linkage of integration from sector to farm could have been incorporated. The final section of the study will focus on long term projections by the BFAP sector model and how they could impact farm businesses in the intermediate and long run. The final outcome is to validate whether long-term projections are plausible at the farm level.

Figure 14 presents a summary of the steps that will be followed in the farm-level analysis and projections for each of the representative farms.

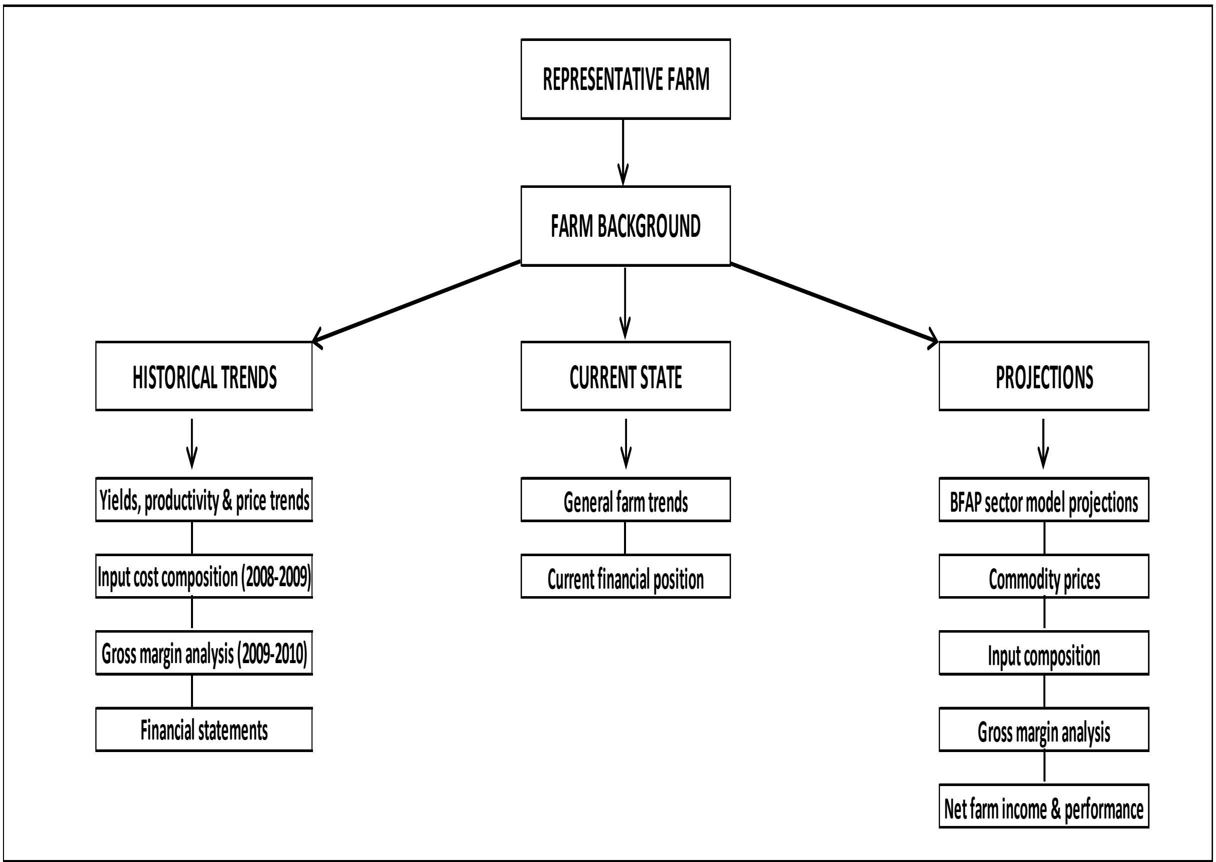


Figure 14: Summary: Representative farm-level analysis framework
Source: Own calculations

4.2 GENERAL ASSUMPTIONS ON A REPRESENTATIVE FARM

In order to meet the research objective to conduct on-farm validations by identifying typical farm businesses, the following general assumptions can be made on the analysis and interpretation of the representative farms:

- The representative farm is typical of the specific output mix and production system as reflected in a specific combination of enterprises, land, capital and labour resources for a specific region.
- The representative farm has long-term as well as medium-term loans with concomitant instalments and interest payments.
- Asset replacement occurs each year at a specific rate depending on cash availability and other calculations.
- Production loan and overdraft facilities are classified as short-term loans and are captured in the model. In addition, the assumption is that short-

term loans will be settled in the same production year and none of the short-term liabilities will be carried over to the next production year.

- The soil and water potential and quality remain constant over time.
- The condition and productivity of equipment remains constant over time.
- The farm business structure remains unchanged.
- The quality of the farm management remains constant.
- The net farm income (NFI) is used as a proxy for farm profitability.
- The ending cash surplus/deficit is used as a proxy for the cash flow (CF) position of the farm business.
- The farm gate price has taken silo differentials of the selective regions into account.
- Normal rainfall will prevail over the projected baseline period.

4.3 NORTH WEST PROVINCE

The following section will include an in-depth discussion of the on-farm and financial structure of the representative farm from the 2008/2009 production season to the 2010/2011 season. Secondly, the financial position will be evaluated by using the BFAP farm-level models. Finally, long term financial projections of the different cash crop enterprises will be conducted to determine certain decision-making drivers of farmers and to establish whether a shift in hectares could be expected in the long run.

The description and background of the representative farm, historical trends, the current state of farming businesses and long term projections of the North West representative farm will be discussed in detail based on the standard operating procedure (SOP) as was stipulated in section 3.3 on p. 41 and the integration of the BFAP system of linked models.

4.3.1 Farm background

The representative farm in the North West province consists of 1230 hectares and is situated in the Lichtenburg district. The production of maize and sunflower forms the main enterprises of the full panel typical farm and the total turnover is further supplemented by the production of livestock. The province receives a summer rainfall distribution with an annual precipitation of 550 millimetres. Since water is considered as a natural restriction in this area, most of the production operates on a dryland production system. The type of tillage system that is common in this district is an intensive tillage approach with prevailing conventional ploughing or deep soil cultivation. The annual cropping rotation of the farm is maize/maize/sunflower/fallow, which means that the production of maize is the main enterprise followed by sunflowers. Therefore, in a specific year, a certain amount of hectares will be utilised by maize and sunflower production and a certain amount will be fallow. The total turnover composition in the 2008/2009 production season can be explained as follows: maize and sunflower receipts contributed 83.8 % and 12.2 % respectively towards the total turnover of the farm business. The share of other farm and non-farm income towards total turnover composition was 4 % in the same period. In the 2009/2010 production year, the contributions from maize and sunflower were 81 % and 14.4 % respectively. The share from other farm and non-farm income towards total turnover was 4.6 %. The total contribution of maize in the 2010/2011 production year was 82 %, 1 % higher than in the 2009/2010 production year but still lower than in 2008/2009. The contribution of sunflower production towards total turnover in the 2010/2011 season was 13.7 %, approximately 0.7 % lower than the year before.

A typical production system in the region is the following: maize and sunflowers are planted during October and November and are harvested during May and June the following year.

In the 2008/2009 production season, a total of 659 hectares of maize was seeded. The maize hectares can be divided into white and yellow maize production. A total amount of 299 and 360 hectares was utilised for white and yellow maize production respectively. The sunflower area consisted of 103 hectares and 180 hectares was fallow. From the 2008/2009 to the 2009/2010 production season, the maize area increased by 9.56 %. The maize area showed a decrease in the 2010/2011 production season by 1.80 %. The total maize area planted in the 2009/2010 and 2010/2011 production seasons were 722 and 709 hectares respectively and thus provide an indication that there was an upward shift in the maize area over the previous two production seasons. The increased area under maize production was mainly at the expense of fallow land. The area for sunflower production, however, has remained relatively the same over the past three production cycles. The sunflower area under production in 2010 and 2011 was 100 hectares.

Figure 15 below illustrates the hectare mobility of the North West representative farm from 2008 to 2011. The total number of hectares of maize increased by 7.5 % between 2008 and 2011. The area that lay fallow decreased by 15 % over the same period. In 2011, sunflower area was 2.91 % down from 2008. This illustration is an example of the proposed objective of determining whether a shift in hectares planted can be expected in the long run due to changing macro and market conditions. Later in the chapter, a detailed study will follow to determine whether an area shift can be expected under a certain set of scenarios and assumptions.

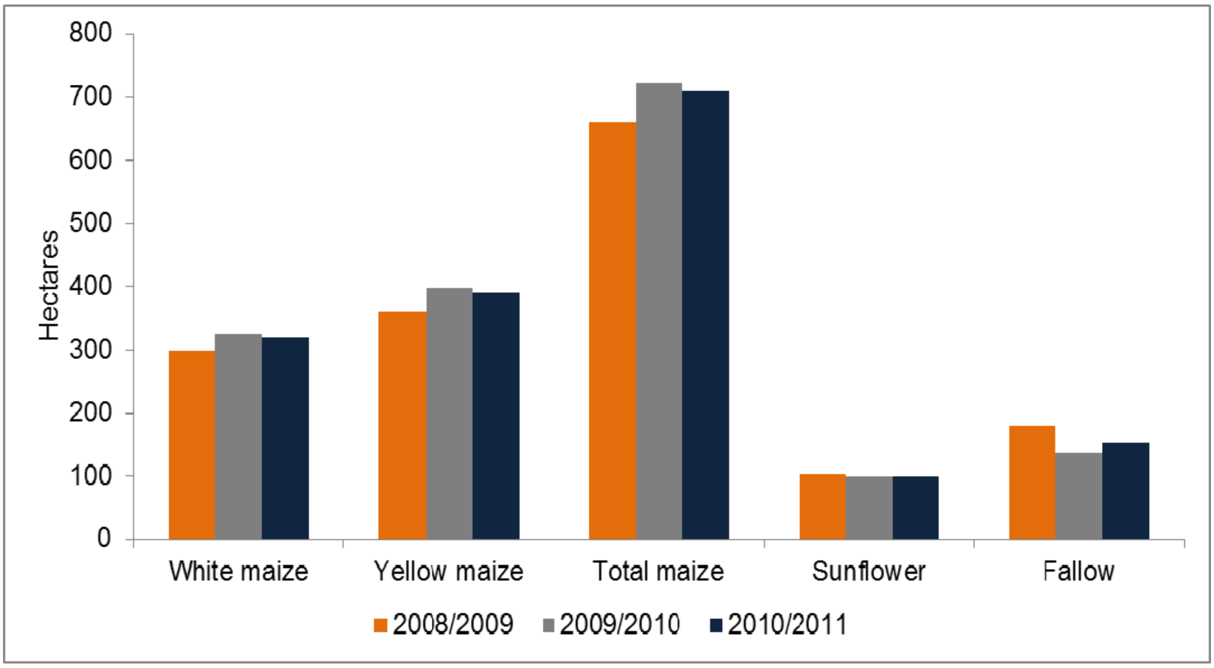


Figure 15: Hectare mobility of the North West representative farm (2009–2010)
Source: Own calculations

Finally, the strategy of farmers is to follow an economical input approach and to operate with a conservative approach to risk. The assumption in this region is that farmers utilise 75 % of their available production loan and overdraft facilities each year at an interest rate of 10.5 %. The concept of asset replacement is incorporated in the BFAP farm level model. The assumption is that if farming businesses indicated a positive farm gross margin, asset replacement will automatically occur at a fixed rate based on a set of calculations. Asset replacement in this region occurs at an average rate of 16 % for vehicles and 7 % for machinery and implements.

4.3.2 Historical trends of the farm business

The historical position and trends of the farm business will provide a brief analysis and interpretation of the financial performance of a typical farm business in the North West province for the 2008/2009 and 2009/2010 production seasons. The financial performance is based on a certain set of model input criteria which will be explained throughout the section. The results obtained in this section are the deterministic output given a set of inputs as explained in 0 Therefore, the farm data together with the input, capital and financial structure of the farm will provide a certain financial output which will assist in evaluating the profitability and sustainability of farm businesses.

The rest of this section will be explained by identifying, analysing and interpreting the input cost composition of each enterprise, the financial structure, asset replacement approach and a detailed output of the profitability and other key financial indicators of farming businesses in the North West province.

4.3.2.1 Yields, productivity and price trends

The yield for maize and sunflowers from 2009 to 2011 is illustrated in Figure 16. In the 2008/2009 production season, a maize yield of 4.97 tons per hectare was achieved. In the 2009/2010 production season the maize yield declined by 6.8 % to 4.63 tons per hectare. The overall performance of the maize yield on the representative farm was still relatively good when considering the amount of input such as fertiliser and seed allocated per hectare. This especially refers to productivity indicators such as nitrogen productivity. During the 2008/2009 season, an amount of 62 kilograms of nitrogen was applied per hectare of maize produced. With an average yield of 4.97 tons per hectare, the nitrogen productivity as efficiency indicator was: for every one kilogram of nitrogen applied, 80.68 kilograms of maize were harvested. Nitrogen productivity in the 2009/2010 production season was lower than a year earlier with a nitrogen productivity of 72.34 kg of maize harvested.

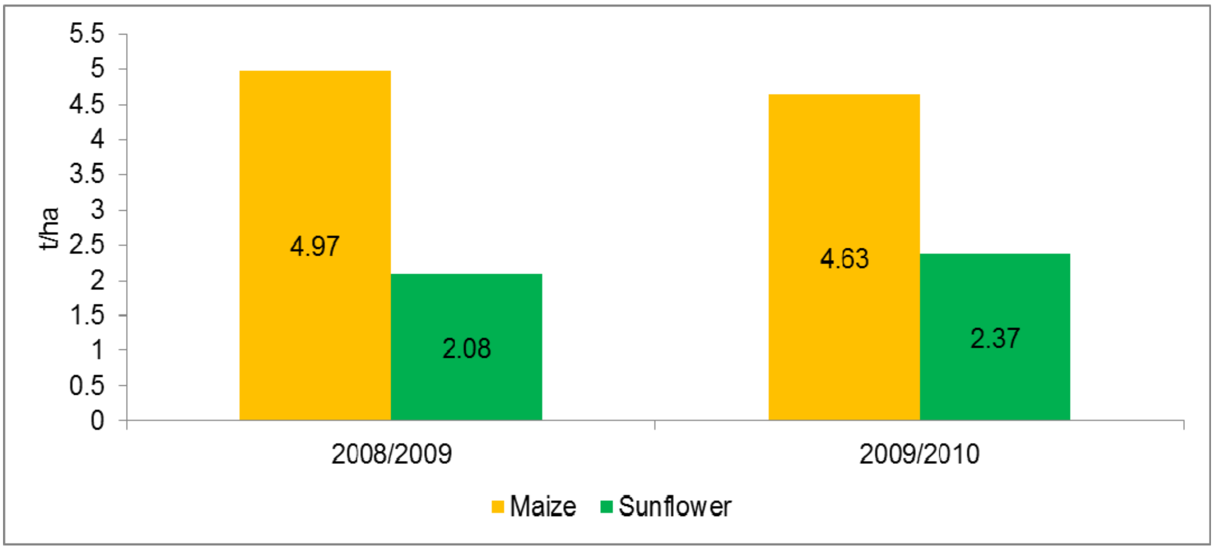


Figure 16: Yield for maize and sunflower (2008/2009–2010/2011)
Source: Own calculations

Sunflower yields had a similar performance to maize production and yield in both the 2008/2009 and 2009/2010 production seasons. During 2009, the average yield for sunflowers was 2.08 tons per hectare. In the 2010 harvest period, the yield increased by almost 14 % to reach a level of 2.37 tons per hectare. This indicates a nitrogen productivity ratio of 1:74, which means that for every kilogram of nitrogen applied per hectare sunflower planted, 74.06 kilograms of sunflowers were harvested.

As stated in the literature review in Chapter Two, decision making in certain types of production systems has become increasingly important over the years, with specific reference to increased productivity and efficiency that largely supports sustainability of farming businesses. The North West representative farm is a perfect example of what a productive and efficient farm might look like (input-output ratio). It would adopt a relatively competitive input approach, but still maintain relatively high production levels and therefore achieve profit maximisation through a productive farming system and a cost minimisation strategy. In addition, this combination largely supports the type of products to be produced in future. If it is a challenging task to produce a certain crop in a certain area that imposes a direct production risk due to natural restrictions, it is likely that the production of that specific crop will decrease.

The price of commodities has a significant impact on the decision as to the type of crop and the area to be planted. In some cases there is a lag effect, which means that the current year's commodity price will affect the area harvested the following year. For example, in a year when a lower than normal maize price is experienced, farm businesses tend to be less optimistic about the crop and the subsequent year's commodity price at harvest, which could lead them to reduce the area under maize.

A farm gate price refers to a basic price with the "farm gate" as the pricing point or the price of the product at the farm (OECD, 2012). In other terms, it is an indication of the farming business's revenue for a specific commodity, normally measured in Rand per ton.

The average maize price realised in the 2009 harvest period for the North West representative farm was R1403 per ton for white maize and R1302 per ton for yellow maize. The average price for white and yellow maize in 2010 was R1135 and R1190 per ton respectively, which is a significant decrease from the average 2009 maize price. The price for sunflowers remained relatively constant over the same period, with a price of R2930 per ton in 2009 and R2914 per ton in 2010.

As mentioned earlier, a farming business's decision-making environment in terms of hectares to be planted can be greatly affected by the price of the commodity at a certain stage, normally just before the start of the planting period. For example, in a year where the price of maize is relatively low, such as was the case in 2010, it is likely the following year that there will be a shift in land use towards planting crops with more attractive prices or leaving more land fallow. A detailed discussion regarding commodity prices and decision making will be presented later in the chapter.

4.3.2.2 Input cost composition (2008–2009)

Fuel and fertiliser can be considered the two most volatile input variables in grain and oilseed production in South Africa. Since 2008, extreme volatility has been visible in both the Brent crude oil price and the Rand/dollar exchange rate as can be seen in Figure 17. In addition, international fertiliser prices indicated a similar volatile trend to fuel, as can be seen in Figure 18. It is also interesting to note the strong correlation between the exchange rate and these prices, which indicates that the Rand/US dollar exchange rate will remain a key driver in agricultural input expenditure since South Africa is a net importer of oil, as well as most fertilisers and other agriculture-related inputs.

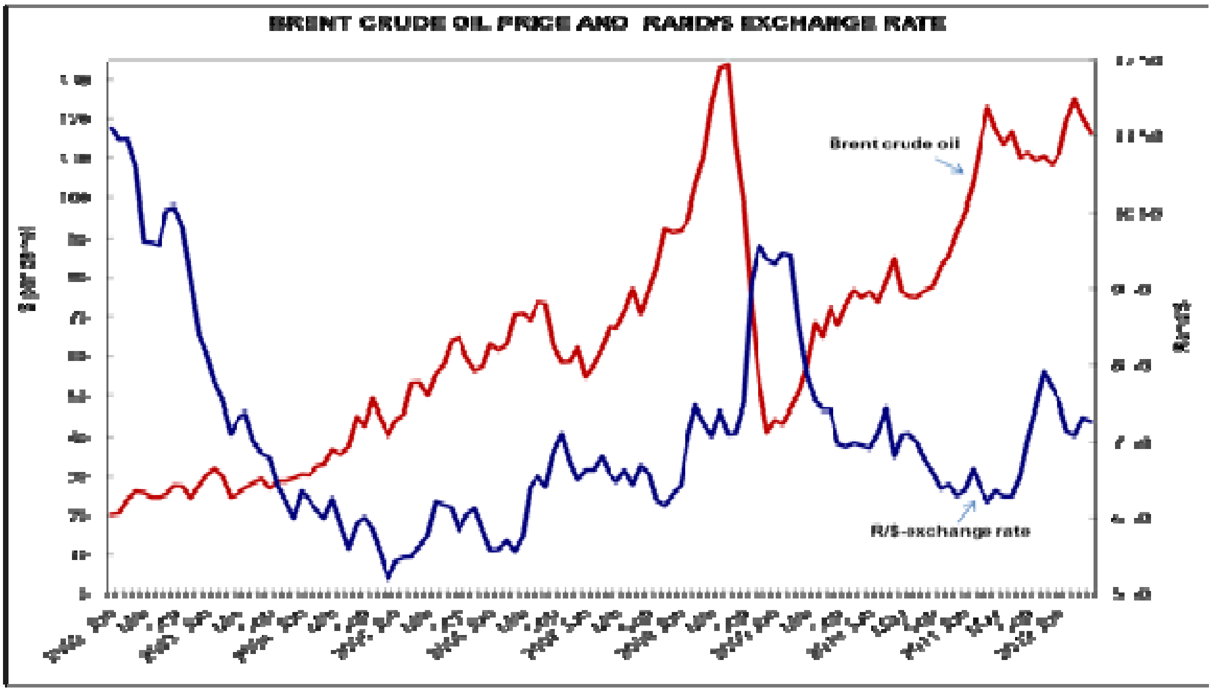


Figure 17: Brent crude oil and Rand / US dollar exchange rate
Source: Grain SA, 2012

Figure 18 illustrates the US dollar per ton for the key international fertilisers on the primary axis. The secondary axis illustrates the Rand/US dollar exchange rate. It is clear from the graph that significant volatility was experienced over the indicated period, especially from 2008 to 2009.

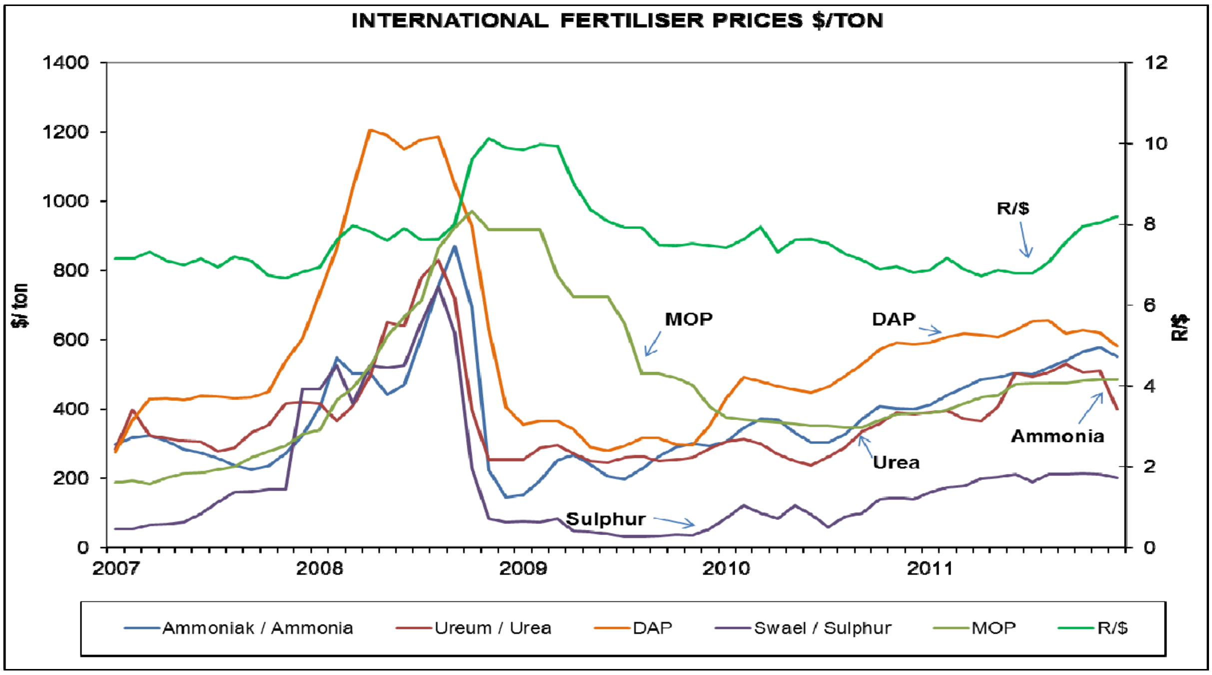


Figure 18: International fertiliser prices (2007–2011)
Source: Grain SA, 2012

The preceding graphs thus explain certain cost trends not only for the North West farm business, but for the remaining farms to be analysed in Chapter Four.

The strategy of farmers in the North West region is to follow an economical input approach and to operate with a conservative approach to risk. The economical input strategy is reflected in the input cost structure for maize and sunflower production, as illustrated by Figure 19 and Figure 20. The direct allocated inputs for maize and sunflower production can be classified as contract work such as harvesting, crop insurance, fertiliser input, fuel, plant protection, lime, marketing costs, seasonal labour and seed. It is important to note that these inputs are directly allocated to the production of maize and are measured on a per hectare basis.

The fertiliser input cost is the highest cost component in the production of maize, followed by fuel costs. During the 2008/2009 production season, the cost of fertiliser and fuel for maize production was R980 and R446 per hectare respectively. From the 2008/2009 to 2009/2010 production seasons, the cost of fertiliser per hectare had increase by 4.9 % to R1028 per hectare. The fuel cost component for the same period had increased significantly by almost 22 % to R543.48 per hectare. Plant protection, seed and marketing costs are the other key input cost components in the production of maize, as is illustrated in Figure 19. The cost of herbicide in the

2009/2010 production season was R320 per hectare, 5.1 % higher than the previous production season. The marketing cost had declined by 24.2 % from the 2008/2009 to 2009/2010 production season to R289.57 per hectare. Since the marketing strategy of farmers could include several drivers, it is a complex task to explain the exact reason for the decline. These drivers include hedging opportunities, grade differentials and other marketing-related costs such as brokerage fees.

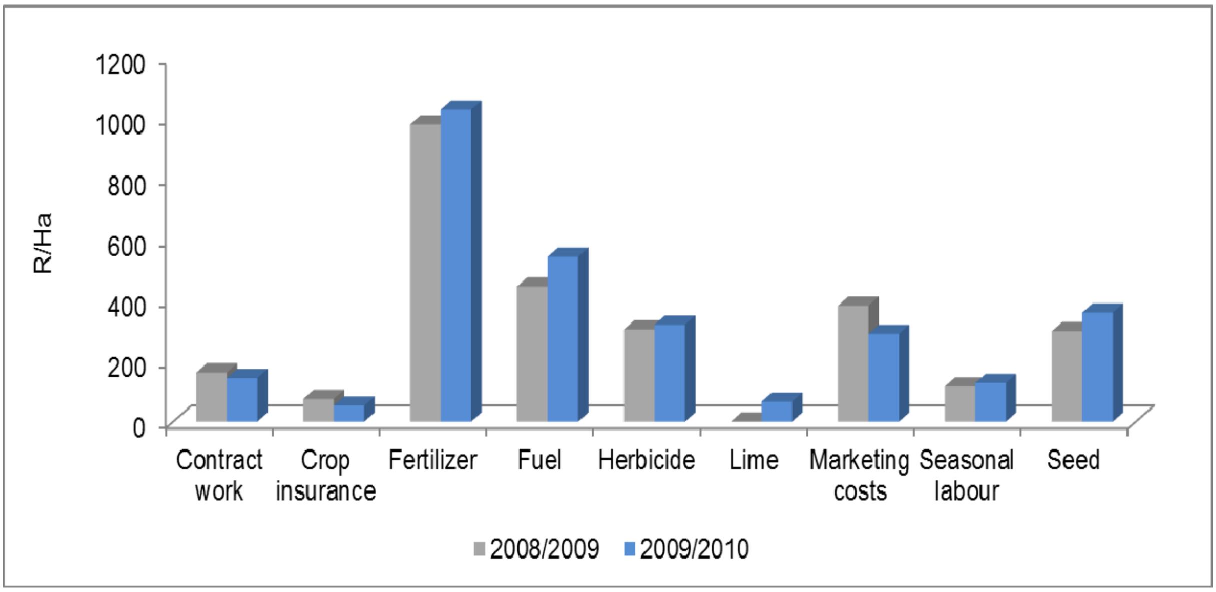


Figure 19: Maize input cost composition – North West farm (2008/2009–2009/2010)
Source: Own calculations

The cost composition for the production of sunflowers is illustrated in Figure 20. During the 2008/2009 production season, the cost for fertiliser, fuel and marketing cost was the highest on a per hectare basis. The cost for fertiliser and fuel was R367 and R522 per hectare respectively.

In the 2009/2010 production season, the decision of the farmer was not to engage in any marketing cost such as hedging. On the other hand, the cost of fertiliser per hectare increased dramatically by 44 %, to reach R530 per hectare in the 2009/2010 production season. The cost of fuel declined by 7 %, to reach R485 per hectare. The costs for contract work, plant protection and seed increased from the 2008/2009 to the 2009/2010 production season, as can be seen in Figure 20.

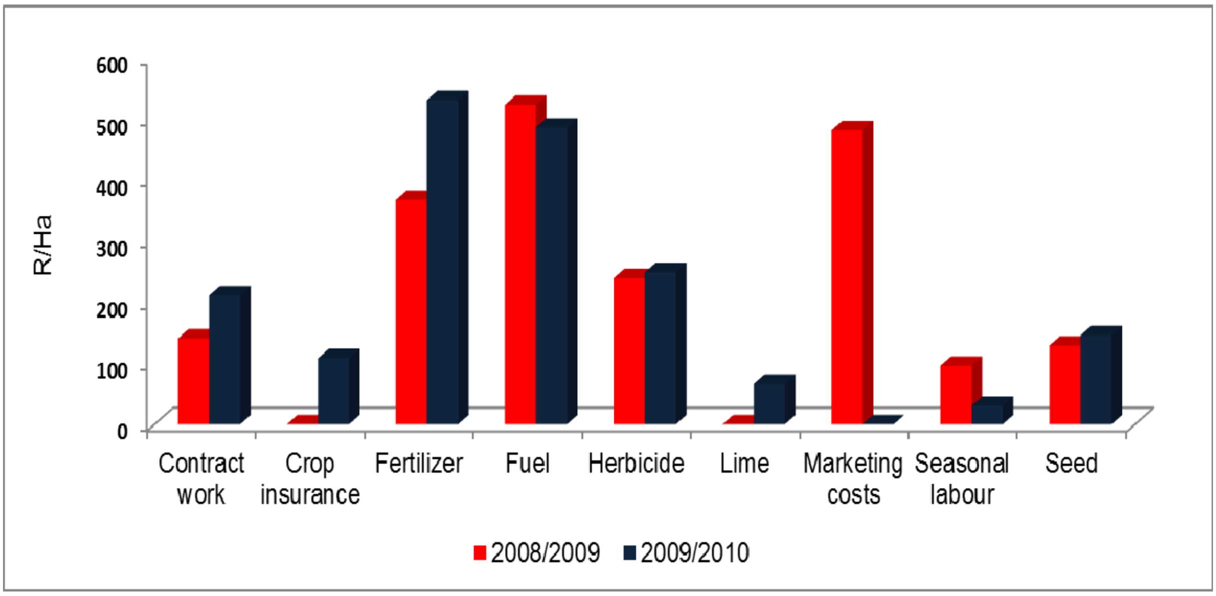


Figure 20: Sunflower cost composition – North West farm (2009–2010)
Source: Own calculations

The total cost per hectare for maize and sunflower production for the period 2008/2009–2009/2010 is illustrated in Table 7. Since the decision-making environment of farm businesses and respective profitability play an important role in terms of the type and amount of input(s) utilised, the cost from one year to the next could differ, especially in years when evidence of increased pressure on profitability exists due to lower anticipated commodity prices during the planting period or severe weather conditions. In the years where, for example, the price for maize is relatively low in comparison with the preceding years, the farmer will follow a conservative input approach to limit his financial risk.

Table 7: Total direct cost per hectare for the production of maize and sunflower (2008–2010)

Crop	2008/2009	2009/2010	% Change
Maize	R3 118	R3 016	−3%
Sunflower	R2 411	R2 002	−16%

Source: Own calculations

4.3.2.3 Gross margin analysis (2008/2009 and 2009/2010)

The United Kingdom Department for Environment, Food and Rural Affairs (2010) define an enterprise's gross margin as the enterprise output (farm gate price per ton multiplied by yield per hectare) minus all direct allocated cost (fertilisers, fuel, seed, chemicals, seasonal labour and other costs that can be directly allocated to produce a specific crop). The gross margin for the representative North West farm is illustrated in Figure 21.

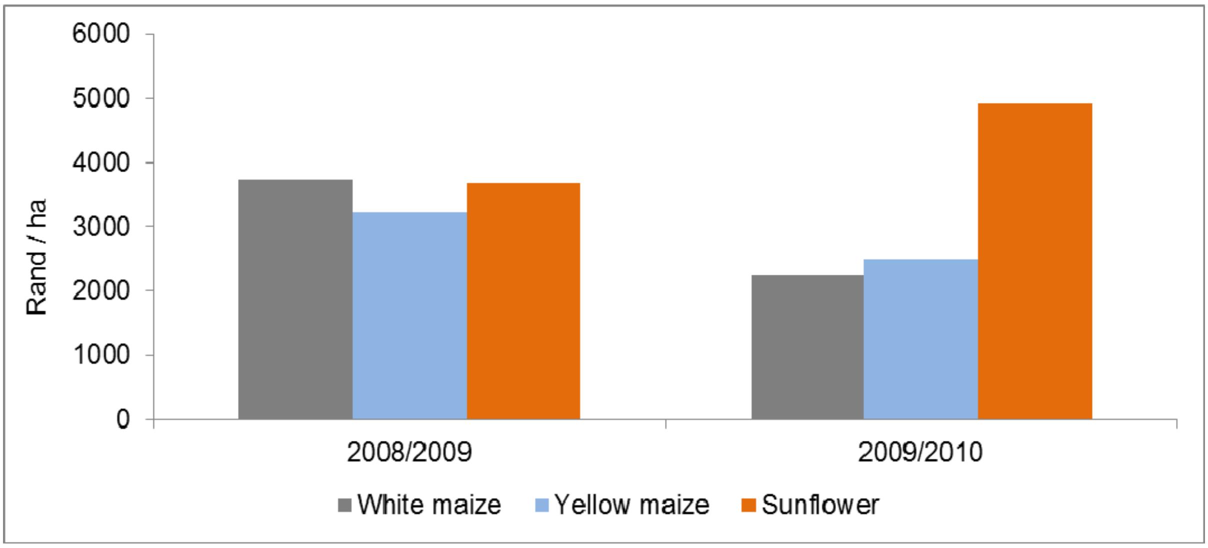


Figure 21: Gross margin analysis for maize and sunflower (2008/2009–2009/2010)
Source: Own calculations

In the 2008/2009 production season, white and yellow maize indicated an enterprise gross margin of R3716 and R3224 per hectare. The gross margin for these two commodities decreased in the 2009/2010 production season by approximately 39.75 and 22.64 % respectively. The reduction can mainly be contributed to the significant decrease in the commodity price of white and yellow maize and marginally lower crop yields. Sunflowers, on the other hand, reported a substantial increase in the gross margin per hectare. During the 2009 harvest period, the gross margin per hectare for sunflower production was R3683 per hectare. In the following year, the gross margin increased by 33.18 % to R4905 per hectare.

The analysis of gross margins of commodities is extremely important when it comes to the selection of crops to be produced. As can be seen from Figure 21, sunflower production in 2009/2010 performed better than maize. However, in 2008/2009, a similar performance to maize was realised. Gross margins will differ from year to year due to various external drivers, different price transmission, rainfall and other important drivers. The impact on the decision of land use may not be so drastic in a specific year, but insufficient gross margin performance over the longer term may result in a reduction in the number of hectares planted of a specific commodity.

4.3.2.4 Financial statements and key financial indicators

The preceding section (Figure 21) illustrated the gross margin analysis of the North West farm business, which provided an image of the relative performance of specific enterprise activities of the farm. The latter is normally associated with costs that can be directly linked to the production of that commodity. It is important, however, to consider the farm as whole, as overhead, financial and capital costs can easily change the financial position of the farm business. To meet the research objective of evaluating the profitability and sustainability of the typical farm in order to determine its long term sustainability, it is important to consider the entire financial position of the farm, which is illustrated by the income statement, cash flow statement and the statement of assets and liabilities.

Figure 2 in Chapter Two showed that a key driver in the decision-making environment of farmers is the ability to maximise profit. Making a profit requires whole farm management. While the production side of the farm business might be easy for individual farmers, a challenge often arises when it comes to managing the finances, especially the overhead component.

Table 8, 9 and 10 below illustrate the North West farm’s income statement, cash flow statement and statement of assets and liabilities, respectively. Table 8 can be further interpreted by observing the net farm income (NFI), which is a proxy for overall farm profitability. In the 2008/2009 financial year, the farm indicated a NFI of R780 054. From 2008/2009 to 2009/2010 the NFI decreased by 42.08 % due to a significant fall in the maize price. The reason for highlighting the overall farm performance and NFI as a proxy for farm profitability is that the overhead component of a farm usually remains fixed over a period of time. This means that overhead costs still need to be accounted for, despite the production intentions in any specific year. In addition to this, economies of scale play a significant role in the financial structure of the farm business as they decrease the overhead component. However, the possibility to expand production might be limited due to land availability and other resources such as available finance and own capital. Thus, if the commodity price performance of a specific crop is not sufficient to cover finance, capital and other costs, it will result in a reduction in the area of that crop.

The relative performance of a specific commodity is influenced by various drivers, as illustrated in Figure 2. The main drivers are the demand for food and fuel, which impacts the mechanism of demand and supply (therefore, balance sheets). Various macroeconomic drivers such as GDP, exchange rates, disposable income and international drivers further impact the balance sheets, and have a direct influence on the price of that commodity.

Table 8: Income statement of the North West representative farm (2008/2009–2009/2010)

Description	2008/2009	2009/2010
Cash farm income		
Grains	R4 953 873	R4 585 877
Other farm income	R78 308	R157 142
Total cash farm income	**R5 032 181**	**R4 743 019**
Cash farm expenses		
Grains	R2 450 197	R2 422 157
Auditor	R108 874	R102 140
Bank charges	R18 927	R13 657
Farm utilities	R50 123	R51 407
Fuel and lubricant (unallocated)	R177 337	R34 077
Full-time labour	R598 968	R568 461
Land rented	R91 200	R95 988
Licenses	R4 207	R6 558
Repairs and maintenance	R324 710	R280 136
Short term insurance	R69 119	R54 957
Total cash farm expenses	**R3 893 662**	**R3 629 538**
Farm gross margin	**R1 138 519**	**R1 113 481**
Interest		
Interest long term debt	R73 500	R105 000
Interest medium term debt	R38 500	R68 375
Interest operating loan	R40 883	R285 826
Total interest	**R152 883**	**R459 201**
Net cash farm income	**R985 636**	**R654 280**
Depreciation	R205 581	R202 440
Net farm income	**R780 054**	**R451 840**

Source: Own calculations

The cash flow statement of the North West representative farm is presented in Table 9. According to Business Dictionary (2012), cash flow refers to the difference in amount of cash available at the beginning of a financial period and the amount available at the end of that period. In other words, a cash flow can be either positive or negative.

In both the 2008/2009 and 2009/2010 financial years, the farm business in the North West province ended with a positive cash flow after family living expenses were covered. What is important to note is the decline in the cash flow position from 2009 to 2010, which can be mainly attributed to lower commodity prices and lower yields. The latter caused the cash inflows of the farm business to decline, which also implies that if this trend continues for a certain period, the business can come under greater pressure, particularly regarding decisions about the land used for a specific crop. In addition, it should be noted that there was a substantial decline in the family living costs from 2008/2009 to 2009/2010.

Table 9: Cash flow statement of the North West representative farm (2008/2009–2009/2010)

Description	2008/2009	2009/2010
Cash inflows		
Beginning cash reserves	R200 000	R74 481
Net cash farm income	R985 636	R656 338
Non-farm income	R132 690	R62 996
Total cash inflows	**R1 318 326**	**R793 815**
Cash outflows		
Cash difference asset replacement	R176 491	-
Principal long-term debt	R36 767	R30 248
Principal medium-term debt	R54 652	R90 115
Income tax	R117 008	R67 776
Total cash outflows before family living	**R384 919**	**R188 139**
Return to family living	**R933 407**	**R605 676**
Family living costs	R664 306	R547 723
Ending cash surplus/deficit	**R269 101**	**R57 953**

Source: Own calculations

The statement of assets and liabilities is presented in Table 10, which provides a snapshot of the net worth or value of the farm business. The balance sheet is an important indicator of the financial position of a farm business at any given time. The net worth of the farm business will be explained later in this section.

The total value of all assets in the 2008/2009 period was R7.2 million. In the 2009/2010 period, a sideways movement followed. The total liabilities in the 2008/2009 and 2009/2010 financial periods were R1.1 million and R1.6 million respectively. In this particular case, asset replacement and land acquisition occurred during the above period. The finance method was mainly by means of borrowed money (foreign capital), which caused an increase in the amount of medium and long term liabilities.

Table 10: Statement of assets and liabilities of the North West representative farm (2008/2009–2009/2010)

Description	2008/2009	2009/2010
Fixed Assets		
Co-operative member funds	R245 620	R247 065
Land and fixed improvements	R6 974 000	R6 989 000
Total fixed assets	**R7 219 620**	**R7 236 065**
Moveable assets		
Equipment and tools	R155 051	R50 000
Implements and machinery	R3 316 821	R3 602 980
Office equipment	R28 848	R28 848
Vehicles	R794 804	R445 815
Total moveable assets	**R4 295 524**	**R4 127 643**
Current assets		
Cash surplus	R269 101	R57 953
Debtors	R13 970	R127 701
Production means	R1 103 221	R1 103 221
Total current assets	**R1 386 292**	**R1 288 875**
Total assets	**R12 901 436**	**R12 652 583**
Liabilities		
Long term liabilities	R700 000	R1 000 000
Medium term liabilities	R350 000	R621 589
Short term liabilities	R67 288	R39 080
Total liabilities	**R1 117 288**	**R1 660 669**

Source: Own calculations

A summary of the key financial indicators of the representative farm in the North West is provided in Table 11 for the 2008 to 2010 period. As stated earlier, the net worth is calculated by subtracting the total liabilities from total assets, and it illustrates the value of the business or owner's equity. The North West representative farm performed particularly well in both periods in terms of liability management, which implies a healthy net worth. However, a decline in the net worth was realised from the 2008/2009 to the 2009/2010 season. The decline can be attributed to a reduction in the value of assets due to depreciation together with an increase in liabilities. The higher level of liabilities caused interest costs to increase, which reduced the net cash farm income and NFI.

The debt to asset ratio is a measurement of a business's financial risk or an indicator of how much of the business's assets has been financed by debt (Investopedia, 2012). Generally, a high debt to asset ratio means that a business has been aggressive in financing assets by foreign capital or borrowed money. The debt to asset ratio of the North West farm business reflected well, as only 8 % in 2008/2009 and 13 % in 2009/2010 of total assets were financed by debt.

Table 11: Summary: Financial indicators of North West farm business (2008–2010)

Financial indicators	2008/2009	2009/2010
Farm gross margin	R1 138 519	R1 113 481
Net cash farm income	R985 636	R654 280
Net farm income	R780 054	R451 840
Return to family living	R933 407	R605 676
Ending cash surplus/deficit	R74 481	R57 953
Total assets	R12 901 436	R12 652 583
Total liabilities	R1 117 288	R1 660 669
Net worth	R11 784 148	R10 991 914
Debt to asset ratio (total debt/total assets)	8 %	13 %

Source: Own calculations

To summarise, the financial statements presented above provide an indication of the relative performance of the farm business at any specific point. Financial statements are important as they largely determine whether a business is going forward or backwards, which impacts the sustainability and decision-making environment of the farm business. Profit maximisation as general assumption and driver in this study will always affect the decision making of the farm business, and therefore could affect the area to be planted in a specific year or over a certain period of time. The latter especially refers to profitability of certain commodities and the assumption therefore pertains that if a certain commodity is unprofitable, its production will be discontinued. A more detailed discussion will follow in the section of the current state of farm business in the North West province.

4.3.3 The current state of the farm business

In the following section, the current position of the farm business will be analysed and compared to the historic position in order to capture updated trends and to determine whether the situation has changed. The current state or position refers to the 2010/2011 production season, i.e., maize and sunflowers planted at the end of 2010 and harvested in the middle of 2011. The current state creates the intermediate linkage between the historical position and projections that will follow in the next section. In addition, the current state of the farm business forms the foundation or base year from which projections will be made. Since historic trends have been discussed in the preceding section, the focus will remain on the 2010/2011 season and the relative change over the study period.

4.3.3.1 General farm trends (yields, input composition and gross margins)

General farm trends refer to yield analysis, input composition and costs and gross margin analysis. Figure 22 illustrates the yield spread from 2009 to 2011. The average maize yield in 2011 was 4.55 tons per hectare, approximately 1.73 % lower than in 2010 and 8.45 % down from 2009. As stated earlier, given the amount and type of input on the representative farm, the maize yield was still good. The sunflower yield in 2011 was 2.03 tons per hectare, which indicates a decline of 14.35 %. However, sunflower yields in 2011 corresponded with yield levels in 2009.

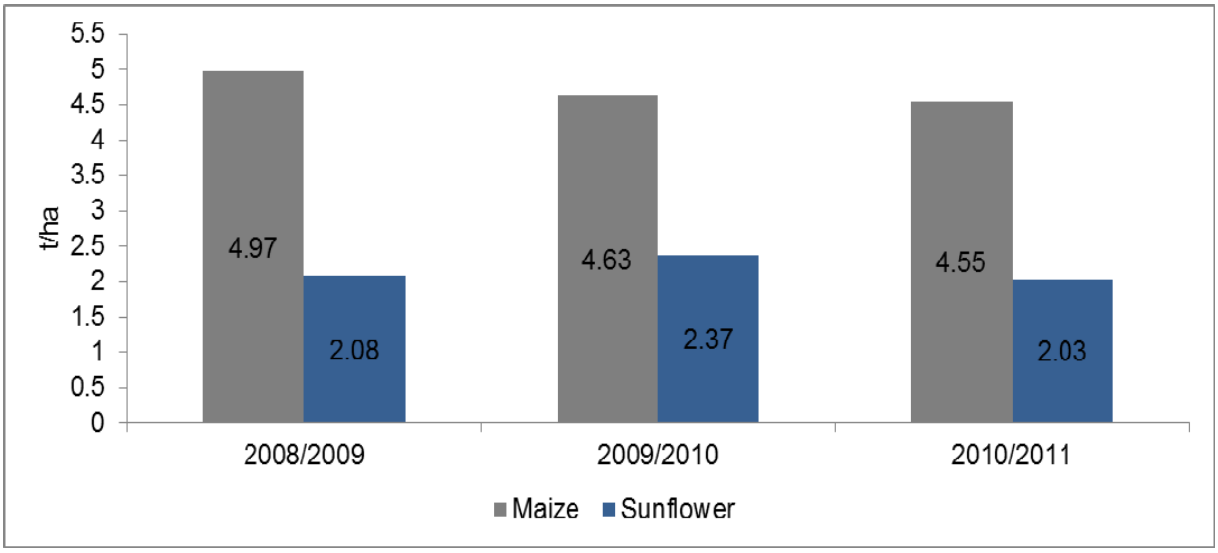


Figure 22: Yield for maize and sunflower (2008/2009–2010/2011)
Source: Own calculations

The input cost composition and costs for maize production over the period from 2008/2009 to 2010/2011 are reflected in Figure 23 below. Fertiliser, fuel and seed are considered the key inputs in the North West farm maize enterprise. In the 2010/2011 maize production season, the cost of fertiliser and fuel were R1046 and R657 per hectare respectively. The cost of fertiliser increased by 1.78 % from 2009/2010 to 2010/2011 and by 6.78 % from 2008/2009 to 2010/2011. A significant increase in the cost of fuel occurred during the same period. Fuel expenses per hectare increased by almost 50 % from the 2008 planting period towards the 2010/2011 cycle. The cost of seed indicated similar increasing trends over the study period. The cost of seed in the 2010 planting season was approximately R502 per hectare, 39.66 % higher than the year before. The total cost of maize production in 2010/2011 was R2897 per hectare.

Despite price increases in the key inputs, the total cost of maize production still reported a decline from 2009/2010 to 2010/2011. The latter can mainly be attributed to a reduction in contract work, plant protection, marketing, seasonal labour and other unforeseen expenses. The fact that a reduction in direct expenses was observed means that the farm business managed inputs and costs carefully. This might have affected yield levels as can be seen in Figure 22. However, one has to keep in mind all contributing factors such as weather and other external drivers; therefore a reduction in input costs does not necessarily mean that yield levels will decline. In addition, farm productivity and efficiency have become an important factor in sustainable farming together with increased input expenditure such as the oil price.

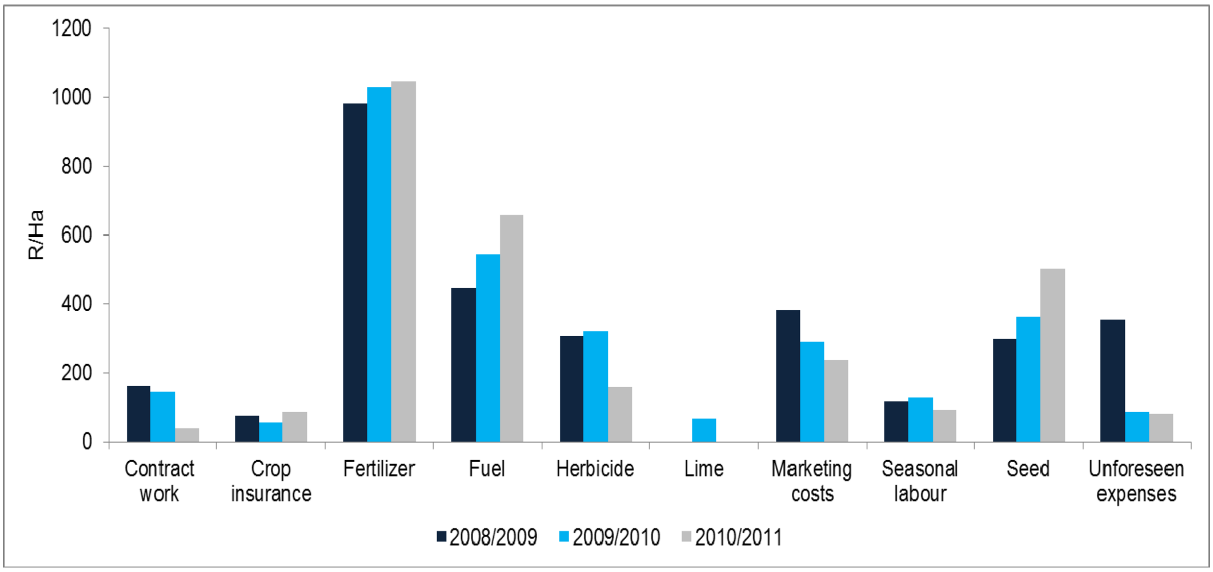


Figure 23: Maize input cost composition (2008/2009–2010/2011)
Source: Own calculations

The direct allocated cost of sunflower production is illustrated in Figure 24. A significant increase in the cost of fertiliser occurred from 2009/2010 to 2010/2011 due to a substantial increase in the price of the specific compound fertiliser used and an increase in the amount of fertiliser applied per hectare. The cost of fertiliser in 2010/2011 was R938 per hectare, 77 % higher than a year earlier. The cost of fuel in 2010/2011 was approximately R611 per hectare compared to R485 per hectare in 2009/2010. The increase in the fuel expense can be mainly attributed to an increase in the oil price. The cost of seed showed a similar increasing trend, which is supported by the linkage that sunflower has with higher oil prices. The cost of seed in 2010/2011 was R223 per hectare. The total cost of production in 2010/2011 was R2563 per hectare, 28 % higher than in 2009/2010.

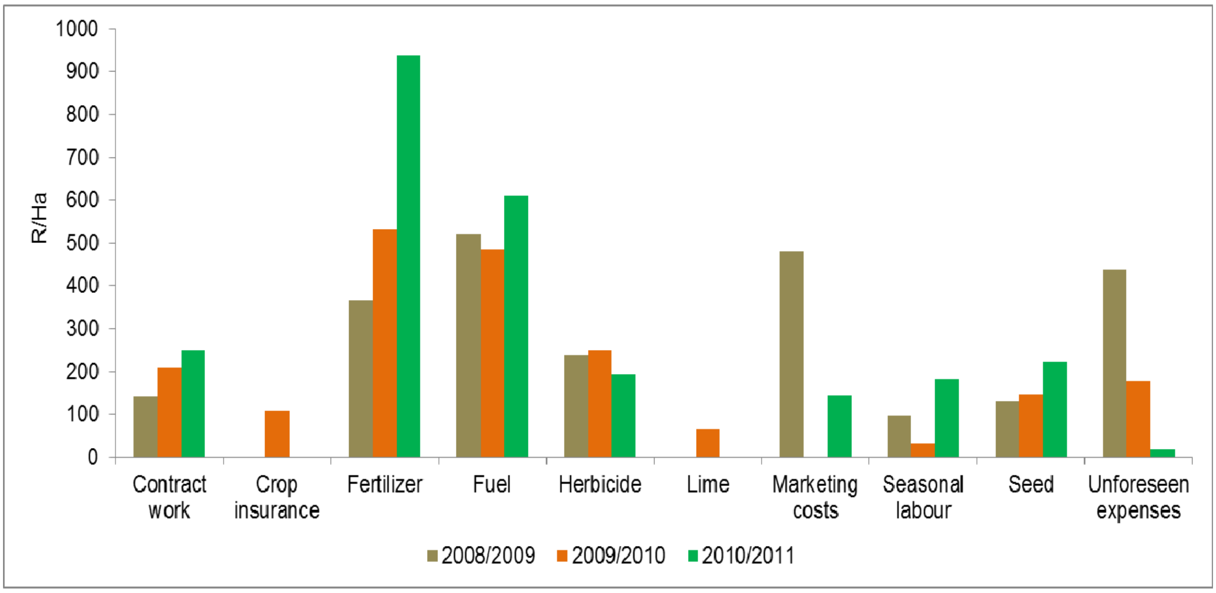


Figure 24: Sunflower input composition (2008/2009–2010/2011)
Source: Own calculations

Figure 23 and 24 clearly show that the cost of key inputs has increased over the study period. Since higher expenses imply that profitability will be affected, farming businesses have become more aware of effective input management. Cost minimisation techniques have therefore become an important business strategy, as is in the case of the North West farm business. This refers to the fact that although the cost of fertiliser, fuel and seed as key inputs has increased, the farm business has managed to reduce the total cost of production by cutting other input-related expenses. The management of agricultural inputs will remain a critical success factor in the sustainability of farm businesses in South Africa and farm managers/owners will continue to focus on remaining efficient in this regard.

The average farm gate price for maize and sunflower is reflected in Table 12. A sharp increase was reported in the price of maize (white and yellow) from the 2009/2010 to the 2010/2011 production season. The average farm gate price for white and yellow maize in the 2011 harvest period was R1422 and R1407 per ton. The average sunflower farm gate price showed a similar increasing trend and increased by 29.10 % between 2010 and 2011. The average price in 2011 was R3762 per ton.

Table 12: Average farm gate prices (R/ton) for the North West region (2008/2009–2010/2011)

Crop	2008/2009	2009/2010	2010/2011
White maize (R/ton)	R1 403	R1 135	R1 422
Yellow maize (R/ton)	R1 302	R1 190	R1 407
Sunflower (R/ton)	R2 930	R2 914	R3 762

Source: Own calculations

In order to achieve the objectives of this research study, it is extremely important to consider commodity prices and the respective drivers behind their formation. This is because the price of a commodity at a specific point can determine the farmer's decisions about what to produce and how much. For example, the drought that prevailed in the United States (USA) in 2012 will affect South African farmers' 2012 intentions about what crops to plant. The US drought greatly boosted the corn (maize) price per bushel, which further impacts the domestic South African maize contract price. A more detailed discussion will follow in the next section of this chapter.

The gross margin analysis for maize and sunflowers is illustrated in Figure 25. It clearly shows that the commodity with the highest gross return in 2011 was sunflowers. The gross margin for sunflower production in 2010/2011 was approximately R4631 per hectare, on average about R1507 per hectare more than maize production in that specific year. The gross margin for white and yellow maize production was R3097 and R3150 per hectare respectively. It is important to note that both maize and sunflower yields show a decrease over the period.

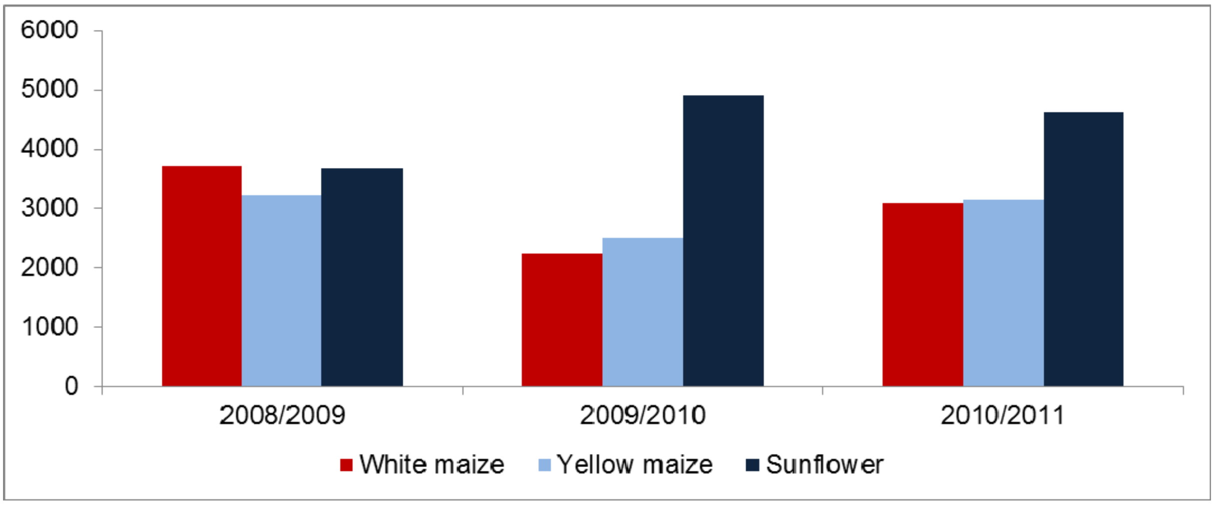


Figure 25: Gross margin analysis for maize and sunflower (2008/2009–2010/2011)

Source: Own calculations

From Figure 25, the assumption can be made that if the high gross margin trend of sunflower over maize production continues and therefore reflects a better profitability level than maize, an area shift towards sunflower production may result. It is important, however, to consider all drivers behind commodity prices – the relative yield levels of the respective commodities, whether additional capital investment is necessary, production and other risks and finally, longer-term projections. When all these factors are considered and the picture remains positive, a relative shift in hectares can be expected in the intermediate to longer term.

4.3.3.2 The current financial position

In the historic financial statement analysis on p.65, the financial position of the North West farm was analysed and discussed. The aim of this section is to provide an update on the financial position of the farm business in 2011, which in addition forms the foundation from which projections will be made in order to capture the long-term view of the farm. It was stated earlier that the overhead composition, financial structure and other non-enterprise linkages are important in the sense that they serve as important business and production pillars and should therefore be managed carefully. This specifically refers to the overhead performance of the business which further impacts the long-term sustainability.

Table 15 illustrates the updated income statement of the North West representative farm. A relatively large increase occurred from 2009/2010 to 2010/2011 in the total grain receipts due to an increase in both maize and sunflower commodity prices. The total production expenses at the same time increased from R2.4 million to R2.7 million. The farm gross margin in 2011 was R229 510 higher than in 2010. However, the NFI did not indicate a similar growth due to an increase in liabilities which at the same time caused an increase in the cost of finance (interest). The total NFI in 2011 was R571 879, only R120 039 higher than the preceding year.

Table 13: Income statement of the North West farm business (2008/2009 – 2010/2011)

Description	2008/2009	2009/2010	2010/2011
Cash farm income			
Grains	R4 953 873	R4 585 877	R5 350 623
Other farm income	R78 308	R157 142	R241 296
Total cash farm income	**R5 032 181**	**R4 743 019**	**R5 591 919**

Description	2008/2009	2009/2010	2010/2011
Cash farm expenses			
Grains	R2 450 197	R2 422 157	R2 773 288
Auditor	R108 874	R102 140	-
Bank charges	R18 927	R13 657	R22 930
Farm utilities	R50 123	R51 407	R57 003
Fuel and lubricant (unallocated)	R177 337	R34 077	R2 808
Full-time labour	R598 968	R568 461	R616 251
Land rented	R91 200	R95 988	R104 683
Licenses	R4 207	R6 558	R5 685
Other cash expenses	-	-	R583 379
Repairs and maintenance	R324 710	R280 136	R2 030
Short term insurance	69 119	R54 957	R80 871
Total cash farm expenses	**R3 893 662**	**R3 629 538**	**R4 248 928**
Farm gross margin	**R1 138 519**	**R1 113 481**	**R1 342 991**
Interest			
Interest long term debt	R73 500	R105 000	R102 217
Interest medium term debt	R38 500	R68 375	R127 139
Interest operating loan	R40 883	R285 826	R297 425
Total interest	**R152 883**	**R459 201**	**R526 781**
Net cash farm income	**R985 636**	**R654 280**	**R816 210**
Depreciation	R205 581	R202 440	R244 332
Net farm income	**R780 054**	**R451 840**	**R571 879**

Source: Own calculations

The North West representative farm's cash flow position is presented in Table 14. The farm indicated a positive cash flow at the end of the 2010/2011 financial period for the third consecutive year. At the end of the 2011 financial year, the farm business's cash surplus was R255 317.

Table 14: Cash flow statement of the North West farm business (2008/2009–2010/2011)

Description	2008/2009	2009/2010	2010/2011
Total cash inflows	**R1 318 326**	**R793 815**	**R1 224 098**
Cash outflows			
Cash difference asset replacement	R176 491	-	R67 150
Principal long-term debt	R36 767	R30 248	R64 136
Principal medium-term debt	R54 652	R90 115	R200 481
Income taxes	R117 008	R67 776	R85 782
Total cash outflows before family living	**R384 919**	**R188 139**	**R417 548**
Return to family living	**R933 407**	**R605 676**	**R806 550**
Family living cost	R664 306	R547 723	R551 233
Ending cash surplus/deficit	**R269 101**	**R57 953**	**R255 317**

Source: Own calculations

Table 15 illustrates that the farm business increased the amount of moveable assets, especially equipment and tools, implements and machinery and vehicles. The total value of moveable assets grew by 24.24 % from the 2009/2010 to 2010/2011 financial period. The total value of moveable assets at the end of 2011 was R5 128 328 and total assets were R14 479 416.

In Table 13 it was indicated that total liabilities increased in the same period, as mentioned above. When considering the increase in the amount of moveable assets, it can be observed that these assets were mainly financed by foreign capital or by medium-term loans, which also caused an upward trend in the total interest cost.

Table 15: Statement of assets and liabilities of the North West farm business (2008/2009–2010/2011)

Description	2008/2009	2009/2010	2010/2011
Fixed Assets			
Co-operative member funds	R245 620	R247 065	R347 046
Land and fixed improvements	R6 974 000	R6 989 000	R6 546 000
Total fixed assets	**R7 219 620**	**R7 236 065**	**R6 893 046**
Moveable assets			
Equipment and tools	R155 051	R50 000	R220 101
Implements and machinery	R3 316 821	R3 602 980	R4 013 324
Office equipment	R28 848	R28 848	R21 592
Vehicles	R794 804	R445 815	R873 311
Total moveable assets	**R4 295 524**	**R4 127 643**	**R5 128 328**
Current assets			
Cash surplus	R269 101	R57 953	R255 317
Debtors	R13 970	R127 701	R294 837
Production means	R1 103 221	R1 103 221	R1 907 888
Total current assets	**R1 386 292**	**R1 288 875**	**R2 458 042**
Total assets	**R12 901 436**	**R12 652 583**	**R14 479 416**
Liabilities			
Long term liabilities	R700 000	R1 000 000	R1 022 168
Medium term liabilities	R350 000	R621 589	R1 210 850
Short term liabilities	R67 288	R39 080	R169 063
Total liabilities	**R1 117 288**	**R1 660 669**	**R2 402 081**

Source: Own calculations

The financial position of the farm is summarised in Table 16 below. The summary can be explained as follows: all receipts from grains and other farm income form the total cash farm income variable. All cash farm expenses will be subtracted from the total cash farm income to illustrate the farm gross margin (FGM). Thereafter, all interest paid or the cost of foreign finance will be deducted from the FGM to indicate the farm business's net cash farm income (NCFI). In order to determine the net farm income (NFI), depreciation is deducted from NCFI.

In order to determine the return to family living, all cash outflows will be deducted from cash inflows. Cash outflows refer to principal payments due to long- and medium-term debt and income tax. Finally, the family living cost is subtracted from the return to family living in order to determine the ending cash surplus or deficit.

It can be observed that the net worth of the farm declined from 2008/2009 to 2009/2010 and then increased from 2009/2010 to 2010/2010. This emphasises the importance of commodity prices, which directly affect the profitability and value of the farm. The debt to asset ratio in 2011 was approximately 4 % higher than the preceding year, mainly due to financing medium term assets.

When comparing the NFI across the study period, it can be seen that the farm business did not perform that well from 2009/2010 and 2010/2011 compared to the 2008/2009 production season. A combination of factors contributed to the weaker performance, where the price of commodities and input expenses played the most important role since yield levels indicated a relatively sideways movement.

Table 16: Key financial indicators of the North West representative farm (2008–2011)

Financial indicators	2008/2009	2009/2010	2010/2011
Farm gross margin	R1 138 519	R1 113 481	R1 342 991
Net cash farm income	R985 636	R654 280	R816 210
Net farm income	R780 054	R451 840	R571 879
Return to family living	R933 407	R605 676	R806 550
Ending cash surplus/deficit	R74 481	R57 953	R255 317
Total assets	R12 901 436	R12 652 583	R14 479 416
Total liabilities	R1 117 288	R1 660 669	R2 402 081
Net worth	R11 784 148	R10 991 914	R12 077 335
Debt to asset ratio (total debt/total assets)	9 %	13 %	17 %

Source: Own calculations

The previous two sections (the historical trends and current position on p.57 and p.69) therefore create the base or interface for projections that will be conducted in the next section. In order to make these projections, the 2010/2011 production year will be considered as the base year.

4.3.4 The impact of the BFAP sector model projections on the North West representative farm

The Bureau for Food and Agricultural (BFAP) sector model was explained in the data analysis section on p.44. It was indicated that the model operates as an econometric regime-switching model within the partial equilibrium framework developed by Meyer (2006). This econometric model has the ability to generate reliable estimates and projections of endogenous variables under market-switching regimes (Meyer, 2006:iv). The approach of this model (BFAP sector model) was to allow the inclusion of features of regime switching in a multi-sector commodity level model, which has the capability of making more accurate projections of the development of the sector under alternative shocks and international drivers (FAPRI model). This model captures the relationships, linkages and integration between various farm indicators such as area under production, commodity yields, total production, direct human consumption, imports, exports and ending stocks of a typical crop in South Africa. It projects possible future outcomes based on the current macro-economic and production environment which have a direct impact on the decision-making environment of farmers. It is important to note that these projections are not a forecast, but rather a benchmark or possible future scenario created under a certain set of underlying assumptions.

In the following section, the projections based on the BFAP sector model will be integrated into the BFAP farm-level model to determine the relative impact on farm businesses in South Africa. This integration specifically refers to the impact of exogenous drivers on the farm business as a whole which includes commodity price projections, input inflation and other macroeconomic drivers. These exogenous drivers all impact the area under production which may provide an indication of whether a shift in hectares can be expected in the intermediate to long term. The reason why the BFAP sector and farm-level models will be integrated is to achieve the objectives of determining whether long term projections are plausible at farm level and secondly, whether a shift in hectares can occur due to exogenous and other macroeconomic drivers.

4.3.4.1 BFAP sector model key projections (2012–2021)

It was stated in Chapter Two (p.27) that the Bureau for Food and Agricultural Policy (BFAP) provides projections annually on domestic markets based on the latest trends and local and international drivers. The key macroeconomic assumptions can be summarised in Table 17 and the key domestic baseline indicators and projections (balance sheet output) in Table 18.

The BFAP (2012) has also determined a set of key underlying assumptions, which form the backbone of this section. The key assumptions can be stated as follows:

- A stagnant and slightly declining oil price due to the impact of Chinese development and new oil resources and the development of alternative sources of energy
- A dampened global and South African economic growth rate, mainly due to sluggish recovery in Europe and the United States of America
- A gradual depreciation in the exchange rate
- High world agricultural commodity prices over the medium term with a declining trend in the long run
- Rising field crop production despite a stagnation in the area under production (except for soybeans) due to significant intensification of production
- Consistent intensification and expansion in meat, eggs and dairy production
- All grain and oilseed markets are influenced by the severe drought in the United States in 2012, the implications of which will be explained in the following sections.

These key assumptions are further supported by actual projections in the tables below. The main assumption is that these drivers and impacts will spill over to the farm business environment and thus affect decisions regarding land utilisation and production. A more detailed discussion will follow in the remainder of this chapter.

Table 17: Key macroeconomic assumptions (2012–2021)

Description	2012	2013	2014	2015	2016	2017	2018
Total SA population (millions)	50.7	50.9	51.2	51.4	51.6	51.8	52.1
Oil price (acquisition price) US $/barrel	110.20	103.94	108.25	106.05	104.94	102.22	97.61
SA cents/Foreign currency							
Exchange rate (SA cents/US $)	804	822	848	876	902	928	954
Exchange rate (SA cents/Euro)	1025	1044	1075	1108	1140	1173	1207
Percentage change (∆ %)							
Real GDP per capita	2.70	3.40	3.62	3.82	4.20	4.14	3.89
GDP deflator	6.20	6.00	5.90	5.60	5.30	5.00	4.80
Percentage (%)							
Weighted prime interest rate	9.55	9.61	9.67	9.74	9.80	9.86	9.93

Source: The Bureau for Food and Agricultural Policy (BFAP), 2012

Table 18 provides the key baseline indicators and projections for farm businesses in the North West province. The table represents the actual index or evolution of the key drivers that affect decisions made by farm businesses.

It can be observed from Table 18 that the producer price of white maize will increase at a faster rate than that of yellow maize in the short run, mainly due to a traditional margin of white maize prices over yellow maize, and secondly that a reduction in the area planted with white maize is anticipated due to an increase in the demand for feed products, as well as urbanisation and class mobility, which cause a shift in consumer demand patterns.

The sunflower producer price is projected to increase by only 18 % over the baseline or study period (2011–2018). The reason for the slow growth of the sunflower producer price is mainly due to the linkage of the sunflower price to the price of oil for US refiners, which is assumed to show a relative sideways movement over the medium to long term.
Table 18 also indicates a sharp increase in the fuel price from 2011 to 2012, which directly impacts the cost composition of farm businesses. Fuel a key input in the production of agricultural goods. Prices for fertiliser in the period 2012 to 2018 are projected to move relatively sideways.

Table 18: Key baseline indicators and projections (2011–2018)

Description	2011	2012	2013	2014	2015	2016	2017	2018
Yellow maize price index (%)	Base year = 100	123	125	116	121	124	127	130
White maize price index (%)		128	126	117	137	135	127	143
Sunflower price index (%)		111	109	110	110	113	115	118
Fuel cost index (%)		140	136	146	148	151	152	151
Fertiliser cost index (%)		97	104	106	108	109	108	107

Source: The Bureau for Food and Agricultural Policy (BFAP), 2012

The relative impact of the underlying assumptions and projections illustrated in Table 17 and Table 18 will be analysed in the following section. The latter includes analyses on commodity price projections, input inflation, gross margin calculations and interpretation on the financial indicators of the farm business. It is important to keep in mind that the farm business projections of certain key indicators are based on the BFAP sector model projections and an attempt will be made later in the chapter to validate these projections and determine what the most likely impact will be on hectare utilisation.

4.3.4.2 Commodity prices

The farm gate commodity price projections for the baseline (study) period are illustrated in Figure 26. The primary axis gives the projected price per ton for white and yellow maize. The secondary axis represents the sunflower producer price. It is important to note that the figure does not represent SAFEX prices, but rather the farm gate price or the price that is realised on the farm, therefore, SAFEX minus all marketing and transportation costs (basis).

The current baseline farm gate projections in Figure 26 indicate that white maize will trade at a margin above yellow maize in 2012, 2015, 2016 and 2018. Figure 1 stated that a significant reduction in the white maize area can be expected due to the rising demand for animal feed and a reduction in the demand for white maize due to class mobility (Figure 12).

The relative changes (upwards and downward) in the white maize commodity price provide an indication that farm businesses will respond to a higher white maize price in certain years, which will force the price back to traditional levels in the subsequent years. The average white and yellow maize price over the baseline period is R1842 and R1753 per ton respectively. The average yellow maize price over the baseline period is approximately 17.42 % higher than the five-year average farm gate yellow maize price (2007–2011). In addition, the average yellow maize projection is almost 3 % higher than the highest price level in the past five years, which provides an indication that the projected maize price (white and yellow) could trade at higher levels over the long run. The latter thus indicates that gross margins will increase and therefore, higher returns can be expected in the long run, especially for yellow maize producers.

It is also important to consider the relative volatility in the white maize commodity price, which could lead to a more difficult decision-making environment. The macroeconomic drivers behind price formation should be kept in mind. The increased demand for animal feed (as a key assumption) where yellow maize and soybean oilcake are important ingredients could initiate a stable market environment due to the fact that consistent demand, anticipated low global stock levels and the competition between food and biofuels will persist in the intermediate to long term.

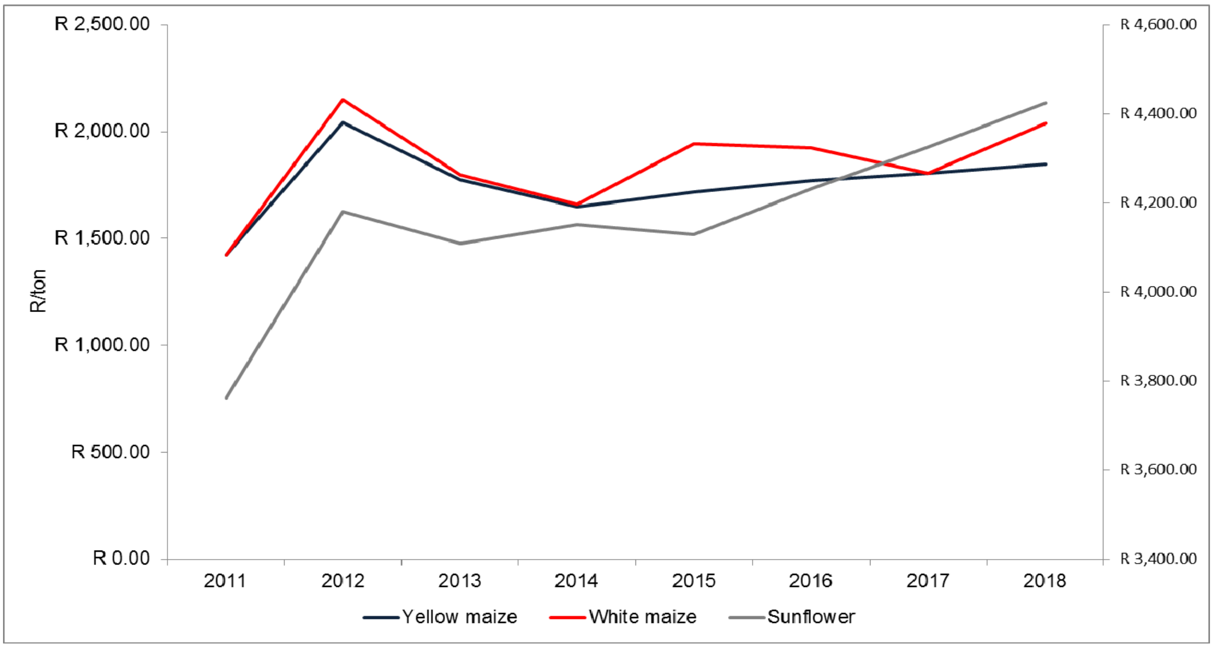


Figure 26: Farm gate commodity price projections, R/ton (2011–2018)
Source: Own calculations

Figure 26 further states that a relatively sideways movement can occur in the sunflower producer price from 2012 to 2015 and from there increase to above R4400 per ton. The average sunflower price over the baseline period is projected at R4164 per ton. It is important to note that the respective input cost composition for sunflower production is significantly lower than that of maize production. The subsequent section will elaborate on this.

4.3.4.3 Input composition

Only the key inputs and the total cost of production for maize and sunflower will be discussed in this section. These inputs can be identified as fertiliser, fuel and seed and they all exhibit a relatively volatile nature in terms of costs.

Figure 27 illustrates the input expenditure projections for white maize production from 2011 to 2018. As can be seen from the figure, three major occurrences can be observed. Firstly, the significant increase in the cost of fuel from 2011 to 2012. It is projected that the cost of fuel will increase by 40 % from R657 to R917 per hectare from 2011 to 2012 and thereafter follow a sideways to marginally higher movement towards the end of the baseline period.

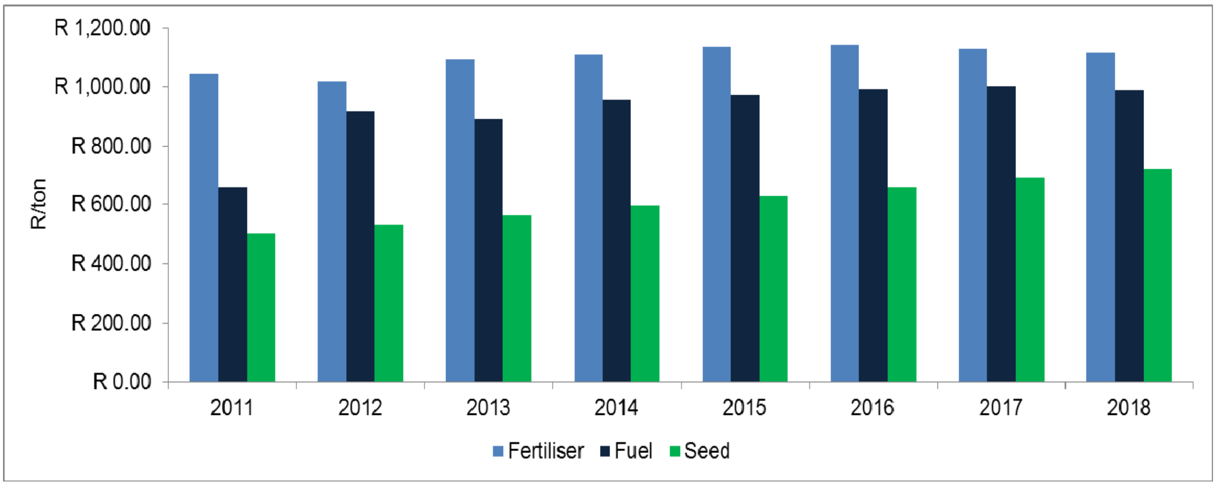


Figure 27: Selective input expenditure projection for maize production (2011–2018)

Source: Own calculations

The second important projection is the sideways movement of the cost of fertiliser (Figure 27). Fertiliser expenses raised numerous concerns from 2008 to 2012, which can be mainly attributed to a weakening Rand exchange rate against the US dollar, social unrest in North Africa and high transportation costs (both deep-sea freight and inland transportation costs). High transportation costs are mainly due to the high and rising oil price over the identified period.

Thirdly, it is projected that the cost of seed will increase at a constant rate over the baseline period to reach R721.67 per hectare in 2018. The total cost of seed in 2011 was approximately R502.78 per hectare.

The selective input expenditure for sunflower production from 2011 to 2018 is illustrated in Figure 28 below. As stated earlier, the cost of fuel will increase substantially from 2011 to 2012 and fertiliser expenditure will increase marginally over the baseline period. The cost of seed will follow the same constant trend as that of maize but at a slower rate. It is projected that the cost of fertiliser, fuel and seed could reach R1000, R921 and R320 per hectare respectively in 2018. The cost of these inputs in 2011 was R938, R612 and R223 per hectare respectively.

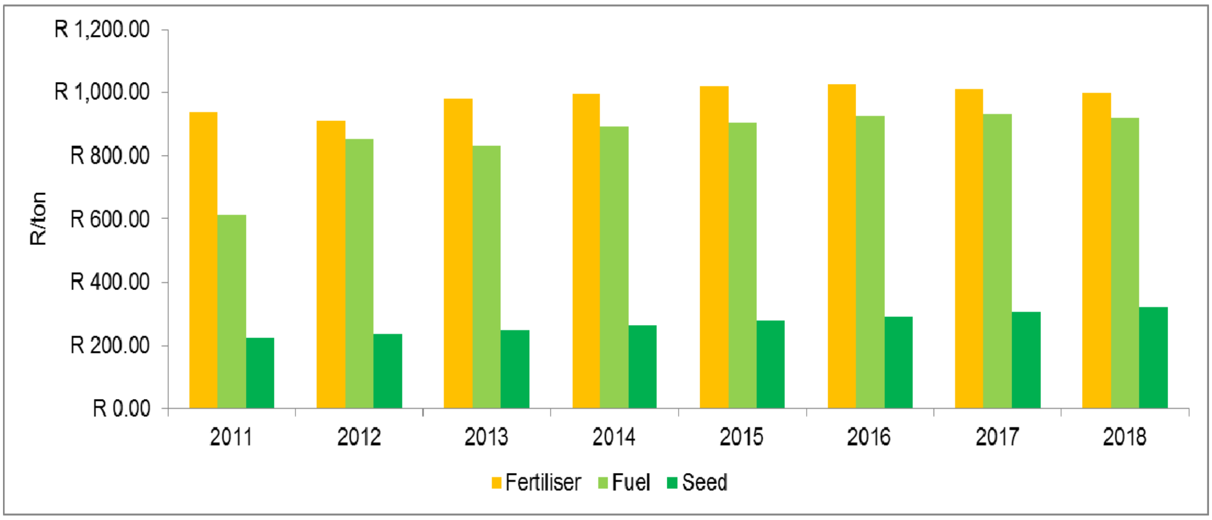


Figure 28: Selective input expenditure for sunflower production (2011–2018)
Source: Own calculations

The total costs of production for maize and sunflowers are compared in Figure 29. It is clear from the graph that maize is more expensive to produce than sunflowers. On average, it is projected that it will cost a farm business R436 per hectare more to produce maize over the baseline period. It is projected that the total cost of production for maize and sunflower could reach R4524 and R4034 per hectare by 2018.

It was stated in Figure 2 that cost structures plays a vital role in the decision-making environment of farm businesses, which may have an effect on land utilisation. Since increasing input expenditure impacts profit maximisation, the effect on land utilisation and commodities to be produced may result in a shift in the intermediate to long term.

An example to illustrate the impact is to identify a typical sensitivity analysis of an enterprise, defined by Investopedia (2012) as a technique that is used to determine how different values of an independent variable will impact a particular dependent variable under a given set of assumptions. In this case, it is also a technique to determine where an enterprise's break-even level is situated, which considers the yield, commodity price and the respective cost of production. The latter is also an appropriate measure of risk, and therefore provides an indication of at what yield and price combination a farm business can still make a profit. Finally, in a scenario where risk increases to such a level where farm businesses cannot operate any longer, a reduction in the area of that specific commodity will occur. Various scenarios will be conducted in Chapter 5 in order to illustrate the impact of these external drivers.

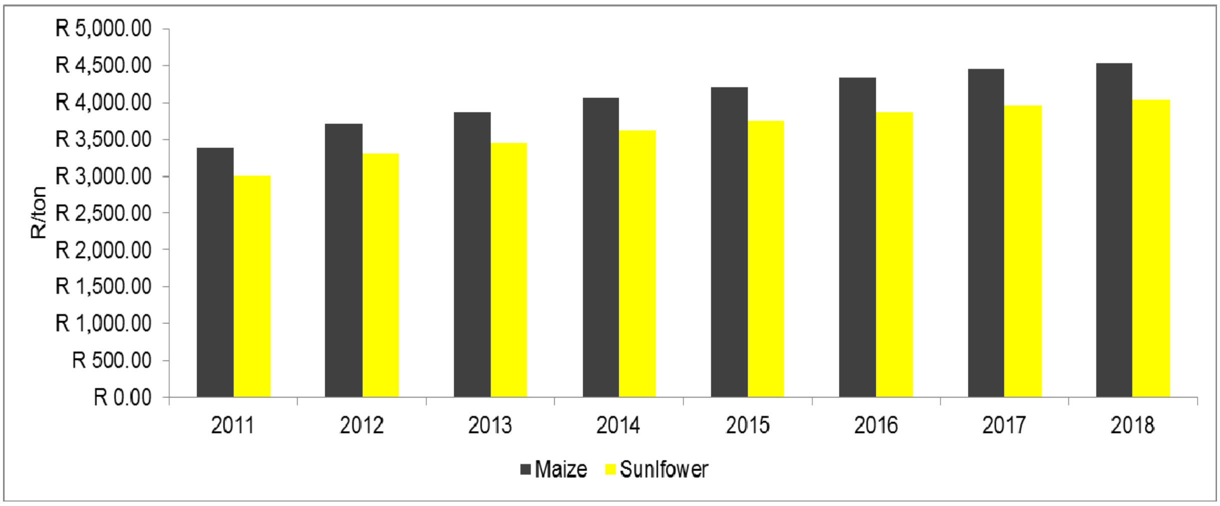


Figure 29: Total cost of production for maize and sunflower (2011–2018)
Source: Own calculations

It should be stated that the message that Figure 29 portrays does not necessarily mean that there will be a big shift towards sunflowers due to the higher cost of maize production. It is rather a combination of factors that influences changes in area utilisation.

4.3.4.4 Gross margin analysis

The section will provide an analysis of the gross margin projections for maize and sunflower production from 2011 to 2018. The assumption made earlier is that profit maximisation plays a key role in the decision-making environment. It was also stated in the previous section that sensitivity analyses can contribute to the farm business risk assessment and decisions regarding land utilisation. In order to determine whether a shift in hectares can be expected in the long term, it is important to analyse the relative enterprise profitability (gross margins). In order to conduct these gross margin projections, it is important to assume that normal weather patterns and rainfall will prevail over the baseline period, which means that yield levels will marginally increase over the period of study due to new technology trends such as seed varieties and production techniques.

Figure 30 illustrates the gross margin projections for the period 2011–2018 for maize and sunflower production. It can be observed from the figure that except for 2012, 2015 and 2018, sunflower production will be more profitable than white and yellow maize production. In addition, it is clear that sunflower production will be more profitable than yellow maize production from 2013 to 2018. A fluctuation in the profitability between white and yellow maize can also be seen in Figure 30 due to commodity price volatility for especially white maize. As stated earlier, the reason for the fluctuation in white maize profitability is due to demand and supply mechanisms. The latter refers to certain years when the white maize price is low and farm businesses reduce the area under white maize production, which causes a supply shock in the subsequent year and creates a higher price equilibrium.

A supply shock is expected in 2012, backed by the severe drought in the United States during the 2012 production season which caused commodity prices to skyrocket. The supply shock in South Africa will lead to a bumper crop in 2013 (if normal rainfall prevails), which could force the maize price down in the same year. Therefore, a lower gross margin in maize production is expected in 2013.

If one considers profit maximisation and all other variables are held constant (risk, balance sheets and other external drivers), it can be stated from Figure 30 that a shift towards sunflower production can be expected due to its relatively better performance as against white and yellow maize production. Given the output of Figure 30, it can also be observed that in certain years, white maize margins will far exceed yellow maize margins. In years where a correction in the white maize balance sheet occurs (which results in a lower white maize equilibrium price), the margin for a white maize enterprise will only be slightly lower than that of yellow maize. Due to a relatively low input cost approach in the North West province, it can be argued that white maize production under current assumptions and projections will remain profitable in the long term, which indicates that an area reduction is unlikely to occur in the intermediate to long term, especially since farm businesses will most likely follow a profit maximisation and cost minimisation approach.

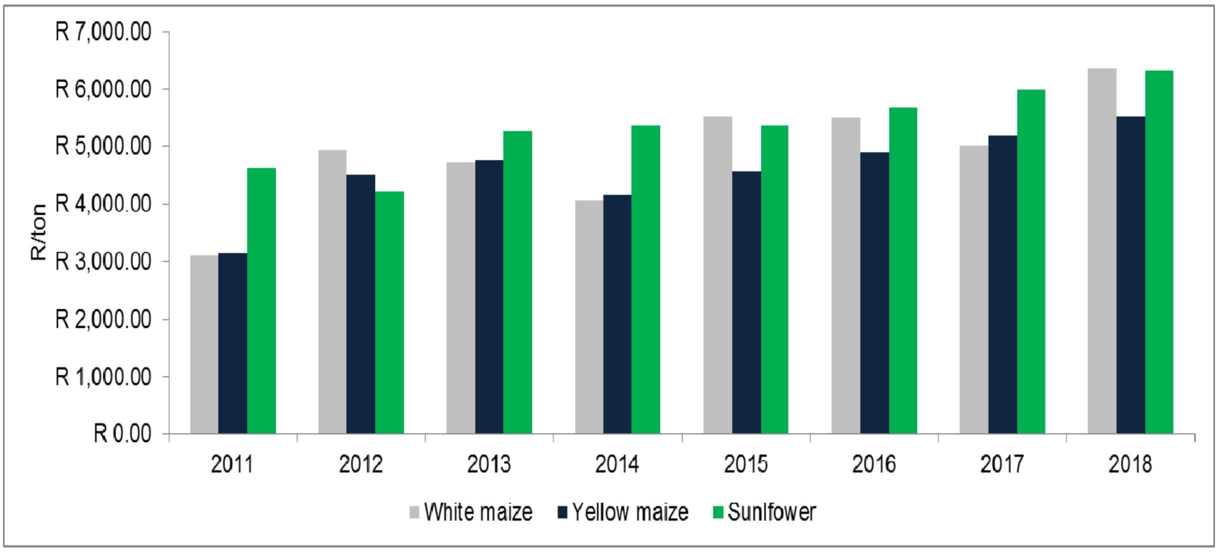


Figure 30: Gross margin analysis for maize and sunflower production (2011–2018)
Source: Own calculations

4.3.4.5 Financial performance indicators

The previous sections focused on enterprise elements and profitability. It is important to consider the farm business as a whole, and thus to consider the key financial indicators and whole farm performance. The Net Farm Income (NFI), as stated earlier, can be interpreted as a proxy for the profitability of a farm business. Figure 31 represents the NFI historical and projected trends from 2009 to 2018.

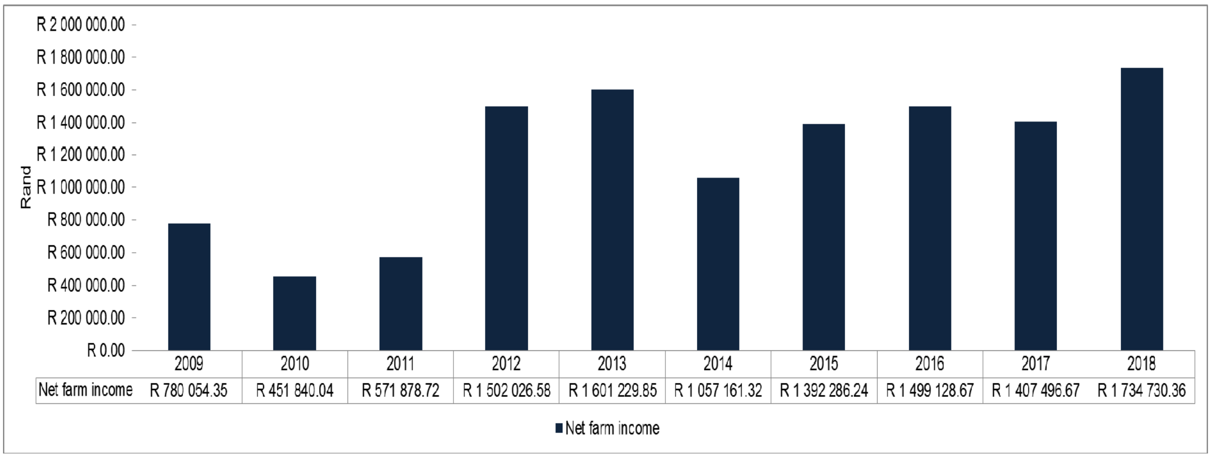


Figure 31: Net farm income for the period: 2009–2018
Source: Own calculations

The average NFI over the projected period (2012–2018) is R1.45 million – approximately 142 % higher than the historic study period (2009–2011).

The figure clearly illustrates that the projected NFI from 2012 to 2018 performs significantly better than in the preceding three years (2009–2011). This further illustrates that, given all underlying factors that influence the BFAP sector model output and projections (especially Figure 1 which illustrated the crop area assumptions), in the intermediate and long term, farm businesses will perform better financially than historical levels.

At this stage, it is important to take a step back and to revise the assumptions of the BFAP sector model projections and how the projected commodity prices are calculated. Figure 1 demonstrated that a decline in the white maize area is expected over the long run, mainly due to the increasing demand for yellow maize (Figure 9) and a stagnant demand for white maize through decreasing maize meal consumption. In the scenario where the white maize area does not decline as projected, a different balance sheet output will prevail, thus a different equilibrium price for white maize will be realised for the baseline period. It is also important to keep in mind the linkage between the BFAP sector and farm-level models, as was discussed in Chapter Three and Figure 13. Based on these assumptions, it can be argued that a reduction in the white maize area as projected in Figure 1 and the BFAP sector model projections in Table 17 and Table 18 will impact the North West representative farm positively in the sense that the financial position reflects better in the projected years than in the historic study period. This also refers to the assumption that farm businesses will try to maximise profits and minimise costs. Another critical assumption is that the crop mixture on the North West farm has to follow the BFAP sector model area projections in order for these financial outcomes to occur.

In Chapter Five, selective scenarios will be created in order to take into consideration the production of other crops, such as soybeans. These scenarios will be compared to the current financial projections of farm businesses in the North West province in an attempt to determine whether other crops might be more profitable (if production conditions allows for them) than the current farm structure and background. This step is necessary in order to take into consideration all the summer rainfall commodities produced and to determine whether long-term projections such as the anticipated growth in soybean consumption and therefore production are plausible at farm level. It is also an attempt to determine what commodities will be produced where.

4.3.5 Conclusion and remarks

It was stated throughout the section that the price of commodities plays a critical role in the decision-making environment of farm businesses and impacts the gross margin per commodity and therefore the over-all farm business performance. The latter plays a significant role in the decision making environment of farm businesses which further impacts the decision regarding land utilisation.

The input cost composition comparison between historical, current and projected trends illustrated that production expenditure has increased from historical patterns and will continue to increase into the intermediate and long term which impacts the gross margin of both maize and sunflower production.

The BFAP sector model's projections with its underlying assumptions also stated that, in the long term, farm businesses will perform better financially compared to historical levels. The reduction in the area of white maize as presented in Figure 1 and its relative impact on balance sheet projections therefore indicate a positive effect at farm level when profit maximisation is a key assumption. Thus, the area stipulated by the BFAP sector model projects a wealthier financial position for the farm business, indicating that the sector model projections are plausible at farm level in the North West region.

This section highlighted the importance of macroeconomic and other exogenous drivers that affect farm-level decision making. The projected increase in the demand for animal feed where yellow maize plays an important role thus creates new market equilibrium conditions that lead to a higher yellow maize price. Farm businesses respond to the higher anticipated price, thus the area under yellow maize has to increase. It should be kept in mind that a farm business normally has limited arable land available and finding room for area expansion is a complex and expensive task. This effect provides an indication that a shift can occur in hectares in order to expand the area of the most profitable crop. Thus, the competition for arable land will remain high.

Finally, it should be kept in mind that production factors such as key rotation systems and risk management by means of differentiation will remain important in the future so a major shift from one commodity to the other is highly unlikely. In Chapter Five, scenarios will be created to illustrate the impact of other drivers behind decisions about land utilisation.

4.4 NORTHERN AND WESTERN FREE STATE

The following section will focus on the historical structure of the farm business in the northern and western Free State together with a detailed discussion of the current state of the farm business, including its relative financial performance. The analysis will conclude with long-term financial projections based on the latest outlook of the BFAP sector model projections to determine how the long-term scenario might emerge.

The previous section included numerous assumptions and drivers affecting the decision-making environment of farm businesses in the North West province. The North West province and the northern and western Free State are quite similar in terms of production techniques, climate, farm management and other drivers and conditions. Thus, numerous topics covered in the previous section will be cross referenced in what follows.

4.4.1 Farm background

The northern and western parts of the Free State are considered the core maize producing region in South Africa and receive summer rainfall. The representative farm is situated in the Bultfontein region in the western Free State and consists of 2 296 hectares of which 1 680 hectares are under a four year dryland rotation with maize and fallow land (maize/maize/fallow/maize). For this exercise, the assumption is that a sunflower enterprise is added to the farm structure in the 2010/2011 production season, as will be explained later. The inclusion of sunflower production integrates the northern Free State farm structure with the western Free State farm business. It should be stated at this stage that the northern and western Free State do not differ significantly in terms of production systems and techniques. It depends on individual farm businesses what type of crops is produced.

The summer rainfall distribution is considered as a natural restriction in this region and the average annual precipitation is 450 millimetres. A conservation tillage operation with a mulch seed approach is utilised on the sandy-loam type soils. Maize as the main enterprise is supplemented by a livestock production component and the respective grasslands consists of 616 hectares. A maize/winter wheat rotation forms part of a small irrigation component, but since the production of winter cereals falls beyond the scope of this study, the production aspect and performance of winter wheat will be excluded from the analysis and financial performance of the farm business.

A typical production system in this region involves the following procedures. Maize is planted in November and is harvested in May/June the following year. During the 2009/2010 season, a total of 1 200 hectares of maize was planted. Fallow land amounted to 440 hectares. For the same period, the share of maize towards the total turnover was 88.6 % followed by wheat with 6 %. The contribution of other farm income towards total turnover was 5.4 %.

Figure 32 represents the hectare mobility over the period 2008–2010 for white maize and sunflower production with a summer fallow system. A marginal shift occurred in hectare utilisation between the 2008/2009 and 2009/2010 production seasons. The production of white maize increased from 1120 to 1200 hectares. The addition of the sunflower enterprise in the 2010/2011 season decreased the area under white maize production.

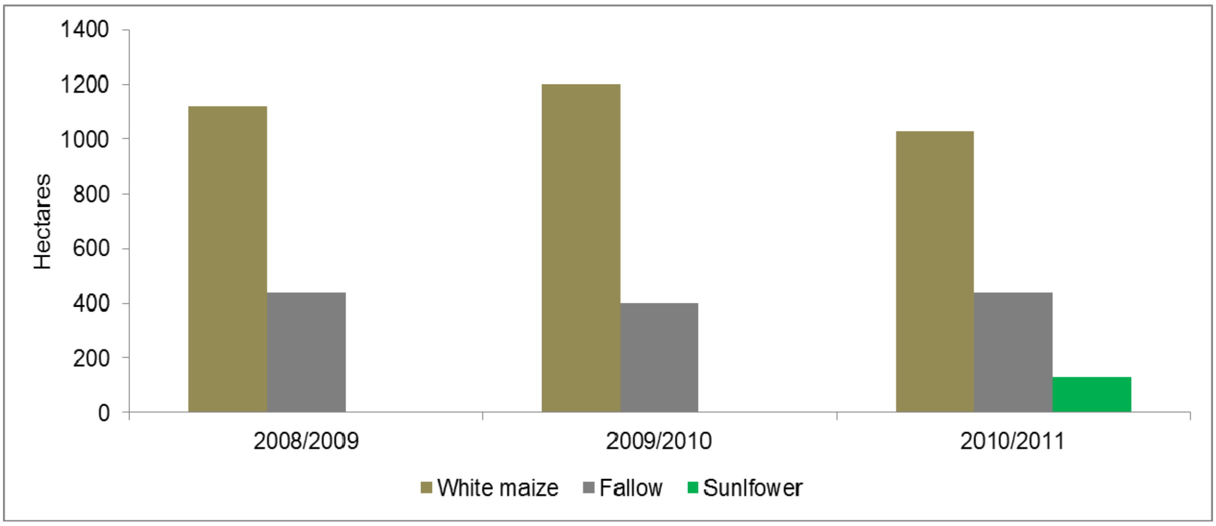


Figure 32: Hectare mobility in the northern and western Free State farm business (2008–2010)
Source: Own calculations

The financial strategy of the farming business is to use own capital and to limit market risks where possible. The average annual percentage of production loans and overdraft facilities used is 80 % at an interest rate of 10.5 %. Asset replacement occurs each year at a fixed rate of 7 % for vehicles and 6 % for implements and machinery.

4.4.2 Historical trends and current state of the farm business

In the previous section (North West analysis), historical trends and the current state of farm businesses were discussed separately. The reason for this was to create a platform on which the rest of the chapter would be based. Thus, in the following section, the historical trends and the current state of the farm business will be integrated and discussed simultaneously, as the current state is only an expansion of the historical position of the farm with some minor changes. In addition, several observations made in the previous section correspond with the environment of the representative northern and western Free State farm business. It should be kept in mind that the current state of the farm business refers to the 2010/2011 production season and this also forms the base year for the BFAP sector model projections that will follow later in the chapter.

4.4.2.1 Yields, productivity and price trends

The yield levels, productivity and commodity price trends will be discussed in the following section. The northern and western Free State are familiar with above normal yields due to the availability of underground water and an efficient production approach with high-tech machinery and equipment. The yields of white maize and sunflower production are illustrated in Figure 33. Since the sunflower enterprise was only added to the farm's production system in the 2010/2011 season, no yield entries are available for the 2008/2009 and 2009/2010 seasons. Sunflowers had a yield of 2.1 tons per hectare in the 2011 harvest season.

White maize yields for the 2009 and 2010 harvest period reported 6.26 and 5.9 tons per hectare respectively. Towards the subsequent year, the white maize yield declined by 0.1 tons per hectare. The yield levels reported by the representative farm in the northern and western Free State performed extremely well when one consider the national average of 4.26 tons per hectare in 2011 (DAFF, 2012).

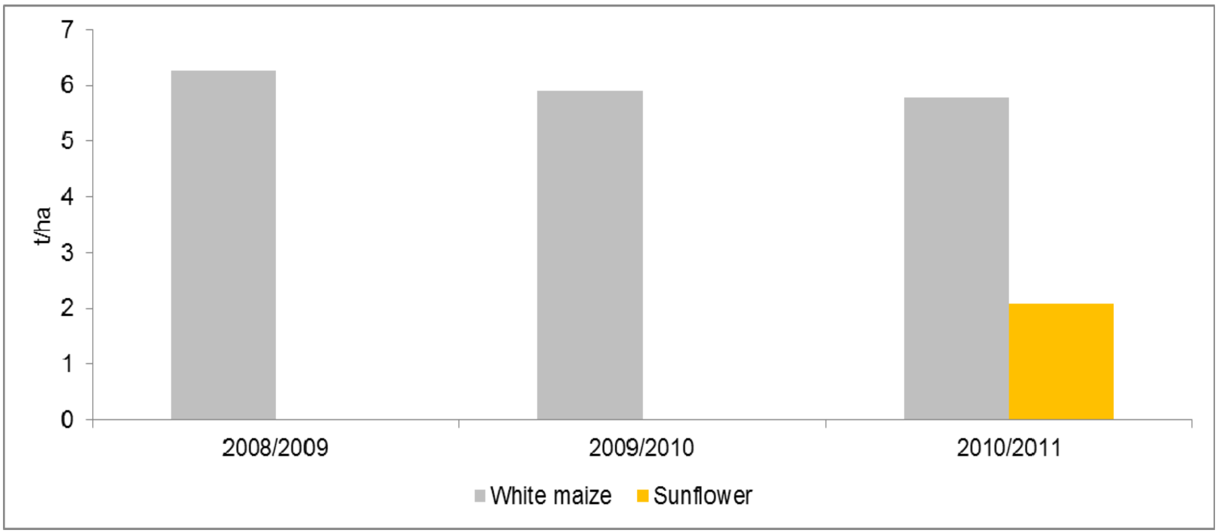


Figure 33: Historic and current yield performance in northern and western Free State (2008–2011)

Source: Own calculations

Increasing productivity and efficiency are both key drivers in primary agriculture and an important factor of profitability. One has to keep in mind the relative input composition behind the anticipated high yield levels and this is further supplemented by the sensitivity analysis discussed on p.83. The break-even point between the respective commodity price, yield and input expenditure should be maintainable to sufficiently profitable levels. An example will be provided in Chapter Five, where specific production and economic scenarios will be created and verified.

The productivity indicators for maize production by northern and western Free State farm businesses are illustrated in Figure 34. The primary axis represents nitrogen application in kilograms applied per hectare and secondly, the nitrogen productivity indicator which can be explained as the kilograms of maize harvested from every kilogram of nitrogen applied per hectare. The secondary axis illustrates the yield in kilograms per hectare, which is an important indicator in productivity analysis.

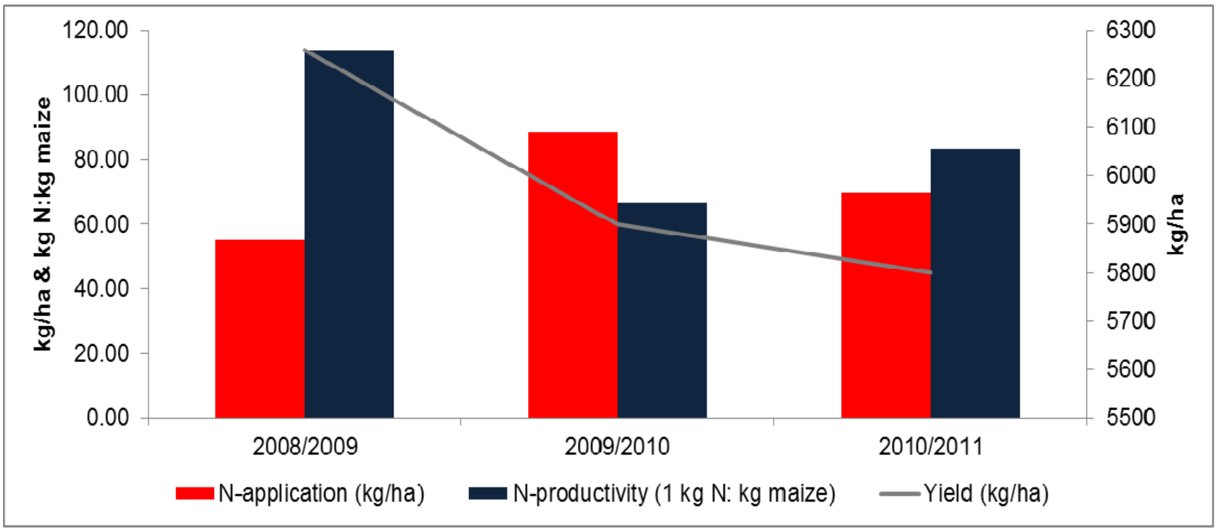


Figure 34: Northern/western Free State maize productivity (2008–2011)
Source: Own calculations

It can be observed from Figure 34 that the amount of nitrogen applied per hectare increased significantly from 2008/2009 to 2009/2010 and then declined to almost 70 kg per hectare. The increase in nitrogen applied together with a lower maize yield in the 2009/2010 production season caused the nitrogen productivity ratio to decline from 1:113 to 1:67. This means that there was a reduction of 46 kg of maize harvested for every kilogram of nitrogen applied per hectare. However, nitrogen productivity levels shown an increase from 2009/2010 to 2010/2011 due to a lower nitrogen application. In the 2010/2011 production period the productivity ratio for nitrogen was 1:83.

Since fertiliser application is considered as a major and volatile input element in maize production which impacts profitability, fertiliser productivity indicators will remain an important driver in both the production system and financial position of the farm business.

It was stated in section 4.3.2.1 on p.57 that the farm gate price refers to a basic price with the "farm gate" as the pricing point or as the price of the product at the farm (OECD, 2012). As stated in the same section, silo differentials, which is the payment that needs to be subtracted from the SAFEX price due to transportation to the reference point (Randfontein), will differ from place to place. Thus, different farm gate prices will occur over the country depending on the location of the farm business. The average white maize farm gate price for the northern/western Free State farm business for the 2008/2009 and 2009/2010 production season were R1243 and R1250 per ton respectively. Towards the end of 2011, the average price increased by approximately 24.32 % to R1554 per ton. The average sunflower price in the 2010/2011 period was R3729 per ton.

It was stated in section 4.4.2.1 on p.57 that the price of commodities has a significant impact on the decision about land utilisation since a low commodity price indicates low profitability levels. It is realistic to mention that, in a business environment such as a factory, if a certain product does not meet the required profitability levels or if alternative products perform better, the unprofitable product will be discontinued or replaced by a more attractive one. However, it is important to consider all relevant drivers and not only financial measurements. This refers to risk management such as differentiation and other risk manageable factors such as the specific production system or rotation, which have different advantages for the farm business.

4.4.2.2 The input cost composition

Figure 35 provides an indication of selective inputs expenditure per hectare for maize production from the 2008/2009 to 2010/2011 production seasons. It is clear from the graph that the cost of fertiliser per hectare has increased significantly over the study period mainly due to a weakening Rand exchange rate against the US dollar together with unrest in North Africa which further impacted the cost of oil (price per barrel).

It is interesting, however, that the cost of fuel per hectare reported a relatively stable and sideways movement over the indicated period. The latter was mainly driven by a drop in the diesel price from 2008 to 2009 together with a reduction in the number of field work operations, which reduced fuel consumption. This was supplemented by investment in new machinery and implements which caused more efficient fuel consumption patterns due to improved tractors. Secondly, adjusted or new tillage equipment from conventional farming methods to minimum tillage operations reduced the amount of passes per hectare. The cost of seed increased from 2008/2009 to 2009/2010, but dropped again towards the 2010/2011 season. It should be mentioned that it is a complex task to compare seed costs over a specific time frame due to different types of seed varieties. These seed varieties include new technology cultivars such as round-up ready maize (glyphosate resistant), *Bacillus thuringiensis* (Bt) varieties and stack genes (combination of genes). Each of these maize varieties exhibits different price levels.

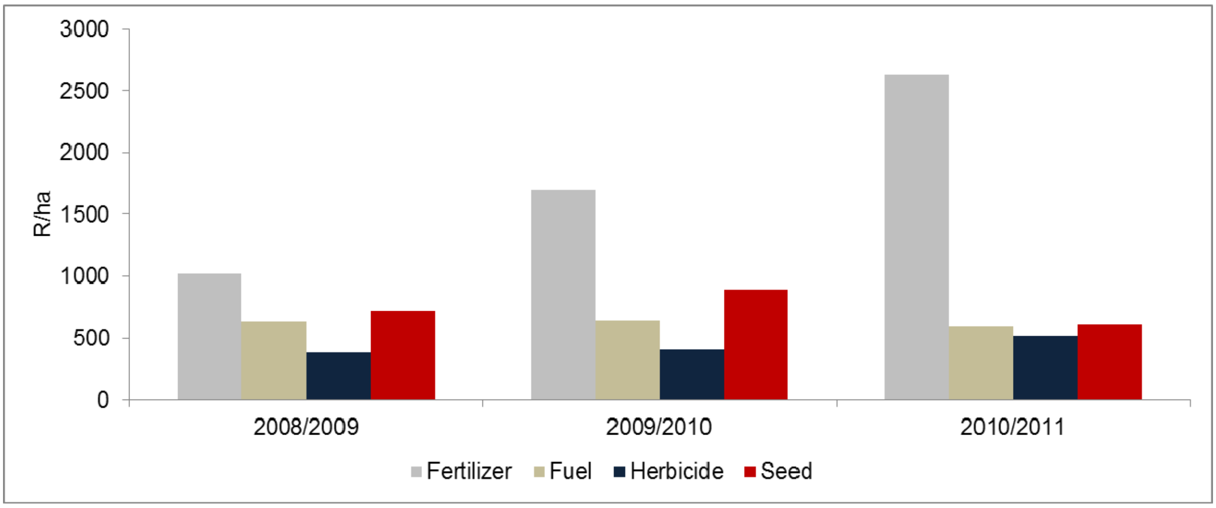


Figure 35: Selective input expenditure for maize production (2008–2011)
Source: Own calculations

To summarise, the cost of fertiliser and fuel in the 2010/2011 (base year) were R2630 and R593 per hectare respectively. The cost of herbicide and seed for the same period were R517 and R608 per hectare respectively.

The input composition for sunflower production in the northern and western Free State is represented in Figure 36. The selective input expenditure refers specifically to the 2010/2011 production period. Since the sunflower enterprise was only added to the farm business structure in the 2010/2011 season, no historical data entries are available, thus, the focus will be on establishing a base year for sunflower production from which projections will be made.

It can be observed from Figure 36 that fertiliser, fuel, crop insurance and seed are the key inputs in sunflower production in the northern and western Free State. It has been stated before that volatility in the prices of fuel and fertiliser creates a difficult decision-making environment for farm businesses since increasing input expenditure in these inputs causes profitability to decline. In particular, fertiliser as the most expensive input should be monitored carefully.

The total cost of fertiliser in the 2010/2011 season was R1558 per hectare, approximately 66.05 % higher than in the North West province. The question then is why do fertiliser costs differ so widely between the two provinces, but yield levels roughly correspond? There are several factors that that might be at work, the most important of which are probably production conditions and soils. The total cost of fuel for the same period was R502 per hectare. The cost of herbicide and seed was R139 and R278 per hectare respectively.

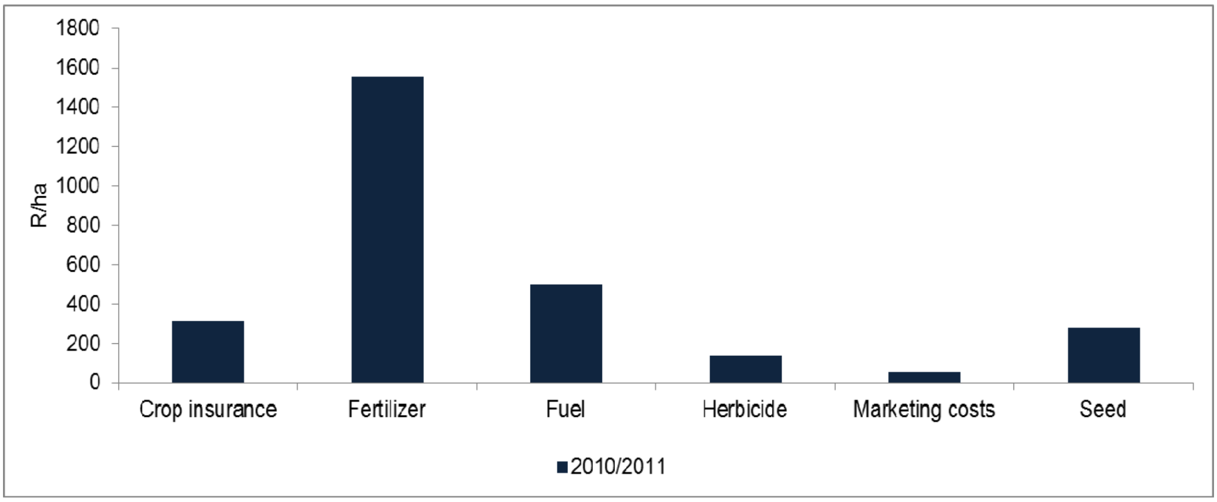


Figure 36: Input cost composition for sunflower production (2010/2011)
Source: Own calculations

The total cost of producing white maize in 2010/2011 was R5202 per hectare and sunflower production cost R4458 per hectare.

The point raised earlier regarding the differences in the cost of production between two or more provinces is an important driver to determine whether a shift in hectares can be expected in the intermediate or long term. Since the input cost composition of different enterprises is an important driver in land utilisation decisions which further impacts profitability, the assumption can be made that farm businesses will strive to produce at the most competitive rate as possible. This point can be expanded to sensitivity analyses and break even points where a comparison between these levels could determine where specific commodities can be produced cheaper and therefore decrease the production risk factor of an enterprise. Chapter Five will focus on these scenarios and comparisons and an attempt will be made to determine whether it will be more profitable to produce sunflower in the North West region or not. Another scenario for the northern-and western parts of the Free State might be to remain with traditional production practises to produce maize or rather includes soybeans into the enterprise structure of the farm business.

4.4.2.3 Gross margin analysis

It was stated in 4.3.2.3 on p.63 that an enterprise budget or gross margin refers to the specific enterprise output minus all direct allocated costs (United Kingdom Department for Environment, Food and Rural Affairs, 2010). At farm level, the calculation is usually the enterprise yield multiplied by the farm gate price and thereafter subtracting the input expenditure that can be allocated directly to the specific enterprise. It was further argued that the gross margins of commodities produced on the farm serve as indicators of the relative financial performance or profitability of the identified commodities. By comparing the results, a farm business would be able to determine what commodity performs financially better.

The following section will therefore focus on the gross margin analysis of the representative farm business in the northern and western Free State. Figure 37 illustrates the gross margin analysis for white maize production from 2008/2009 to 2010/2011 and sunflower production in 2010/2011.

The gross margin for white maize production in the 2008/2009 and 2009/2010 production seasons was R4050 and R2542 per hectare respectively. The drop in gross margin for 2009/2010 from 2008/2009 can be attributed to a lower yield level and production input inflation. The gross margin for white maize indicated an increase of approximately 50 % from 2009/2010 to 2010/2011 due to a substantially higher maize commodity price. The gross margin at the end of the 2011 harvest period was R3811 per hectare.

The figures further indicate that sunflower production was more profitable than white maize production in 2011, mainly due to a high sunflower yield of 2.1 tons per hectare together with a sunflower farm gate price of R3729 per ton. The lower cost of producing sunflowers further contributed to the higher gross margin.

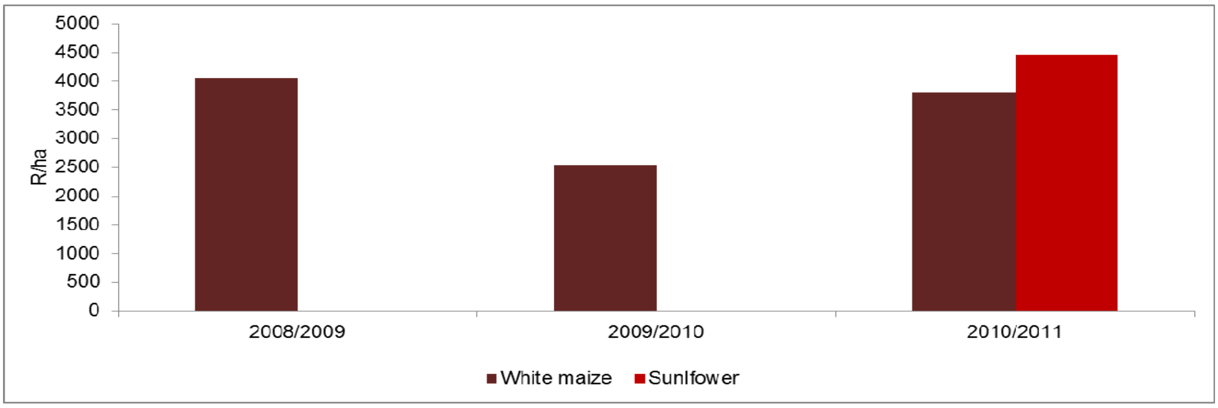


Figure 37: Gross margin analysis for northern and western Free State (2008–2011)

Source: Own calculations

It was stated in the North West analysis that by measuring the relative performance of gross margins of commodities largely influence the decision making of farm businesses which further has a significant impact on land utilisation decision-making. Since farm businesses normally take profit maximisation and cost minimisation approaches, the output of gross margins largely determines whether a shift in hectares can be expected in the intermediate or long term. It should be kept in mind that several factors contribute to land utilisation decisions and that the enterprise's relative financial performance is only a driver in the process. In addition, it is important to integrate land utilisation decisions with a sensitivity analysis approach since the latter could determine at what risk the farm business will have to continue production. Chapter 5 will explain the concept of sensitivity analysis in more detail.

4.4.2.4 The financial output

The following section will focus on the summary of the financial output of the farm business, which includes the overhead component, asset replacement and the finance structure. It is important to keep in mind the objectives of interpreting the overall performance of the farm business stipulated in 4.3.2.4 on p.65 and 4.3.3.2 on p.74. In these sections, it was stated that the relative performance of a farm business is not only determined by gross margin profitability, but rather a combination of enterprise performance, overhead expenses, provision for asset replacement and the cost of finance. This combination establishes important business and production pillars for a typical farm business and should all be carefully managed.

Table 19 represents a summary of the overall financial position of the farm business situated in the northern and western Free State. As stated earlier, in order to simultaneously analysing the northern and western Free State, the asset structure and debt-to-asset ratio will be excluded from this analysis due to the difference in the amount of moveable assets owned by the respective farm businesses.

It can be observed from the table below that the farm business indicated a healthy return over the study period, except in 2009/2010. The net farm income (NFI) as a proxy for farm profitability was R1.7 million in the 2008/2009 production season and R15 4812 in 2009/2010.

Table 19: Summary of the financial performance of the farm business (2008/2009–2010/2011)

Financial indicators	2008/2009	2009/2010	2010/2011
Farm gross margin	R2 922 984	R1 609 742	R2 650 127
Net cash farm income	R2 106 856	R560 812	R1 929 891
Net farm income	R1 700 493	R154 812	R1 185 262
Return to family living	R1 250 371	R268 625	R1 849 792
Ending cash surplus/deficit	R847 026	−R131 375	R1 849 792
Total liabilities	R1 725 120	R3 874 482	R4 361 222

Source: Own calculations

The 2009/2010 production period gives a perfect example of the volatility that farm businesses face due to volatile commodity prices and increased agricultural expenditure. The NFI was substantially lower than in the year before, which resulted in a negative cash flow. This implies that pressure is placed on the subsequent production year due to a negative bank opening balance. A low NFI together with a deficit cash flow also means that it will be a complex task to take advantage of seasonal trends or other advantages throughout the year such as a low price for a specific agricultural input at a certain time of the year. In addition, if a negative cash flow arises, the general production activities of the farm business may have to be financed by a production loan or overdraft facility, which implies additional costs of finance or interest costs.

The table also shows that the level of liabilities increased substantially over the study period. In 2008/2009, total liabilities were R1.7 million. In the 2009/2010 and 2010/2011 financial periods, the amount had increased to R3.8 million and R4.3 million respectively. The latter implies that the cost of obtaining foreign capital increased substantially over the period. The total interest paid at the end of 2009 was R816 128. The same cost increased by 28.52 % a year later, to R1.04 million. This clearly shows that the finance structure plays a critical role in the overall performance of a farm business. For example, if the level of liabilities had remained the same in the 2009/2010 period as in the 2008/2009 financial year, the farm business would have indicated a positive cash flow position.

The previous sections have given a snapshot of the relative production and financial performance of the representative farm business in the northern and western Free State. The illustration of historical trends and determining the current position of the farm business thus creates a platform or base from which projections can be made. In the following section, the output and projections of the BFAP sector model as stipulated by section 4.3.4.1 on p.78 will be applied to the representative farm in the northern and western Free State in order to determine a possible future scenario or position. It should be kept in mind that the 2010/2011 production period is used as the base year for projections.

4.4.3 The impact of the BFAP sector model on the northern and western Free State farm business

The North West projection analysis in section 4.3.4 explained the integration between the BFAP sector and farm-level models in order to illustrate why the exercise is conducted. In addition, Figure 1 stated that the result of the BFAP sector model balance sheet output may cause the total area under white maize to decline over the baseline period (2012–2021). The key macroeconomic assumptions and baseline indicators were discussed in section 4.3.4.1 on p.78 and in Table 17 and Table 18. Given these macroeconomic key drivers and the balance sheet output from the BFAP sector model, the assumption remains that a spill-over effect to farm level can be anticipated, thus impacting the decision-making environment of a typical farm business in the northern and western Free State.

The following section will therefore focus on the most likely future position of the representative farm business. In Chapter Five, production and macroeconomic scenarios will be created in order to determine whether external and other drivers could impact land utilisation changes. It is thus important to keep in mind that the following section only expands the current position to the most likely future outcome, given the output of the BFAP sector model. Other drivers such as the incorporation of other enterprises such as soybeans are therefore excluded from this section; however, scenarios will be created later in the study to assess the anticipated external drivers.

4.4.3.1 Commodity price projections

The farm gate price projections for white maize and sunflower production on the northern and western Free State representative farm are illustrated in Figure 38. The primary axis and red line illustrate the white maize price projections and the secondary axis and blue line represent the sunflower farm gate price projections.

The figure clearly indicates that a substantially higher white maize price is expected for the baseline period compared to historical levels. However, price volatility may occur due to demand and supply mechanisms, which were explained earlier. Since the demand for white maize is expected to decline over the baseline period due to urbanisation, class mobility of consumers and the increasing demand for yellow maize, a demand shock for white maize is expected to occur in certain years which will result in a higher equilibrium price. The effect can be observed in the figure and is represented by the upward and downward trend in the price of white maize (red line). It is projected that the white maize price could range in the R2200 per ton level by 2018. The average projected white maize price for the baseline period is approximately R2027 per ton.

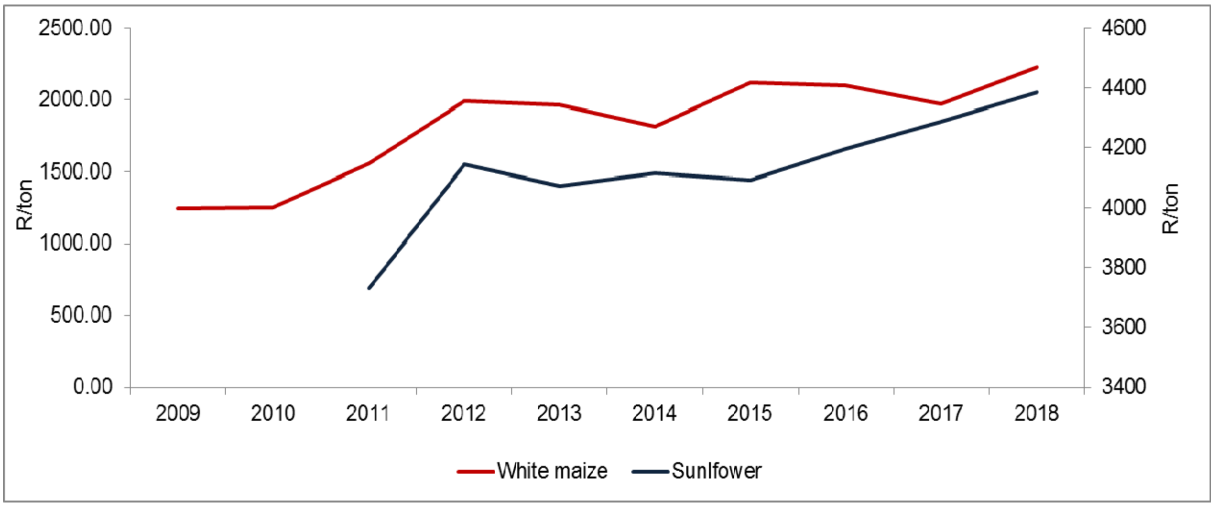


Figure 38: White maize and sunflower farm gate price projections (2012–2018)
Source: Own calculations

The sunflower price is expected to increase significantly from 2011 to 2012, and then decrease marginally towards the end of 2013 due to a supply response and a lower anticipated oil price. Thereafter, a sideways movement is expected towards the end of 2015 and then a spike towards the end of the baseline period. It can be argued from the figure that the production of sunflowers will become more profitable in the future due to a higher anticipated price. The average sunflower price might reach R4385 per ton by 2018. The average projected sunflower price over the baseline period is R4127 per ton.

The commodity prices shown in Figure 38 have to be combined with the respective yield levels and input cost structures in order to determine the relative enterprise performance in the future. The previous assumption that farm businesses will follow a profit maximisation approach still stands. Land utilisation decisions should be combined with other factors, however, such as production risk, differentiation, over-all farm performance and new technologies. The output of a combination of these factors could lead to a shift in land use in the northern and western Free State.

4.4.3.2 Input cost composition

It was stated in the background section that the northern and western areas of the Free State follow a minimum tillage approach in the respective production systems. The Ecology Dictionary (2012) defines minimum tillage as a farming technique that reduces the degree of soil disruption and therefore improves the levels of moisture in the soil. The techniques include leaving crop residues on the field. Particular advantages include reductions in energy consumption by farm machinery and equipment, less soil erosion and lower soil moisture losses during the fallow season.

It was stated in Figure 2 that production systems and techniques are important drivers in the farm business decision-making environment, particularly the decision on land utilisation. The example of minimum tillage operations as stated earlier is only one of the many factors that improve production systems techniques and technology. Technology, in this particular case refers to improvement in agricultural machinery such as no-tillage planters and other tillage equipment. The relationship that for example, minimum tillage operations have with the respective input cost composition is that they could reduce input expenditure such as energy or fuel costs by reducing the number of field work operations and activities. Technological improvements of agricultural machinery and more efficient tractors, on the other hand, reduce fuel consumption and thus lead to better fuel consumption patterns.

The input cost composition for maize and sunflower production will be discussed in the rest of this section. Figure 39 presents selective input expenditures and the total cost of maize production. Fertiliser, fuel, herbicide, marketing and seed expenditure are displayed on the primary axis. The total cost of maize production is illustrated on the secondary axis. It is clear from the graph that the cost of fertiliser by far exceeds other input-related expenditure. The projection is that fertiliser expenditure will move relatively sideways over the baseline period (2011–2018) but will remain the key input in the future. The second observation from the graph is that the cost of fuel will increase significantly from 2011 to 2012 due to the spike anticipated in the BFAP sector model (Table 18). The latter indicates that fuel expenditure will increase from R593 to R827 per hectare from 2011 to 2012. Finally, it is expected that herbicide, marketing and seed expenditure will increase at the rate of inflation.

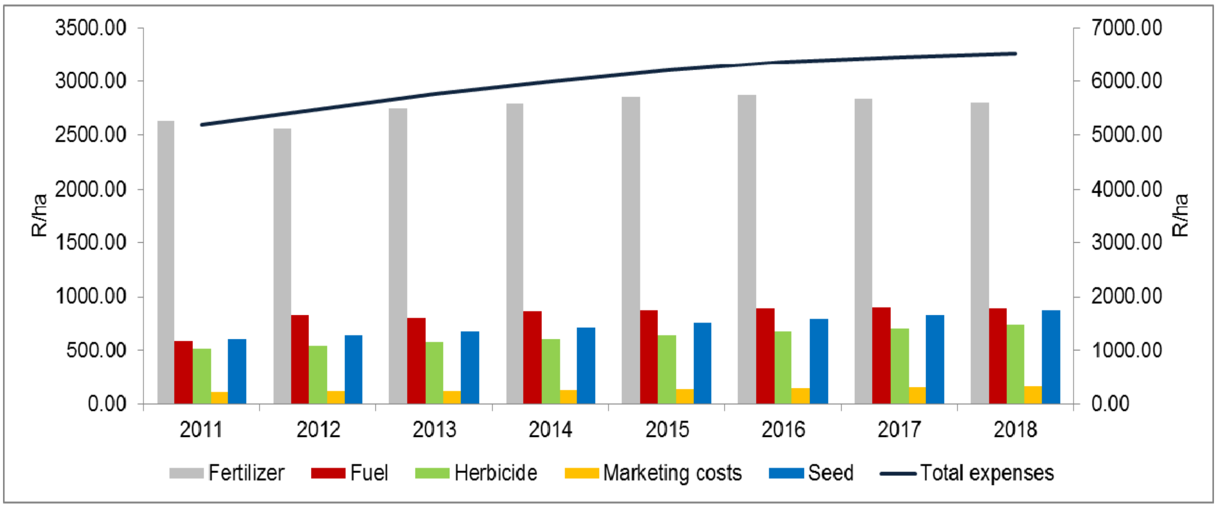


Figure 39: Selective input expenditure projections for maize production
Source: Own calculations

Figure 39 also shows that the total cost of production will place continuous pressure on the profitability levels of farm business. The total cost of maize production in 2011 was R5202 per hectare. It is expected that the total cost of production could reach R6533 per hectare by 2018, R1331 per hectare more than in 2011. In order to justify the increase in expenditure from a financial point of view, one can argue that either the commodity price of white maize or yield levels have to increase. An illustration is provided in Figure 40 where the total cost of production and the white maize commodity price projections are plotted on a graph.

The figure represents the white maize farm gate price projections and the total cost of production from 2013 to 2017. The primary axis illustrates the farm gate price per ton and the secondary axis presents the total cost of production. In addition, to support the argument, two linear trend lines for maize farm gate price and total cost of production have been included in the graph. The figure clearly shows that the total cost of production will increase at a faster rate than the white maize farm gate price.

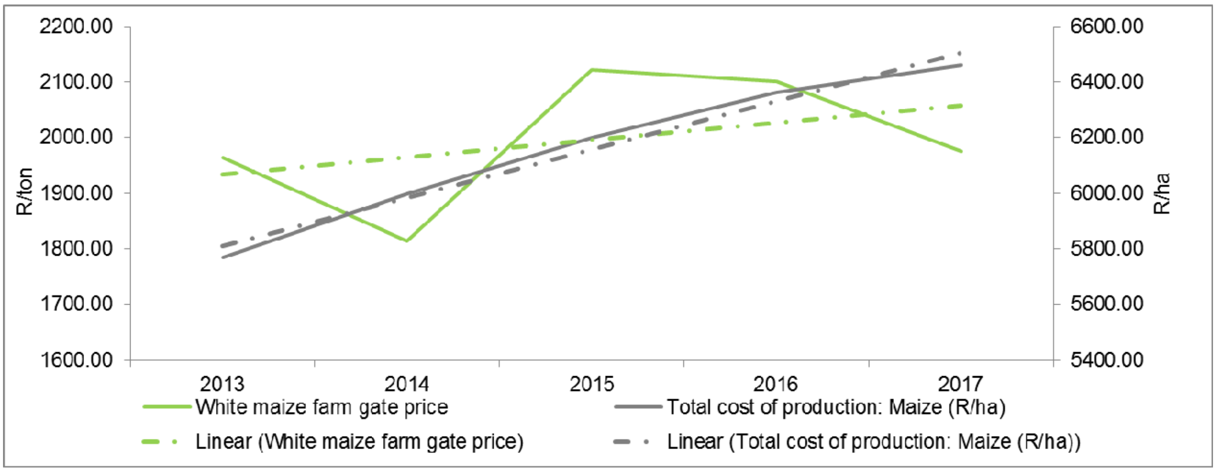


Figure 40: White maize commodity price vs. total production cost (R/ha) (2013–2017)

Source: Own calculations

It is important to keep in mind, however, at what rate the respective variables could increase. Figure 41 illustrates the respective rate of increases over the period 2013 to 2017. The figure represents the relative annual change in percentage and their respective linear trend-line.

The total cost of production, as presented in Figure 40, will increase over the identified period, but at a slower annual rate. It can also be noted from the graph that a constant declining growth rate in input expenditure is expected. On the other hand, the white maize farm gate price indicates a relatively sideways to marginally decreasing trend-line over the period. However, annual changes in the white maize price still remain extremely volatile, especially from 2014 to the end of 2016. This effect was discussed earlier and can be attributed to demand and supply mechanisms and responses.

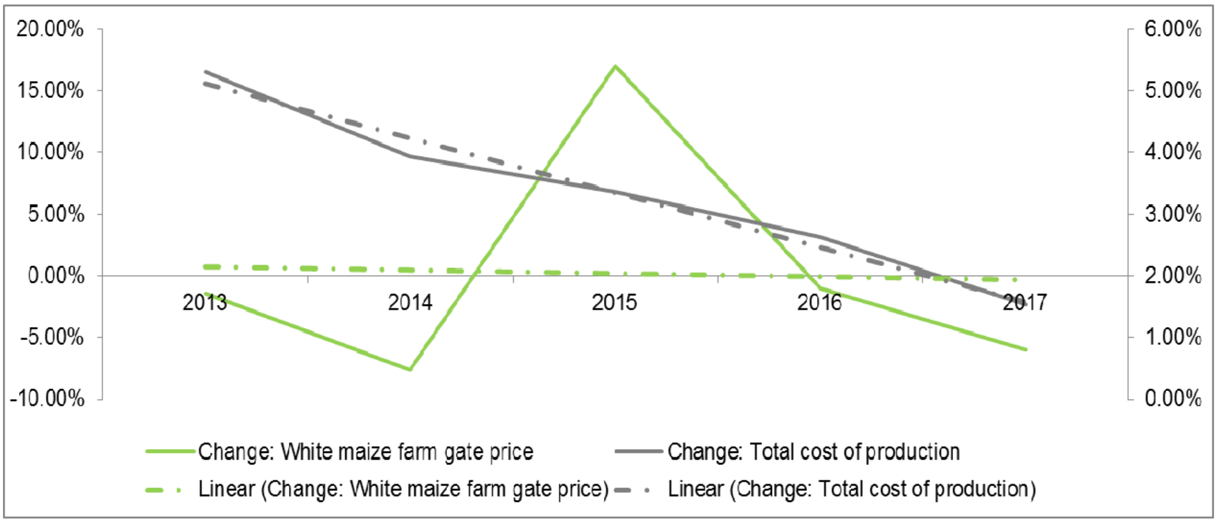


Figure 41: Rate of change: Maize farm gate price and total production cost (2013–2017)

Source: Own calculations

Figure 40 and Figure 41 therefore illustrate that sufficient gross margin levels for white maize production will become more intense in the future due to a sharper increase in input expenditure and a relatively volatile white maize farm gate price. When consider performance in real terms, cost pressures might be more severe in the future, which creates a question mark around whether farm businesses will be able to compete against annual inflation.

The answer to this lies in the concepts of productivity and increased efficiency in agricultural production. The preceding section focused on the cost per hectare and did not incorporate possible yield increases in the long term. Figure 42 presents a similar graph to Figure 40, but the production cost in the former is reflected in Rand per ton.

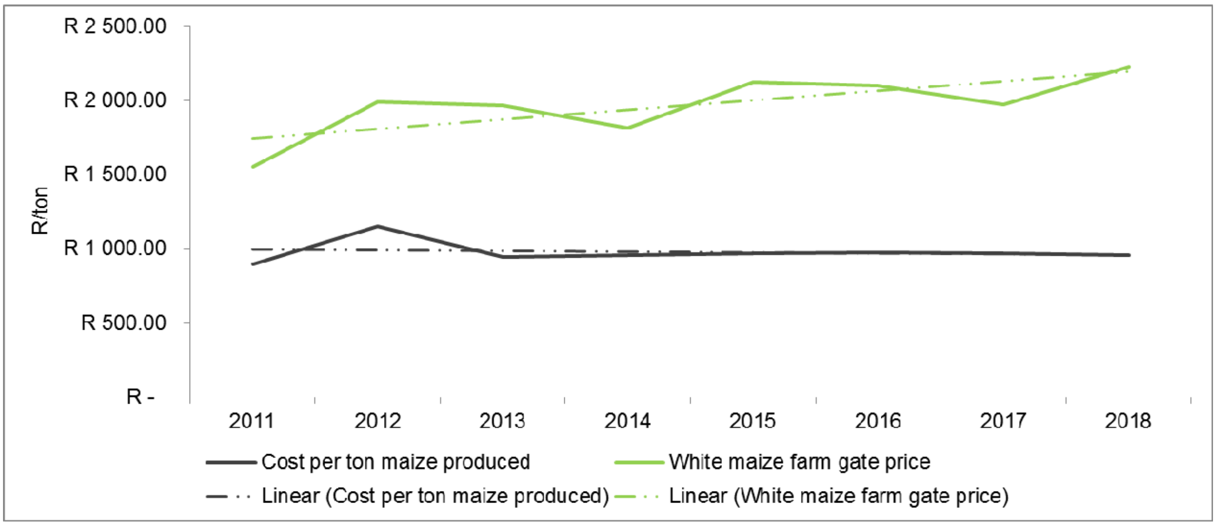


Figure 42: White maize commodity price vs. production cost per ton maize produced

Source: Own calculations

It is evident from the figure that the white maize farm gate price increases at a faster rate when the production cost is reflected on a per ton basis. This provides a contrary picture to that in Figure 40 and indicates that farm businesses could compensate for increasing input expenditure through increased productivity.

Figure 43 illustrates the sunflower input composition for the northern and western Free State farm business and represents only selective inputs. The red line (secondary axis) represents the total cost of production. It can be seen from the graph that the two key inputs in sunflower production are fertiliser and fuel costs. It is projected that the cost of fuel could increase by R254 per hectare from 2011 to 2018. The cost of fertiliser, on the other hand, is expected to move relatively sideways to a marginal increase over the baseline period. The cost of fertiliser and fuel is projected at R1659 and R756 respectively per hectare by 2018.

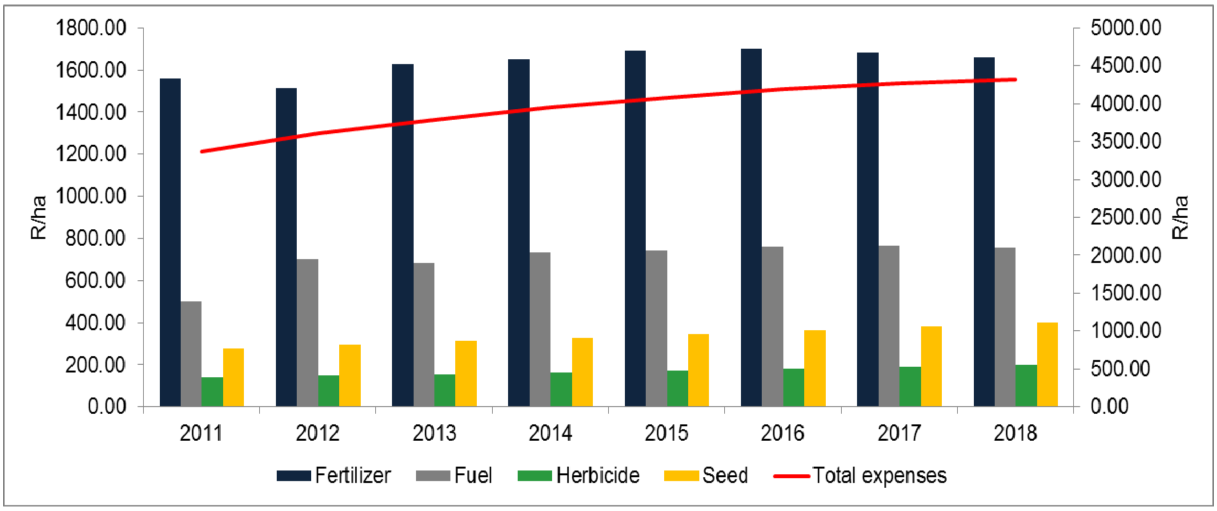


Figure 43: Selective input expenditure for sunflower production (2011–2018)
Source: Own calculations

The commodity prices for white maize and sunflower production with the respective input expenditures were discussed in the preceding section. The combination between these key drivers in the decision-making environment of farm businesses together with anticipated yield levels establishes a platform for gross margin analysis. The latter, as stated earlier, is extremely important in determining whether a shift in hectares might occur in the future, specifically from a financial and enterprise performance point of view. The following section will focus on the relative performance of each enterprise by constructing basic gross margins for each enterprise.

4.4.3.3 Gross margin analysis

The gross margins for white maize and sunflower production are illustrated in Figure 44. The red and yellow lines represent the yield assumption for the baseline period. Both maize and sunflower gross margins experienced a decline from 2011 to 2012 due to drought conditions and less than average rainfall. The drought was particularly severe in the North West province and the northern and western Free State and caused lower yields that affected profitability.

The gross margin in 2011 for white maize and sunflower production was R3811 and R4457 per hectare respectively, which again shows that sunflower production was more profitable than white maize. Towards the end of the 2012 season, a higher commodity price for white maize resulted in a sideways movement in the respective gross margin per hectare. However, the gross margin for sunflower production declined significantly in the same period. The gross margin in 2012 is expected to range in the region of R3987 per hectare for white maize and R2293 for sunflowers.

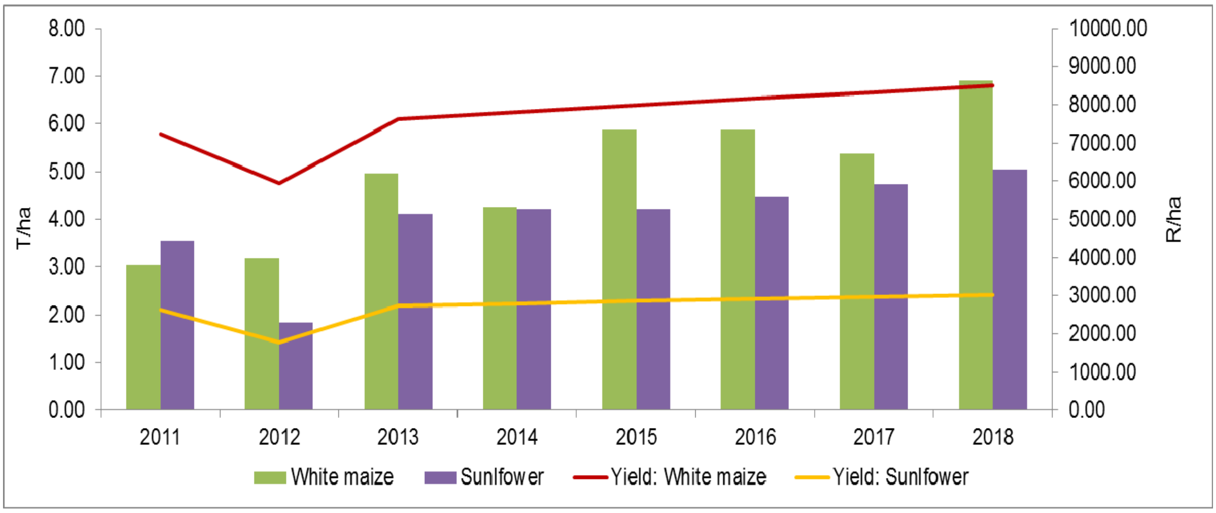


Figure 44: Gross margin analysis: white maize and sunflower production (2011–2018)

Source: Own calculations

The rest of the baseline period illustrates that white maize production will remain more profitable than sunflower due to high anticipated yields and the respective commodity price of white maize. What is interesting to note is the fact that a similar analysis (Figure 30) in the North West province indicated that sunflower production might be more profitable than white maize production in certain years. Since profit maximisation is one of the key assumptions in this study, it can be argued from Figure 30 and 44 that farm businesses in the North West would favour sunflower over white maize production. Furthermore, white maize production in the western and northern Free State will remain more profitable than sunflower production because higher white maize yields can be achieved in this region (Figure 33). It should be stated again that gross margin and enterprise sensitivity analyses supplement one another as they both provide indicators of the profitability and risk connected to different commodities.

Gross margin analysis and profit maximisation techniques give farm businesses a powerful tool to make decisions about land utilisation. It should be stated again that if all production factors and other external drivers are kept constant, the North West province will remain in favour of sunflower production above white maize. This is largely due to the respective yield levels of these commodities. In the northern and western Free State on the other hand, the opposite will prevail. Thus, white maize will remain the more profitable crop in the region. Finally, this does not take into account the introduction of other crops such as yellow maize and soybeans. Similar scenarios will be tested in Chapter Five.

4.4.3.4 Financial statements and indicators

The commodity price projections, input composition and yield assumptions were discussed earlier and the respective impact and linkage of these three key drivers on the profitability or enterprise gross margins were illustrated in Figure 44. It was stated in section 4.3.2.4 on p.65 that the overhead structure of a farm business also plays a significant role in its sustainability and performance due to various costs that cannot be directly allocated to a specific enterprise. However, these unallocated costs make up a great part of the overall management of the firm and without overhead or management related costs, a business cannot operate efficiently. The overhead structure refers to management, office, labour, finance, asset replacement, family living and other essential costs. In order to meet the research objective of evaluating the profitability and sustainability of representative farm businesses, the overall financial performance and the impact of the BFAP sector model on the northern and western Free State farm business should be analysed. The latter will be illustrated by a typical income statement and a summary of the key financial indicators of the farm business (Table 20 and Table 21).

The income statement for the northern and western Free State farm business is illustrated in Table 20 below. For the purpose of this exercise, only the 2011, 2014 and 2018 years are shown. It can be observed from the table that grain receipts are projected to increase substantially over the illustrated period, mainly due to an increase in the farm gate price of white maize. The table indicates that the total grain receipts in 2011 were R10.3 million. It is projected that the total income from grain and oilseed production can increase by approximately 24.84 % towards the end of 2014. By 2018, the total cash farm income might reach R17.01 million. Table 20 thus indicates the positive effect of increasing commodity prices (Figure 38) on the overall performance of the farm business, especially considering the gross revenue from production. It should be kept in mind that farm businesses in this region are able to reach above-average yield levels especially in white maize production. In addition, the total production and overhead expenses will increase over the identified period, but at a slower rate than cash income for farms.

Table 20: Income statement of the northern and western Free State farm business (2011, 2014 and 2018)

Description	2011	2014	2018
Cash farm income			
Grains	R10 301 613	R12 860 927	R17 013 053
Total cash farm income	R10 301 613	R12 860 927	R17 013 053
Cash farm expenses			
Grains	R6 054 038	R6 689 709	R7 290 913
Bank charges	R176 451	R210 354	R257 391
Farm utilities	R62 558	R74 578	R91 254
Fuel and lubricant (unallocated)	R102 474	R149 275	R154 388
Full-time labour	R215 203	R256 552	R313 919
Land rented	R437 100	R521 083	R637 603
Management salary	R87 000	R103 716	R126 908
Other cash expenses	R330 000	R393 405	R481 375
Repairs and maintenance	R87 540	R104 360	R127 696
Short term insurance	R92 000	R109 057	R132 053
Total cash farm expenses	**R7 651 486**	**R8 620 579**	**R9 623 888**
Farm gross margin	**R2 650 127**	**R4 240 348**	**R7 389 165**
Interest			
Interest long term debt	R218 022	R231 825	R218 104
Interest medium term debt	R221 022	R612 487	R758 714
Interest operating loan	R281 192	R356 694	R408 598
Total interest	**R720 236**	**R1 201 006**	**R1 385 415**
Net cash farm income	**R1 929 891**	**R3 039 342**	**R6 003 750**
Depreciation	R744 629	R759 224	R718 353
Net farm income	**R1 185 262**	**R2 280 118**	**R5 285 397**

Source: Own calculations

Table 20 further indicates that interest on medium term liabilities will increase significantly from 2011 to 2018. The total interest on medium term liabilities in 2011 and 2018 were R221 022 and R758 714 respectively. The reason for the substantial increase is the provision for asset replacement which the BFAP Finsim model incorporates. The assumption of the model is that in certain years where the farm gross margin is positive, the amount of assets replaced in that specific year will increase in comparison with previous years. However, an additional assumption of asset replacement is that a fixed percentage of assets replaced in a specific year will be financed by means of foreign capital or medium-term liabilities. This increases the cost of finance and interest on medium-term liabilities, as can be seen in Table 20.

The net farm income (NFI) can be utilised as a proxy for farm profitability and is shown in Table 21. In 2011, the NFI was R1.9 million. Towards 2014, the NFI is projected to increase by 92 % to R2.2 million. It is further projected that the NFI could increase to R5.2 million by 2018. As stated earlier, the fundamental reason for the increase is due to higher anticipated commodity prices.

Table 21: Key financial indicators of the northern and western Free State farm business (2011, 2014 and 2018)

Financial indicators	2011	2014	2018
Farm gross margin	R2 650 127	R4 240 348	R7 389 165
Net cash farm income	R1 929 891	R3 039 342	R6 003 750
Net farm income	R1 185 262	R2 280 118	R5 285 397
Total assets	R16 742 372	R23 771 924	R35 948 119
Total liabilities	R4 361 222	R6 743 911	R7 716 272
Net worth	R12 381 150	R17 028 013	R28 231 848
Debt to asset ratio (total debt/total assets)	26 %	28 %	21 %

Source: Own calculations

The debt-to-asset ratio is expected to decrease over the period because the value of assets is increasing at a faster rate than liabilities. The increasing value of assets is due to the amount of excessive cash available (after family living expenses) after a specific financial year, re-invested in the farm business. Thus, the opening cash balance or reserves remain to increase over the baseline period, and this forces the debt-to-asset ratio to decrease.

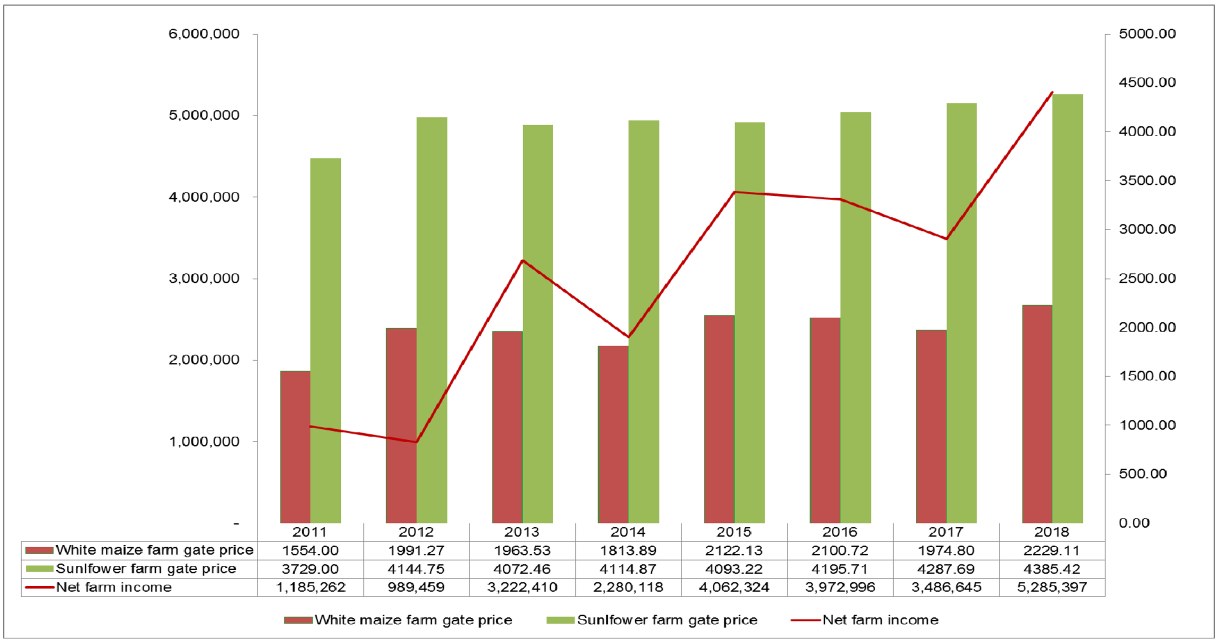


Figure 45: NFI of the northern and western Free State farm business (2011–2018)

Source: Own calculations

Figure 45 illustrates the linkage between commodity price projections and NFI. The primary axis (red line) represents the NFI of the northern and western Free State farm business over the baseline period. The green and red bars (secondary axis) illustrate the white maize and sunflower farm gate price projections for the same period. What is interesting is the theory of economies of scale which can be observed from the figure. The OECD (2002) defines economies of scale as the phenomenon where the average cost per unit of output decreases with the increase in scale or magnitude of the output of a farm business. In this case, the hectares used by the farm business serve as a perfect example that if hectares under production increase, the total overhead and production costs become relatively cheaper. It is clear from the figure that a small increase in the commodity price causes a substantial increase in the total profitability of the farm. The opposite is true for a decrease in commodity prices.

Finally, the average projected NFI over the baseline period is R3.06 million, indicating that farm businesses in the northern and western Free State will remain profitable in the long term given the current outlook of the BFAP sector model projections. Secondly, the assumption that farm businesses will re-invest their positive cash balance after a specific financial year demonstrates that the sustainability of these firms is plausible in the long term. The question whether a shift can be expected in land utilisation should be verified by introducing macroeconomic and production scenarios, since numerous shocks may occur which could impact the respective financial position significantly. This refers to examples such as if the maize commodity price reverted to its traditional low levels. This would mean that the profitability of enterprises would decrease because of production input inflation, which normally increases annually. A second example refers to the assumption that normal weather will prevail over the baseline period, which is highly unlikely. This also influences profitability and in a case where consecutive annual drought conditions are experienced, the impact on farm profitability may be devastating. However, the current and projected farm business position from a financial perspective looks very good, so current structure and production decisions may remain unchanged.

4.4.4 Conclusions and remarks

The preceding sections focused on the general and financial position of the representative farm business situated in the northern and western Free State. In addition, the impact of long-term projections made by the BFAP sector model on the farm business was illustrated to determine what long-term situation might prevail.

The respective yield levels for white maize and sunflower production in the northern and western Free State reflected extremely well. The latter favours enterprise gross margins significantly, which further boosts the overall profitability of the farm business. It was stated in Figure 34 that nitrogen application per hectare is relatively high compared to other regions such as the North West province. High nitrogen application in fact caused lower productivity. The higher nitrogen application indicates that a high fertiliser cost per hectare can be expected in this region.

Fertiliser and fuel as key and volatile inputs will remain the key inputs in this region and projections further stated that the cost of production will become more expensive in the future which farm businesses has to carefully manage. Production practises such as minimum tillage favour the farm business in the sense that fewer operations occur, which decreases the cost of fuel.

An interesting observation was the fact that the total cost of production is expected to increase at a faster rate than the white maize commodity price. The latter indicates a challenge to farm businesses since in real terms: profitability of enterprises may decline or experience a sideways movement.

The gross margin levels and projections reflected well and are expected to maintain this performance over the baseline period. Under the assumption that a farm business will re-invest the available cash at the end of a financial period into the firm, sustainability of the business is certain under the current BFAP sector model projections. This specifically refers to high white maize price projections over the baseline period, illustrated in Figure 38.

Thus, the general conclusion of the analysis is that farm businesses in this region will continue with current production trends. The historical production trend of white maize land utilisation will most likely continue since white maize production is expected to be more profitable than sunflower production. This excludes assumptions such as the introduction of new crops in the specified region.

4.5 EASTERN FREE STATE

The following section will focus on the representative farm business in the eastern Free State by interpreting and analysing the farm background, structure, production systems, profitability and over-all farm performance. Since the identified farm business was included in the study during 2012, limited historical data is available. However, an attempt will be made to illustrate the farm business's basic historical trends and position. Thereafter the 2010/2011 production season will be used as a platform or base year in order to determine the long term impact by the BFAP sector model.

At this stage of the study, it is important to revise and summarise the research objectives. Firstly, it is important to determine whether a shift in hectares might occur in the intermediate to long term, which is supplemented by farm business decision-making criteria. Various drivers impact the decision-making environment of a farm business and it is important to determine these drivers and evaluate how they might change in the future. Secondly, a key objective of this study is to identify representative farm businesses in selective regions in the summer rainfall distribution area and determine their current financial position. In addition, projections made by the BFAP sector model will impact the current position of the identified farm businesses and therefore it is important to determine the long term impact of these anticipated drivers and projections. Thirdly it is important to validate whether the anticipated macroeconomic and production projections are plausible at farm level. An interface can be created between the BFAP sector and farm-level models by integrating the drivers between the two agricultural environments. Finally it is important to create long term macroeconomic and production scenarios in order to illustrate how the situation may change and the relative impact at farm level.

The description and background of the representative farm, historical trends, the current state of farming businesses and long-term projections for the eastern Free State representative farm will be discussed in detail, based on the Standard Operating Procedure (SOP) and the integration of the BFAP system of linked models.

4.5.1 Farm background

The representative farm in the eastern Free State is situated in the Reitz/Petrus Steyn region and produces maize and soybeans as summer crops and wheat as a winter crop. The total size of the farm is 1677 hectares. Arable farming in this region is generally supplemented by a livestock component, which provides diversification and risk dispersion. The average annual rainfall ranges between 760 and 800 millimetres, mostly during the summer. The annual rainfall in this region is generally good, but sufficient rainfall especially at critical production stages is a problem in certain years.

A combination of tillage systems is used in the eastern Free State and these vary from minimum to conventional tillage. For the purpose of this analysis, the anticipated approach is a conventional tillage system with predominantly conventional ploughing or deep soil cultivation. Farming is generally dryland arable production with some irrigation enterprises spread over the region. However, the standard operation procedure (SOP) rejected an irrigation enterprise and this will therefore be excluded in this section. The annual cropping rotation of the farm business is soybean/maize/fallow/wheat where maize and soybean production make up the main enterprises. The total turnover composition in the 2010/2011 production year can be demonstrated as follows: Maize, as the main enterprise, contributed 44.2 % towards the total turnover. The contribution of soybean and wheat production was 14.9 and 17.1 % respectively. It should be noted that insufficient rainfall and drought conditions during the 2010/2011 production season caused yields of summer crops to decline significantly compared to long-term averages. Other farm income such as contracting work, livestock income and leasing of machinery contributed a total of 23.9 % towards the total turnover of the farm business.

A typical maize production system involves planting maize in mid-October and harvesting is done from May to June the following year. The soybean seeding period starts at the end of October and harvesting takes place in May the following year. Wheat is planted in June and harvested the same year in December. Since the study only focuses on summer crops, wheat production will be excluded from this section; however, it will still be included in the overall performance of the farm business.

In the 2010/2011 season, a total of 387 hectares was used for maize production on the representative farm. The total soybean area consisted of 249 hectares and wheat production accounted for 198 hectares. The rest of the arable land was left fallow. Figure 46 illustrates the hectare mobility of the eastern Free State farm business from the 2008/2009 to 2010/2011 production period. It can be observed from the figure that maize hectare utilisation decreased substantially from the 2008/2009 to 2009/2010 season. The total area under maize production in 2009/2010 was 320 hectares, approximately 43.04 % lower than in 2008/2009. A further decrease of 18.12 % occurred from 2009/2010 to 2010/2011 to 262 hectares. The soybean area indicated a similar trend and declined by 124 hectares from 2008/2009 to 2009/2010 and then increased to 169 hectares in the 2010/2011 production period.

According to Grain SA data (2012), the average SAFEX yellow maize price from 1 July 2009 to the beginning of October 2009 averaged at R1285.85 per ton, approximately R629.37 per ton or 32.86 % lower than the same period in 2008. With a silo differential of R117 per ton at that stage it would have implied a farm gate price of R1168.85 per ton, which could definitely discourage a farm business's decision regarding land allocated to a specific commodity. This can be observed in the case of maize hectare mobility from 2008/2009 to 2009/2010, which decreased substantially (Figure 46). A similar decline occurred in the producer price of soybeans from 2008 to 2010 which again is an important driver of land utilisation decisions (BFAP sector model, 2012). As stated earlier, a farm business will normally conduct numerous analyses such as gross margin budgets and sensitivity analysis before a decision is made regarding what crop to produce in a specific year and to what extent. If these analyses indicate a bearish nature, production of the specific commodity may decline in that year. This shows that commodity prices remain a key driver in the decision-making environment of farm businesses.

The total hectares under maize and soybean production in the 2010/2011 production period were 262 and 169 hectares respectively, and this forms the base on which projections will be made later in the section.

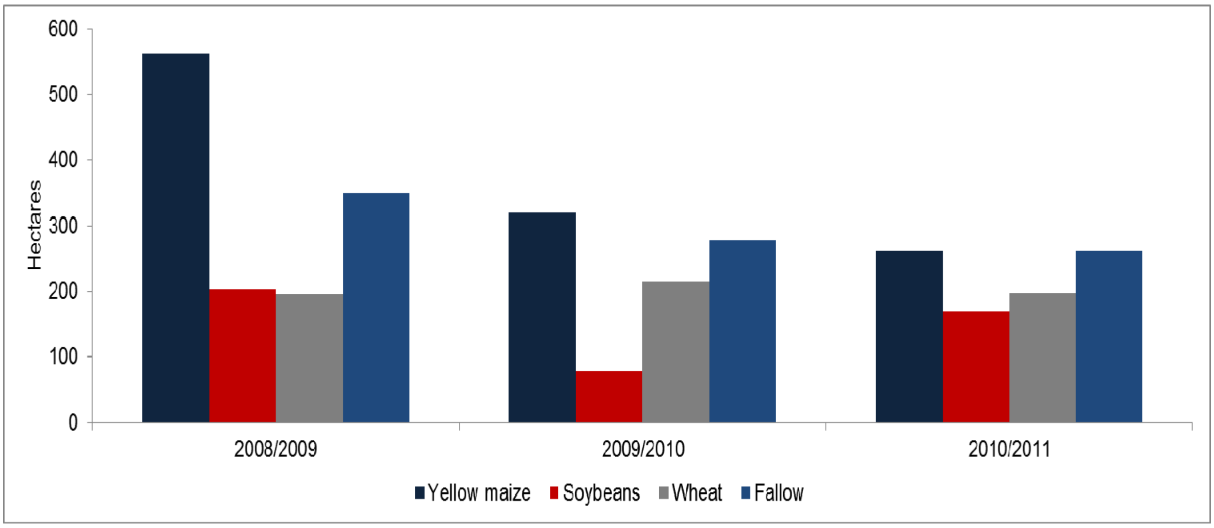


Figure 46: Hectare mobility of the eastern Free State farm business (2009–2011)
Source: Own calculations

What is important to note is that this farm business relies predominantly on a summer fallow period in order to produce wheat during the winter. Since rainfall is normally limited during the winter, the summer fallow period is used as a moisture conservation technique in order to build up sufficient soil moisture for the winter crop. The reason why this is mentioned is that it influences the number of hectares available for summer crops. In a scenario where wheat production shows unprofitable margins in the future, an increase in summer crops can be expected.
Finally, the general strategy of the farm business is intensive focus to keep fields clean from herbicides and moist conservation. From a financial perspective, profit maximisation and diversification are key drivers in the farm business. Annually, 45 % of the available overdraft facility will be utilised and asset replacement for vehicles will occur at a fixed rate of 8 % and 6 % for implements and machinery.

The following section will focus on a basic overview on historical trends, the current state of the farm business and projections made by the BFAP sector model and the respective impact at farm level. The sub-categories will focus on yield performance, the respective commodity input compositions, gross margin analysis and the overall farm business performance.

4.5.2 Historical trends

The eastern Free State farm was introduced into the study in 2012, thus concrete historical data are not available. However, certain key historical trends will be outlined in the following section with the focus on previous yield levels, farm gate prices, selective input expenditure and historic gross margin indicators.

4.5.2.1 Yield levels and farm gate prices

The historical yield trends of the eastern Free State representative farm business are illustrated in Figure 47 below. It can be seen that both maize and soybean yields were low in 2010/2011 due to insufficient rainfall. The yield for yellow maize and soybean in the period was 3.92 and 1.02 tons per hectare respectively.

Yellow maize performed particularly well in 2008/2009 and 2009/2010. The yield reported in 2008/2009 was 13.45 % higher than in the year before. In the 2010 harvest, the yellow maize yield declined marginally to 5.38 tons per hectare. The four-year average yellow maize yield was 4.98 tons per hectare.

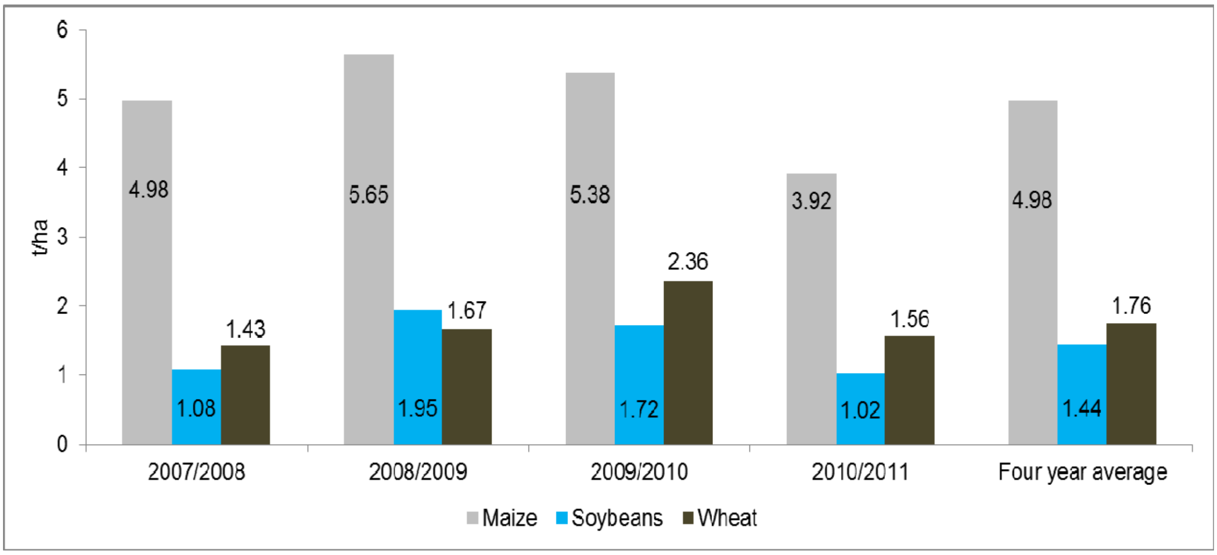


Figure 47: Historical yield trends of the eastern Free State farm business (2008–2011)
Source: Own calculations

The soybean yield in the eastern Free State was unsatisfactory in the 2007/2008 and 2010/2011 seasons. The reported yield in these years was 1.08 and 1.02 tons per hectare, which had a significant impact on gross margin profitability, as will be seen later in this section. However, the soybean yield was particularly good in 2008/2009 and 2009/2010. The average yield in these two years was 1.95 and 1.72 tons per hectare, which was above the national average of 1.19 and 1.66 tons per hectare respectively (PRF, 2012). The four-year soybean average yield was 1.44 tons per hectare at the end of the 2011 production season.

The yield, price and input combination analysis of wheat production in the eastern Free State and the respective impact on gross margins will be explained later in the section. Since the profitability of wheat may impact the area under summer fallow, a brief attempt will be made to determine whether there might be a shift in land use.

Figure 48 represents the farm gate price of yellow maize and soybeans from the 2007/2008 to 2010/2011 production periods. Is should be kept in mind that a farm gate price and the SAFEX price are not the same since the farm gate price makes provision for certain deductions due to silo differentials and fees. Thus, the farm gate price is the actual income per ton that a farm business records.

Figure 48 indicates that both yellow maize and soybean commodities reported declining price trends from 2007/2008 to 2009/2010. The yellow maize farm gate price realised in 2008 was R1577 per ton. At the end of 2009, the average yellow maize price was R1480 per ton, approximately 6.15 % lower than in 2008. Then there was a major drop in the yellow maize commodity price and a decline of R378 per ton was reported. However, towards the end of the 2011 season, the price of yellow maize recovered and shifted back to R1427 per ton.

The average soybean farm gate price in the 2009/2010 season was R2456.50 per ton, 39.12 % lower than in 2008 and 26.42 % lower than in 2009. Towards the end of the 2010 production period, soybean farm gate price recovered marginally and increased to R2873 per ton. However, low yield levels practically caused a negative enterprise margin, as will be seen later in the section.

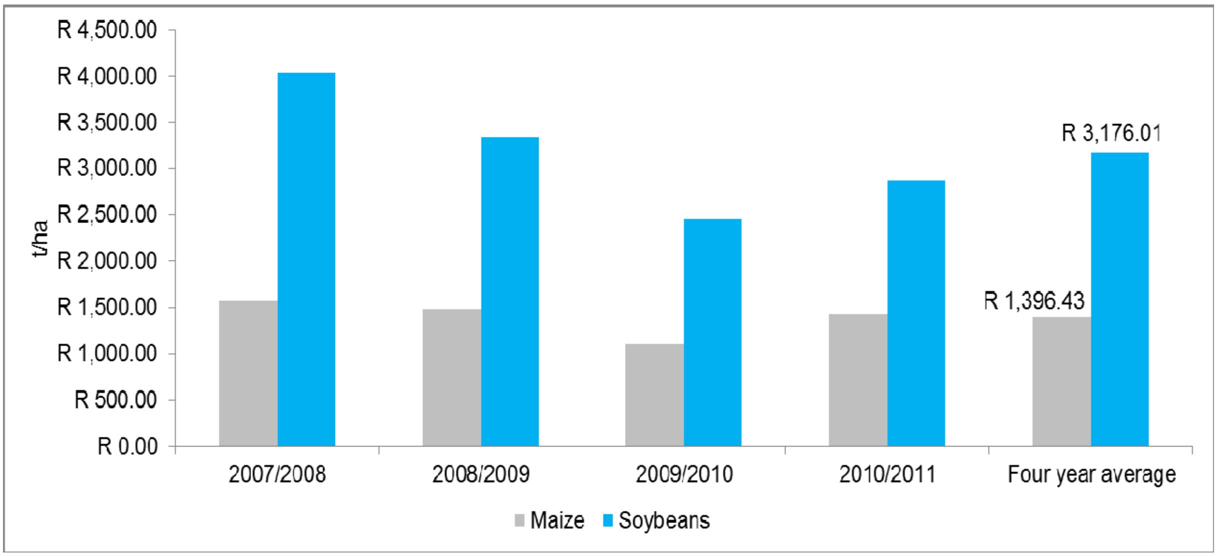


Figure 48: Maize and soybean farm gate prices (2007/2008–2010/2011)
Source: Own calculations

It was stated in earlier sections that the linkage between a commodity price and the decision of land utilisation is an extremely important driver and useful indicator. If one combines Figure 46 and Figure 48, one could argue that the lower farm gate price caused a reduction in hectare utilisation, as can be seen in Figure 49.

The primary axis illustrates the hectare mobility of yellow maize and soybean production from 2008/2009 to 2009/2010. The secondary axis illustrates the substantial drop in the farm gate price of yellow maize and soybean commodities.

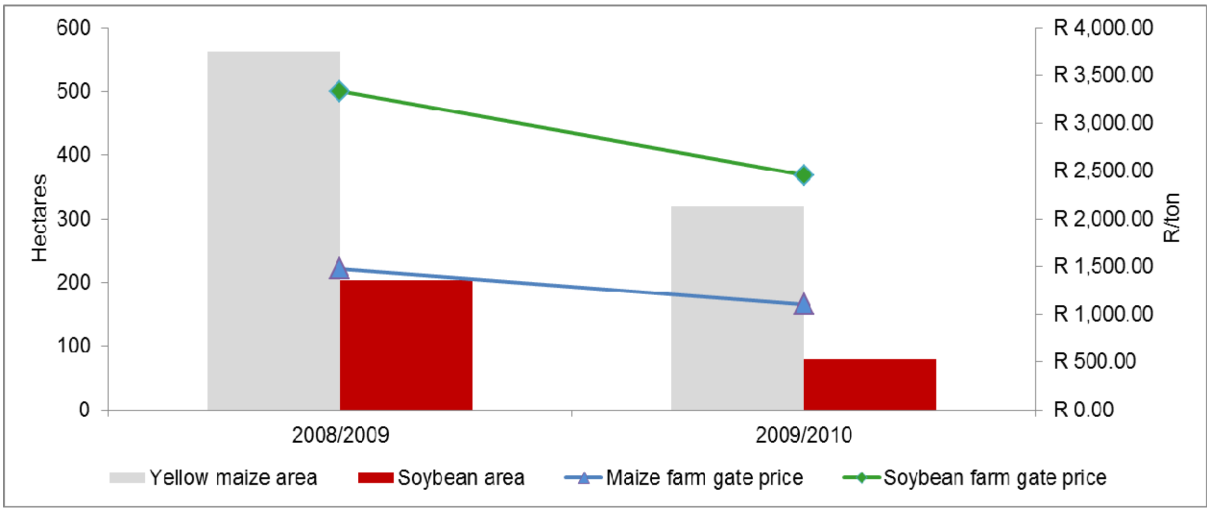


Figure 49: Linkage between farm gate price and hectare utilisation (2008/2009 and 2009/2010)
Source: Own calculations

The assumption made here is that farm businesses will have access to commodity market futures prices, which indicates that a farm business can be aware of certain commodity price trends and future directions. This is illustrated in Figure 50 below. It can be noted that the SAFEX commodity derivatives for white and yellow maize illustrate the anticipated future prices based on a set of market information, macroeconomic and other drivers. Thus, farm businesses can identify beforehand in what direction a commodity price may shift. For example: The mark to market (MTM) price on 27 September 2012 for white maize deliveries in September 2013 was R2150 per ton.

JSE JOHANNESBURG STOCK EXCHANGE
SAFEX Commodity Derivatives

Domestic Futures Prices 27-Sep-2012

Contract	Change	Closing Bid	Closing Offer	MTM	VWAP	High	Low	Volume	Open Interest	Option Volatility
WHITE MAIZE FUTURE										
Oct-2012	74.00	2262	2265	2265.00		2273.00	2140.00	276	342	0.00
Dec-2012	52.00	2297	2300	2289.00 X		2306.00	2172.00	3950	19555	26.50
Mar-2013	57.00	2312	2315	2315.00		2321.40	2195.00	636	4377	25.00
May-2013	27.00	2122	2135	2132.00		2133.00	2120.00	11	164	26.50
Jul-2013	22.00	2102	2109	2102.00 X		2115.00	2050.00	520	3766	25.50
Sep-2013	0.00	0	2162	2150.00		0.00	0.00	0	1	0.00
YELLOW MAIZE FUTURE										
Oct-2012	60.00	2277	2290	2290.00		2290.00	2190.00	270	621	0.00
Nov-2012	21.00	2277	2313	2277.00		0.00	0.00	0	2	0.00
Dec-2012	71.00	2316	2321	2319.00		2321.20	2183.00	1841	12825	25.00
Mar-2013	58.00	2322	2330	2325.00		2326.20	2205.00	205	2355	25.00
May-2013	25.00	2130	2136	2135.00		2140.00	2120.00	19	204	26.00
Jul-2013	17.00	2090	2096	2095.00		2105.00	2068.00	162	3537	27.00

Figure 50: SAFEX commodity derivatives, 27 September 2012
Source: Farmwise, 2012

To refer back to Figure 49, the most likely cause for the reduction of maize and soybean area utilised (2008/2009 to 2009/2010) was the substantial drop in the commodity prices of yellow maize and soybeans, which discouraged production for that specific year.

4.5.2.2 Selective input expenditure

The selective input expenditure for yellow maize and soybean production is presented in Figure 51 and Figure 52 for the period 2007/2008 to 2010/2011.

Figure 51 clearly indicates that the cost of fertiliser was extremely volatile over the identified period. The total fertiliser expenditure in the 2007/2008 period was R574.40 per hectare and has increased by 250 % to reach R2011.60 per hectare in the subsequent year. The major increased can be supported by Figure 18 where the international fertiliser price spike in 2008 was illustrated. The total cost of fertiliser in 2009/2010 and 2010/2011 were R959.80 and R1360 per hectare.

The cost of fuel dropped between 2007/2008 and 2009/2010 but increased substantially towards the 2010/2011 period. As was stated in the northern and western Free State case study, the use of new technology has the advantage of increased efficiency and decreased fuel consumption and thus reduces the total cost per hectare. However, in years where the oil price is high and the exchange rate depreciates against the US dollar, farm businesses have to unfortunately incur the increased costs. It should be stated that in this particular case, it is a combination between increasing cost of fuel due to international and macroeconomic drivers and more field operations in that particular year. The assumption in this case is that the farm business decided on deeper tillage in the 2010/2011 production season, which lessened efficiency and in the end forced up the cost per hectare.

Finally, the cost of seed increased at a relatively constant rate over the period with an average annual increase of 25.18 %. In agricultural terms and especially seed expenses, a 25.18 % annual increase is significantly high. The latter is not necessarily due to an increase in the cost of a specific variety, but rather a shift to more advance varieties such as genetically modified organisms (GMOs) which are more expensive. The total cost of seed in the 2010/2011 production season was R658.80 per hectare, 92.18 % higher than in 2007.

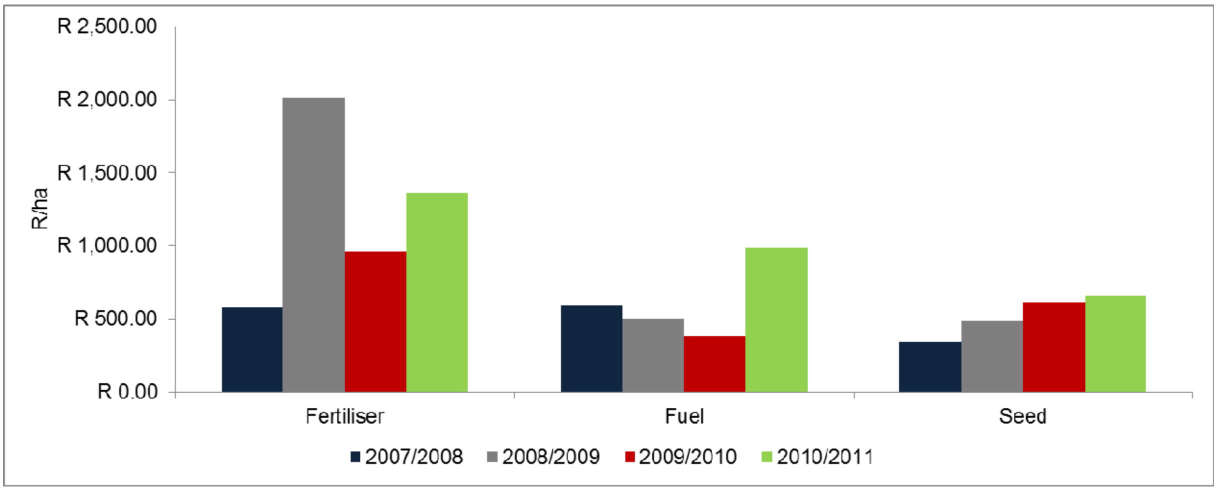


Figure 51: Selective maize input expenditure for the eastern Free State (2007/2008–2010/2011)

Source: Own calculations

Figure 52 represent selective input expenditure for the production of soybeans from 2007/2008 to 2010/2011. Fertiliser expenses indicated a similar volatile trend than maize. The impact of the international fertiliser price hikes in 2008 (Figure 18) can clearly be observed in the figure. The cost of fertiliser has increased substantially from 2007/2008 to 2008/2009. The total cost of fertiliser in 2008/2009 was R915.30 per hectare, approximately 179 % higher than the year before. Towards the end of the 2010/2011 season, the total cost was R627 per hectare, 57 % higher than in 2009/2010 but 31 % lower than in 2008/2009.

In addition, the cost of fuel showed similar volatility to fertiliser over the period. The total cost of fuel in 2007/2008 was R281.20 per hectare and reported a significant increase of 82 % towards the end of 2009. From 2008/2009 to 2009/2010, fuel expenses decreased by 17.19 % to R423.80 per hectare. Thereafter, another fuel input shock occurred and fuel expenses rose by 85 % to R783.70 per hectare.

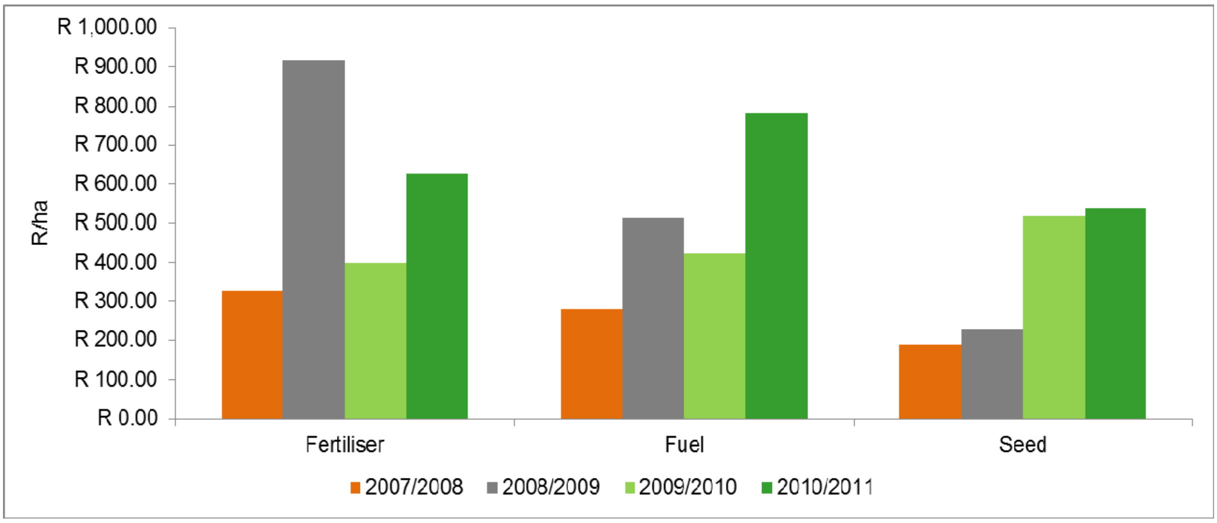


Figure 52: Selective soybean input expenditure for the eastern Free State (2007/2008–2010/2011)

Source: Own calculations

The cost of seed in the 2007/2008 and 2008/2009 production period was R189.20 and R228.60 per hectare respectively. Towards the end of 2010 and 2011, seed cost increased to R517.50 and R538.40 per hectare respectively. Two major drivers can influence soybean seed input inflation. Firstly the ability of farm businesses to restrain seed from the previous crop which means that a certain amount of harvested seed in a specific year will be kept aside for the following planting season. The latter is a common practise in South Africa. The second driver that impacts the cost of seed is the robust linkage between the respective soybean commodity price (domestic or world reference price) and the cost of seed as agricultural or direct input. Since availability of historical data is restricted in the case of the Eastern Free State, the assumption can be made that in 2007/2008 and 2008/2009 the farm business utilised the previous harvested seed for reproduction and a fixed amount of expenditure was incurred for seed treatment and/or the acquisition of new varieties or additional seed.

4.5.2.3 Enterprise gross margin analysis

The eastern Free State farm business's historic gross margins are presented in Figure 53 below. The orange and green bars illustrate the gross margins for maize and soybeans respectively and a four-year average has been included in the graph. The general perspective that can be obtained from the graph is that yellow maize production outperforms soybean production. The four-year average gross margin illustrates that, on average, the yellow maize margin was R1305 per hectare higher than soybeans.

However, an important factor should be kept in mind when analysing the farm's enterprise performance, which is the advantages of crop rotation, especially maize/soybean rotation. Numerous studies have demonstrated the advantages of combining soybean production with maize instead of producing maize on a monoculture basis. It has been estimated that maize yields increased on average between 5 % and 20 % higher in a crop rotation with soybeans than producing maize continuously (Bullock, 2008). Soybean production releases a fixed amount of nitrogen into the soil which is available for uptake by the following maize crop (Kasasa, Mpepereki, Musiyiwa, Makonese and Giller, 1999), so that the maize crop requires less nitrogen (Schlegel, Dhuyvetter and Schaffer, 1994). Thus, the conclusion can be made is that there are three major advantages to having a soybean crop as part of a production system rotation, namely, increased yield due to improved soil fertility and nitrogen fixing by soybeans, increased maize yields in the subsequent year due to releases of nitrogen by soybeans and a decrease in input expenditure as less fertiliser is required.

Thus, if one refers back to Figure 53 it should be kept in mind that the higher gross margin of maize is greatly supplemented by the soybean crop that forms part of the important rotation. Soybean production therefore increases the maize yield and decreases the amount of nitrogen it requires, which decreases the input costs of maize production.

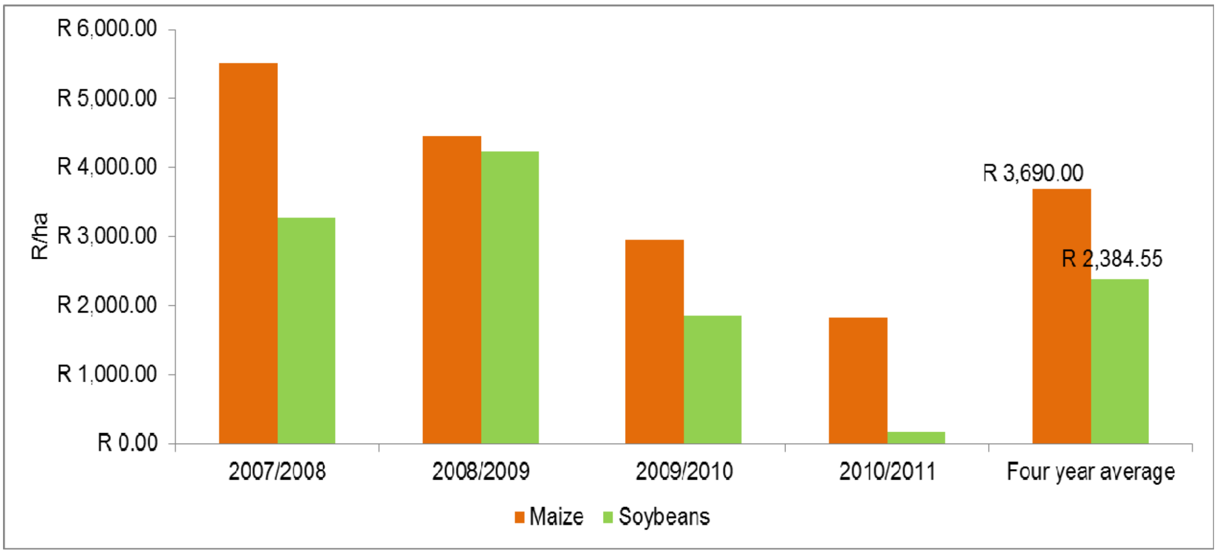


Figure 53: Enterprise gross margin analysis (2007/2008–2010/2011)
Source: Own calculations

Figure 53 can be further interpreted by observing the actual annual performance of maize and soybean production. In the 2007/2008 season, the total gross margin for maize and soybeans was R5511 and R3269 per hectare respectively. In the subsequent year, the gross margin for maize production decreased by 19 %. Soybeans reported an increase of 29.48 %, mainly due to a substantial increase in yield levels. Both maize and soybean gross margins reported decreases from 2009 to the end of 2010. The 2010/2011 season can be characterised as a year where there was insufficient rainfall, which had a devastating effect on the gross margin of soybeans. The gross margin of soybean production in overall terms showed a loss when taking overhead costs into consideration. The production of maize still indicated a positive margin, but a major decrease from the preceding year and when compared to a four-year average. The drought in 2010/2011 indicates that soybean production possesses a relatively high production risk due to its sensitivity to insufficient water.

Risk management and dispersion are important drivers in the decision making of farm businesses. This means that there is a marginal trade-off between certain production advantages such as rotational enterprises, diversification and production and other risk factors. The latter especially refers to the fact that maize yields increase when rotated with soybeans, but in years of too little rain, the gross margin of soybeans may substantially underperform, which will affect the net profit outcome. The general conclusion is that the economic value of rotations and risk trade-offs could determine whether there might be a shift in hectares in future. Simultaneously, the fact that soybean production is sensitive to insufficient rain will influence farmers' decisions about land utilisation, especially in regions where drought is a regular occurrence. Thus, the assumption can be made that in regions where lower annual rainfall is expected, the decision to shift to a rotational system such as maize and soybeans might be more complex than in regions where there is more reliable rainfall.

4.5.3 The current state and impact of the BFAP sector model projections at farm level

The following section will analyse the effect of the BFAP sector model projections for the eastern Free State farm business, using the 2010/2011 production year as a baseline, and then integrate these projections with the BFAP farm-level model.

Table 17 and Table 18 illustrated the key baseline assumptions and indicators that would have an impact at farm level. However, Table 18 should be updated in order to make provision for soybean commodity price projections. Table 22 illustrates the updated key baseline indicators and projections for the eastern Free State farm business.

It can be observed from the table that farm gate price projections for wheat reflect better than the historical farm gate price, which on average was R2313.71 per ton from 2009/2010 to 2010/2011. The average BFAP sector model projection for the farm gate price of wheat is R3216 per ton over the baseline period (2012–2018) and this will boost gross margins significantly. The assumption can therefore be made that farm businesses in the eastern Free State will be encouraged to grow wheat in the long term and the leave the land fallow in summer. The farm gate price for soybeans is expected to increase by 34 % from 2011 to 2012 and an additional 11 % increase to 2013. However, a substantially decline is projected towards the end of 2014.

Table 22: Key baseline indicators and projections (2011–2018)

Description	2011	2012	2013	2014	2015	2016	2017	2018
Yellow maize price index (%)	Base year = 100	141	143	116	121	124	127	130
Soybean price index (%)		134	145	110	117	123	127	130
Wheat price index (%)		122	122	112	114	117	120	124
Fuel cost index (%)		140	136	146	148	151	152	151
Fertiliser cost index (%)		97	104	106	108	109	108	107

Source: Own calculations

For the remainder of the section, Table 17 and Table 22 will form the fundamentals of the projections that will be illustrated in the eastern Free State farm business analysis.

4.5.3.1 Yield and commodity price projections

It was stated in previous sections that the yield, price and input combination determine the farm business's enterprise gross margins, which serve as a profitability indicator. Since weather remains one of the key unknown factors, the assumption in the study is that normal rainfall/weather will prevail. However, from a realistic point of view, it is highly unlikely that normal weather will continue over the baseline period.

The yield projections for yellow maize and soybean production for the eastern Free State farm business are illustrated in Figure 54. The figure clearly indicates that in 2011 and 2012 drought conditions impacted yield levels negatively for both maize and soybean production. The severity of the impact can be noted when the yield levels are compared to the baseline average of 5.36 tons per hectare for yellow maize and 1.45 tons per hectare for soybeans. The average yield in 2011 was 3.92 and 1.02 tons per hectare for yellow maize and soybeans respectively. A marginal decrease is expected towards the end of the 2012 season for both commodities.

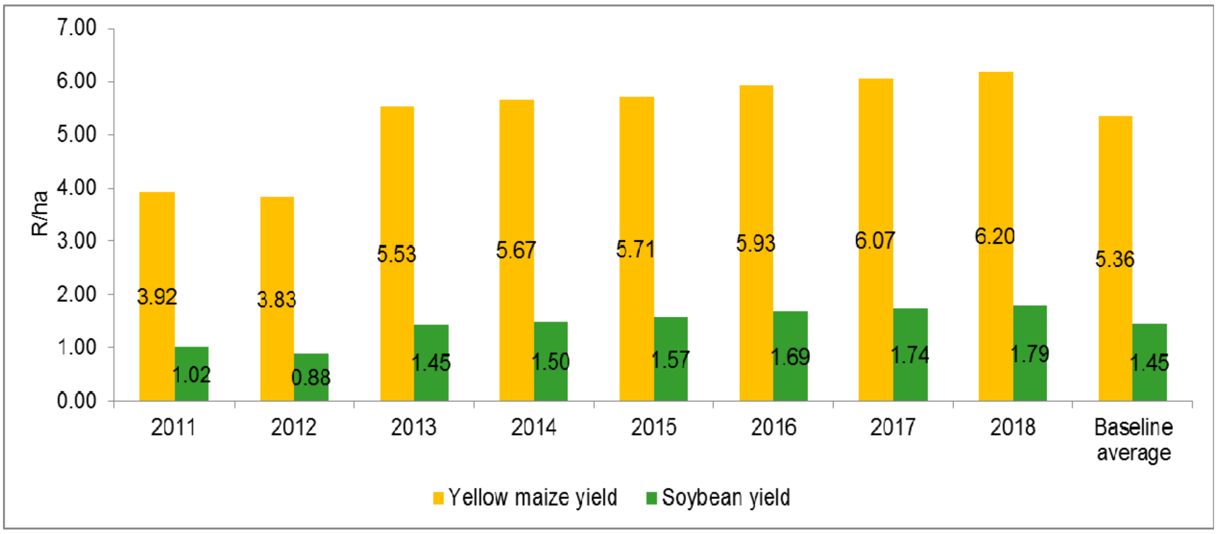


Figure 54: Yield projections for eastern Free State farm business (2011–2018)
Source: Own calculations

As stated before, the baseline average yield from 2011 to 2018 is 5.36 tons per hectare for yellow maize and 1.45 tons per hectare for soybean production. In addition, it can be observed that yield levels for both yellow maize and soybeans are expected to increase marginally over the baseline period due to the assumption that technology improvements, best farm practise and increased productivity will prevail. The respective yield levels illustrated in Figure 54 should be kept in mind when the gross margin analysis is conducted later in the section.

Figure 55 illustrates the farm gate price projections for yellow maize, soybeans and wheat from 2012 to 2018. The light blue line illustrates the average farm gate price projection for soybeans in the eastern Free State. The yellow line represents the average baseline price projection for yellow maize. The average price for soybeans is projected at R3543.08 per ton and yellow maize at R1788.44 per ton. The average wheat price is projected at R3216 per ton, which provides an indication that higher gross margins could be realised in the intermediate to long term, which has an impact on the area under summer fallow.

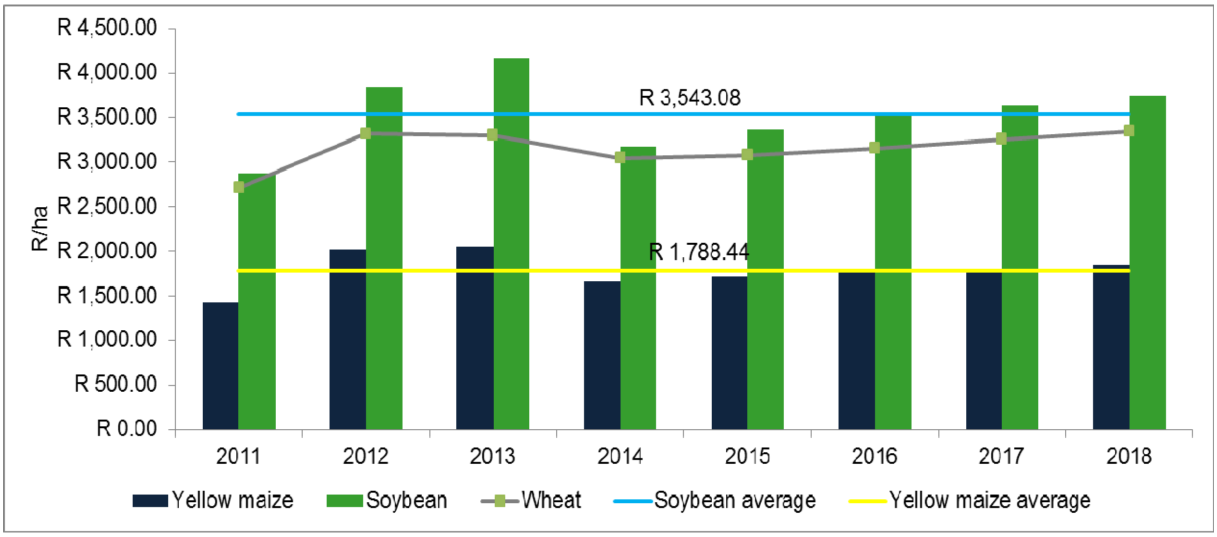


Figure 55: Farm gate price projections for eastern Free State farm business (2011–2018)

Source: Own calculations

The figure further illustrates that a decline in both the maize and soybean price could realise from 2013 to 2014. This is due to exceptionally high commodity prices in 2012 and 2013 which will trigger production (area increase) in the 2012/2013 season. Since normal weather is one of the key assumptions in the BFAP sector model, it is anticipated that the 2013 harvest will produce a bumper crop that may cause a supply shock and thus shift commodity prices to lower equilibrium levels in 2014. From 2015 to the end of the baseline period it is expected that both yellow maize and soybean farm gate prices will increase gradually. The anticipated 2018 farm gate price for yellow maize and soybeans are approximately R1852 and R3748 per ton respectively.

4.5.3.2 Input cost composition

Figure 56 and Figure 58 represent selective input expenditure for yellow maize and soybean production over the period from 2007 to 2017. Thus, the historical position is compared to what is expected in the long term. Figure 56 represents key maize expenditures, which can be categorised into fertiliser, fuel and seed expenses. Firstly, it can be observed that fuel expenditure is significantly higher than in the North West province and the northern and western Free State farm businesses (Figure 27 and Figure 39). In addition, it is expected that fuel expenditure will even be higher in the long term when compared to historical levels. It was illustrated in Table 22 that fuel expenses are expected to increase by 40 % from 2011 to 2012.

Thereafter, a marginal annual increase is expected towards the end of the baseline period.

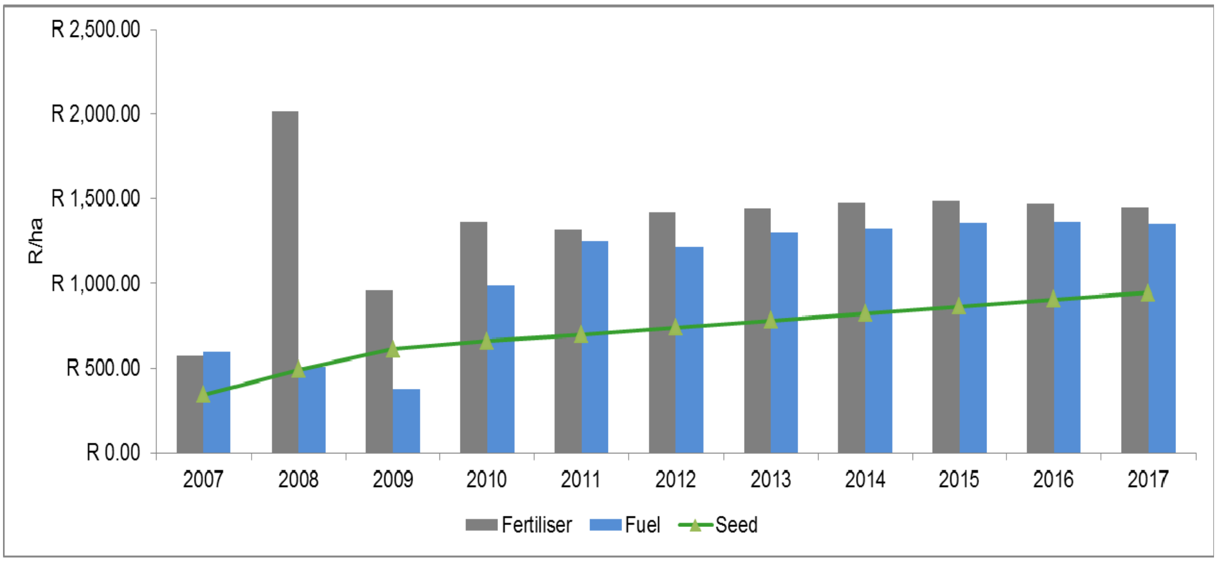


Figure 56: Selective input expenditure for maize production (2007–2017)
Source: Own calculations

The total cost of fuel in 2010 was R985.20, approximately 162 % higher than in 2009. Towards the end of the 2011/2012 period, it is expected that farm business might pay up to R1249 per hectare for fuel. Currently, fuel expenses are projected at R1349 per hectare by 2018. It should be stated that there is a possibility that the increase in fuel expenses from 2009 to 2010 was due to increased tillage in that specific year in order to engage in a deeper tillage operation to loosen up the soil. However, the assumption will remain that actual fuel expenses will continue to follow the BFAP sector model projections from 2010 onwards.

Secondly, Figure 56 illustrates that a marginal increasing trend in the cost of fertiliser will occur over the baseline period, but the anticipated fertiliser cost projections reflect higher than historical levels. When compared to the northern and eastern Free State, the cost of fertiliser in the eastern Free State is on average 90.84 % cheaper than in the western and northern Free State. When comparing the yield levels of these two identified regions, the western and northern Free State maize yield is only marginal higher than in the eastern Free State. It should be stated that two different types of maize are produced in the two regions, but the fact remains that incorporating soybeans into maize rotation could result in a reduction in fertiliser expenditure as is in the case of the eastern Free State representative farm. It is projected that the cost of fertiliser in 2013 and 2017 could reach R1442 and R1448 per hectare respectively, on average 6.29 % higher than in 2010.

Finally, the cost of seed is expected to increase gradually over the baseline period with an average annual increase of 5.20 %. Seed expenditure is projected at R945.62 per hectare in 2017/2018.

Figure 57 below illustrates the production cost measured on a per ton basis, thus, the actual expenditure to produce one ton of maize. The reason why this is included is to indicate productivity, which therefore takes into consideration improved yield levels of maize production.

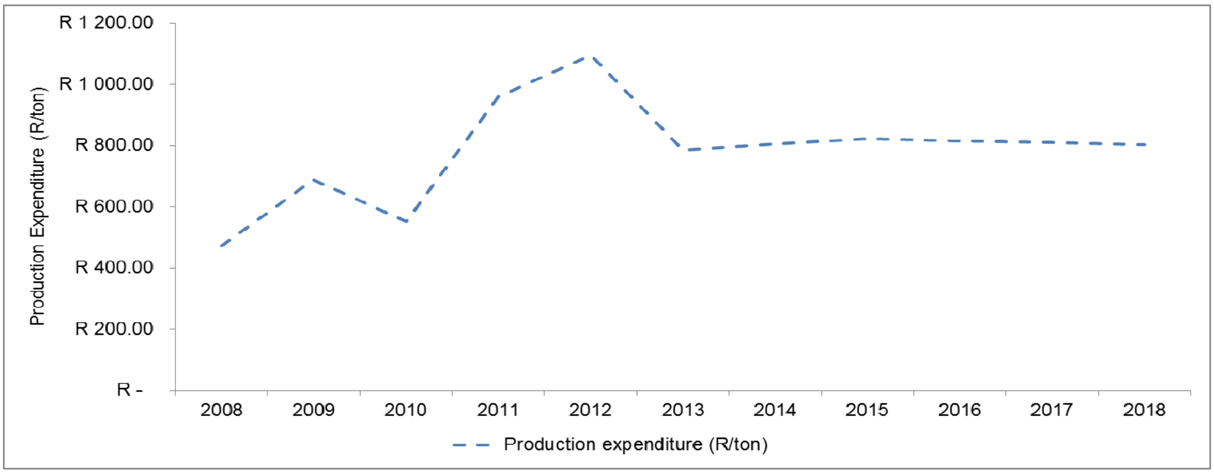


Figure 57: Maize production expenditure measured in R/ton (2008–2018)
Source: Own calculations

It can be observed from the graph that in 2011 and 2012 where lower yield levels occurred, the cost per ton increased significantly when compared to 2008–2010. The key assumption that normal weather will prevail over the baseline period further indicates that the cost per ton will trend sideways from 2013 to 2018. It is thus evident that farm businesses should aim to increase productivity levels in order to compensate for increased agricultural input expenditure.

Figure 58 illustrates selective input expenditure for the production of soybeans on the eastern Free State representative farm business. The grey and blue bars reflect the cost of fertiliser and fuel respectively. The green line indicates the cost of seed per hectare. What is important to note from the figure is that the cost of fuel exceeds the cost of fertiliser from 2009 to 2017. The average expenditure on fuel in 2009 and

2010 was R423.80 and R783.70 per hectare respectively. Towards the end of the 2013 production season, it is expected that farm businesses will spend up to R1141.63 per hectare on fuel. A marginal increase is expected for the remainder of the baseline period.

The total cost of fertiliser in 2009 and 2010 was R399.90 and R627.00 per hectare respectively. It is projected that fertiliser expenditure will follow a sideways movement towards the end of the 2017/2018 period. In addition, it is projected that the cost of fertiliser from 2012 to 2017 will not experience the same hike as in the case of the 2008 season. However, the model does not incorporate major policy reforms, which could lead to a recurrence of the 2008 input shock trend in fuels and fertilisers.

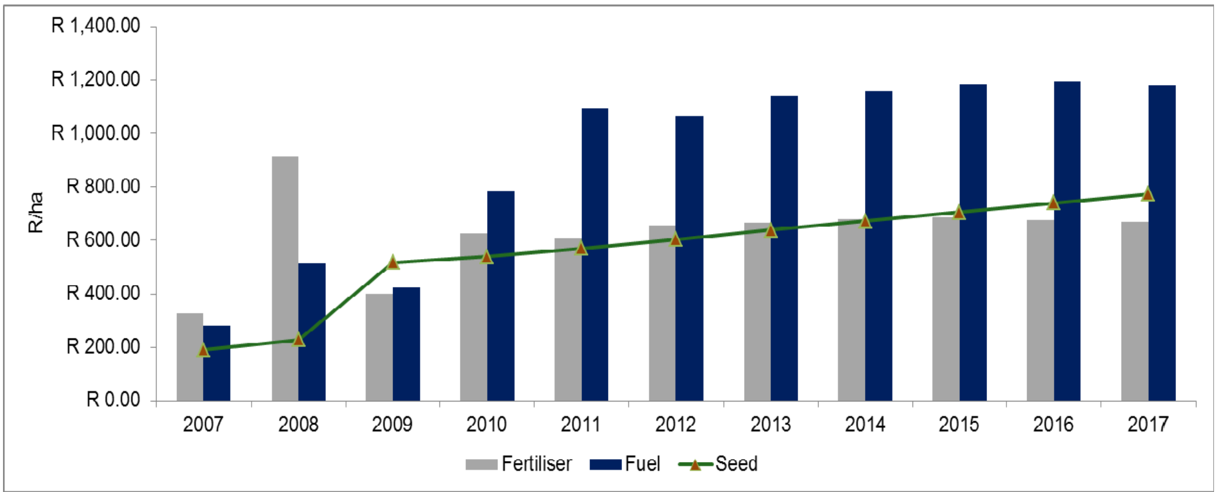


Figure 58: Selective input expenditure for soybean production (2007–2017)
Source: Own calculations

Finally, the cost of seed is projected to increase at a constant annual rate of 5.18 % over the baseline period. Soybean seed expenses in 2010 and 2011 were R538.40 and R570.70 per hectare respectively and are projected at R772.80 per hectare by the end of 2018. It was stated earlier that soybean expenditure could fluctuate annually due to sowing of previously harvested soybean seed. Since this is a complex task to incorporate in a farm-level model, the assumption can be made that farm businesses will continue to purchase new seed as was in the case in 2009, 2010 and 2011.

4.5.3.3 Gross margin analysis

The gross margin projections for yellow maize, soybeans and wheat from 2008 to 2018 are illustrated in Figure 59 below. It was stated earlier that the limitations of this study is to consider only the summer rainfall region and commodities, but since wheat is an important driver in the decision regarding summer fallow area utilisation, it has been included in the gross margin analysis and projections to evaluate the most likely long-term profitability.

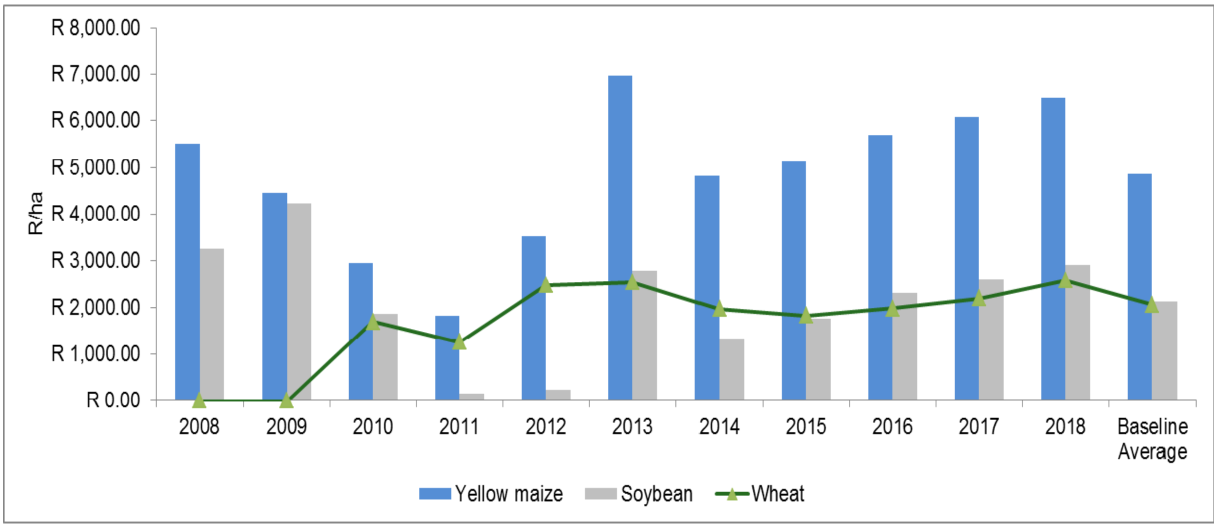


Figure 59: Gross margin projections for eastern Free State farm business (2008–2018)
Source: Own calculations

In general, Figure 59 illustrates that soybean gross margins will most likely not accomplish the same profitability levels as yellow maize over the baseline period. This is mainly due to the fact that historical yield trends were not favourable and thus future anticipated yield levels are lower. In 2009, however, the average soybean yield was 1.95 tons per hectare, which caused the gross margin to nearly correspond with yellow maize profitability. The assumption can therefore be made that it is essential to increase soybean yield in order to improve gross margin levels significantly and to compete with yellow maize profitability levels. On the other hand it was stated in section 4.5.2.3 on p126 that soybean production has a positive effect on yield levels of maize when utilised in a rotational production system. It can therefore be anticipated that the current high yellow maize yield levels which implies increased gross margin levels would not have realised in the absence of soybean production.

Figure 59 also shows that there is a relatively high risk associated with soybean production. In 2011 and 2012, the low yield levels of soybean production impacted the gross margin negatively. It is clear from the figure that in this period soybean production basically made a negative profit in the sense that one has to consider that the overhead component must be allocated to the respective enterprises. Therefore, several factors could influence the decision-making environment of farm businesses in the eastern Free State and in the above case, a trade-off will exist between the advantages of a rotational system and the respective risk involved in producing soybeans. Future decisions on land utilisation trends will be based on the relative performance of yield levels in soybean production in the sense that if farm businesses are not able to improve yield levels in the future, a shift may occur away from soybean production. However, the trade-off between increased yield levels of maize production with the anticipated risk of producing soybeans should be calculated in order to determine the most profitable scenario.

Furthermore, it is expected that the gross margin for both yellow maize and soybean production will decline in 2014 due to a possible supply shock in 2013. It was stated earlier that the severe drought in the United States in 2012 caused commodity prices to skyrocket. The high price levels of maize and soybeans in particular will boost the area under production in 2012/2013 season significantly. Commodity prices are thus expected to decrease towards 2014 due to the supply response of farm business to increase production with the result of lower gross margins in 2014 when compared to 2013.

Finally, the gross margin for yellow maize and soybean in 2013 is projected at R6972 and R2796 per hectare respectively. In 2018, the gross margin could range at R6505 per hectare for yellow maize production and R2910 per hectare for soybeans. The average gross margin over the baseline period for yellow maize and soybean production are R4863 and R2135 per hectare respectively. Wheat profitability is expected to remain positive and higher than previous reported gross margin levels due to the anticipated increase in the wheat commodity price over the baseline period. The assumption can therefore be made that the production of wheat will continue in the future, which will increase the area under summer fallow.

4.5.3.4 Financial output, performance and projections

The subsequent section will focus on the overall performance of the farm business in the eastern Free State, thus take into consideration the overhead structure of the firm. In order to determine the long term sustainability position of the farm business, one should keep all drivers in mind that contribute to the profitability of the firm. This refers to overhead or fixed costs, which include the cost of finance, asset replacement and other related cost in order to manage the business. The financial statements are illustrated in Table 23, Table 24 and Table 25 below and represent the income statement, cash flow statement and statement of assets and liabilities for the eastern Free State representative farm business.

The gross margin profitability analysis of the eastern Free State indicated that due to drought in 2011 and 2012, enterprise profitability did not perform that well. The effect is transferred to the overall farm business performance as can be seen in the income statement in Table 23. Total grain receipts in 2011 were R4.9 million and total farm expenses, R4.7 million, which indicates insufficient funds to cover the cost of finance or interest. After depreciation, the net farm income (NFI) as profitability indicator reflected negatively. The total NFI at the end of the financial year in 2011 was – R305062. However, towards 2015 and 2018, the financial picture reflects better due to anticipated normal yield levels and increasing commodity prices. It is projected that the NFI could range in the region of R1.5 million in 2015 and R2.6 million in 2018 given the set of assumptions stipulated in Table 17 and Table 22. Furthermore, it can be observed that the total interest paid is expected to increase over the period due to asset replacement, which causes medium-term liabilities to increase.

Table 23: Income statement for the eastern Free State farm business (2011, 2015 and 2018)

Description	2011	2015	2018
Cash farm income			
Grains	R3 731 522	R7 450 845	R9 529 283
Other farm income	R1 170 567	R1 473 623	R1 707 519
Total cash farm income	**R4 902 089**	**R8 924 469**	**R11 236 801**
Cash farm expenses			
Grains	R2 731 331	R4 155 855	R4 768 386
Bank charges	R453 900	R571 413	R662 109
Fuel and lubricant (unallocated)	R128 829	R190 620	R194 095
Full-time labour	R656 344	R826 270	R957 416
Land rented	R217 044	R273 236	R316 604
Repairs and maintenance	R495 922	R624 315	R723 407
Short term insurance	R50 415	R62 930	R72 364

Description	2011	2015	2018
Total cash farm expenses	**R4 733 785**	**R6 704 638**	**R7 694 380**
Farm gross margin	**R168 304**	**R2 219 831**	**R3 542 421**
Interest			
Interest long term debt	R37 350	R16 968	-
Interest medium term debt	R39 119	R154 926	R252 344
Interest operating loan	R223 671	R359 017	R420 014
Total interest	**R300 140**	**R530 910**	**R672 358**
Net cash farm income	**-R131 836**	**R1 688 921**	**R2 870 063**
Depreciation	R173 226	R174 900	R206 247
Net farm income	**-R305 062**	**R1 514 021**	**R2 663 815**

Source: Own calculations

The result of low yield levels due to the impact of insufficient precipitation therefore illustrates the severe impact of the overall financial performance of the farm business. Therefore it can be emphasised that weather conditions will remain an unknown factor and will significantly influences the decision making and sustainability of farm businesses. For example, in the scenario that drought occurs for two or three consecutive years, sustainability of the farm business may be at risk since debt levels can only be tolerated and accounted for up to a particular stage. This is further supplemented by considering the cash flow statement represented in Table 24 below.

Table 24: Cash flow statement for the eastern Free State farm business (2011, 2015 and 2018)

Description	2011	2015	2018
Total cash inflows	**R121 630**	**R3 417 268**	**R6 309 605**
Cash outflows			
Net Cash Farm Income	R131 836	-	-
Principal long-term debt	R56 650	R77 032	-
Principal medium-term debt	R60 719	R391 850	R564 787
Income taxes	-	R475 815	R629 449
Carryover debt	**R450 000**	**-**	**-**
Total cash outflows before family living	**R699 206**	**R944 697**	**R1 194 236**
Return to family living	**−R577 576**	**R2 472 570**	**R5 115 369**
Family living cost	R404 000	R508 594	R589 319
Ending cash surplus/deficit	**−R981 576**	**R1 963 976**	**R4 526 050**

Source: Own calculations

The negative NFI put substantial pressure on the cash flow position of the farm business as can be seen in Table 24. The amount of cash outflows (carry-over debt, principal payments and a negative cash farm income) exceeded the amount of cash inflow, which led to a negative return to family living. The ending cash deficit in 2011 was almost R1 million which reflects a particularly unhealthy position since farm business will be required to make use of borrowed funds in order to continue production and thus ensure the sustainability of the farm business. However, increased yields and commodity price projections caused enterprise gross margins to increase from 2012 and onwards. This results in positive cash flow positions in both 2015 and 2018. The key message that Table 23 and Table 24 gives is that several consecutive drought years can easily place the sustainability of a farm business in jeopardy and this will remain a key driver in the future. Risk dispersion and diversification are thus essential in order to reduce production and other risks and to ensure that sustainability will remain a high priority.

The statement of assets and liabilities of the eastern Free State farm business is presented in Table 25. Due to higher anticipated income levels from 2013 and onwards, it is projected that the value of assets will increase substantially from 2011 to 2015 and from 2015 to 2018. This is due to the asset replacement strategy of the farm business, which implies that in years where a positive farm gross margin is experienced, asset replacement will occur at a faster rate. Thus, the value of moveable assets which include more efficient tractors, machinery and production equipment will increase as the income of the firm increases. The upscale to more efficient machinery and equipment is essential for long-term sustainability.

Table 25: Statement of assets and liabilities for the eastern Free State farm business (2011, 2015 and 2018)

Description	2011	2015	2018
Fixed Assets			
Land and fixed improvements	R85 330	R107 422	R124 472
Total fixed assets	**R85 330**	**R107 422**	**R124 472**
Moveable assets			
Equipment and tools	R71 371	R77 198	R80 549
Implements and machinery	R1 647 270	R1 781 766	R1 859 096
Vehicles	R1 817 243	R1 965 617	R2 050 926
Total moveable assets	**R3 535 884**	**R3 824 582**	**R3 990 570**
Current assets			
Cash surplus	-	R1 963 976	R4 526 050
Debtors	R1 100 642	R1 385 595	R1 605 518
Production means	R1 323 100	R1 665 647	R1 930 020
VAT receivable	R206 380	R259 811	R301 049
Total current assets	**R2 630 122**	**R5 275 029**	**R8 362 638**
Total assets	**R6 251 336**	**R9 207 032**	**R12 477 680**
Liabilities			

Description	2011	2015	2018
Long term liabilities	R415 000	R166 359	-
Medium term liabilities	R372 559	R1 237 122	R1 949 155
Short term liabilities	R1 531 576	R692 393	R802 291
Total liabilities	**R2 319 135**	**R2 095 874**	**R2 751 446**

Source: Own calculations

The total value of assets in 2015 and 2018 are projected at R9.2 and R12.4 million respectively. The total value of liabilities is expected to decrease from 2011 to 2015 due to a decrease in the value of short-term liabilities (carry-over debt and overdraft facilities). However, as stated earlier, the value of medium-term liabilities is expected to increase from R372 559 to R1.2 million from 2011 to 2015 due to asset replacement. The total value of liabilities in 2015 and 2018 is projected at R2.09 and R2.75 million respectively.

4.5.4 Conclusions and remarks

The eastern Free State farm business was the first analysis to include soybean production in the summer rainfall area. Figure 1 stated that a significant increase in the soybean area is expected in the intermediate to long term due to current demand for soybean oilcake. There is a positive crushing margin for soybean crushers, which encourages the production of soybeans through the erection of new soybean crushing plants. However, the projected increase in the area under soybeans in Figure 1 will depend on various factors which were partially reflected in the eastern Free State analysis. From a production point of view, both positive and negative factors will contribute to the viability of an increase in soybean cultivation.

Firstly, including soybeans in a maize rotation system can substantially improve the yield levels of the subsequent maize crop, which also implies higher gross margin levels. It has also been assumed that the respective cost of fertiliser could decline for maize production due to nitrogen fixation in root nodules by soybean growth processes. This indicates that if the assumption of normal rainfall prevails, the rotation system with maize and soybean production will continue in the future and even shift towards a 50:50 ratio. However, in years of poor rainfall, soybean production poses a major risk since low yield levels imply that a farm business would experience negative income. This was the case in 2011 and 2012 where drought impacted gross margin levels negatively and finally caused a negative farm income.

Thus, the assumption can be made that farm business in the eastern Free State should adopt a strategy of consistently improving soybean yield levels since only a marginal increase in yield can lead to profitability levels that can compete with yellow maize production. Land utilisation decisions regarding yellow maize and soybean production will depend on the relative offset between having the advantages of higher maize yield levels and the respective risk profile of soybean production.

Secondly, the projection of the BFAP sector model indicated that the price of wheat could rise in the intermediate term compared to historical price trends. Since farm business in the eastern Free State has experienced extremely volatile conditions regarding wheat markets in the past, the area under wheat has decreased substantially over the years. However, the anticipated increase in the wheat price may have a positive effect on production since the higher price would imply that higher gross margins could occur and therefore boost farm profitability. It is also important to keep in mind that risk dispersion is essential in the eastern Free State since rainfall has fluctuated significantly in the past three years. The assumption can thus be made that wheat production will continue in the future, which will increase the area under summer fallow.

Thirdly, despite an inadequate overall performance in 2011 and 2012 due to insufficient rainfall, it is expected that if normal precipitation prevails, the farm business will recuperate from its negative financial position in the intermediate term. Sustainability, as a key objective of the study, therefore reflects well given normal rainfall and the anticipated increase in commodity prices.

4.6 MPUMALANGA

According to a study conducted by BFAP (2012), Mpumalanga possesses 46.4 % of the 1.5 % high potential available arable land in South Africa. Furthermore, Mpumalanga is the key soybean producing region in South Africa and produced roughly 239 250 tons of soybeans in the 2009/2010 season (NAMC, 2012). It was further stated by the NAMC (2012) that farm business's decisions about the production of soybeans largely depends on the commodity price of substitute crops such as maize, diversification strategies and the benefits that are associated with crop rotation practices. Since maize and soybean production in Mpumalanga are relatively important when considering the contribution to total production in South Africa, one can argue that there is a relatively strong competition between these two commodities since different drivers impact the decision of land utilisation as was stated earlier.

The next section will focus on the representative farm business situated in Mpumalanga by illustrating the farm background, production trends, financial position and projections based on the BFAP sector model. It should be stated that the typical farm business was only included in 2012, thus historical production trends, commodity prices and other information about the farm are limited. However, the report on the soybean value chain analysis by the NAMC (2011) has been used to briefly demonstrate specific historical trends and conditions.

4.6.1 Farm background

The representative farm business in the Mpumalanga region is situated in the Standerton/Volksrust/Amersfoort region and consists of maize and soybean production as summer crops. A relatively large livestock enterprise contributes to the total turnover of the farm business in order to compensate for risk diversification and dispersion. The total size of the farm business is 3100 hectares where the majority of available land is utilised for animal grazing. The farm business recently adopted the strategy of introducing irrigation by centre pivots in order to reduce the risk of insufficient and ineffective rainfall. The general strategy of the business is to maximise productivity and to increase the effectiveness of commodity marketing skills by means of hedging strategies. In addition, soybean and maize production occurs on a 50:50 production ratio, which captures the benefits of nitrogen fixation of soybean production. It should be mentioned that farm businesses with livestock enterprises in the region use grain harvest residues for fodder during the winter period. Thus, there is an economic advantage in having grain leftovers after each harvest as it reduces the cost of feed, the most expensive cost variable in livestock production. The average annual precipitation is 648 millimetres, with most of the rain falling in summer. Adequate rainfall and low night temperatures are considered some of the production limitations or natural restrictions.

The farm business uses a conservation tillage approach, which includes minimum tillage operations for soil moisture conservation. Since irrigation enterprises are relatively common in the region, an irrigation enterprise will be included in the analysis. In addition, the region is relatively known for livestock production, which plays a crucial role in terms of sustainability. Income obtained from livestock production supplements grain and oilseed production and it will therefore be included in the overall financial performance of the farm business. Maize is rotated with soybeans, which means that half of the available arable area in any specific year will be under soybean production and the remainder under maize. In a typical maize production system, maize is planted in October and harvested the next year at the end of May and beginning of June. A typical soybean production system includes soybean seeding in the middle of October and beginning of November and harvesting at the beginning of May the next year.

The turnover composition for the 2010/2011 production season can be illustrated as follows: Yellow maize contributed 47 % to the total turnover of the farm business. The production of soybeans contributed 21.3 % towards the total turnover and livestock and non-farm income contributed 21.3 and 4.5 % respectively.

Furthermore, the representative farm business in Mpumalanga used 250 hectares for yellow maize production and 250 hectares for soybean production in the 2010/2011 production season. A total of 100 hectares of irrigation area was used for yellow maize and soybean production on a 50/50 rotation basis in the same period. Thus, the total arable land available in the mentioned period was 600 hectares.

Since the availability of historical soybean production data is particularly limited, a brief background on historical trends will be given by referring to the value chain study conducted by the NAMC (2011). According to the study, 75 % of commercial farm businesses in South Africa use recycled soybean seed and the majority of the seed is genetically modified. According to Purdue University (2012), the soybean is one of the Leguminosae family of plants and a special characteristic of the family is their ability to live in a symbiotic (mutually beneficial) relationship with specific bacteria. *Bradyrhizobium japonicum* which is one of the rhizobial species is a bacterium that lives in a symbiotic relationship with soybeans and has the ability to fix atmospheric nitrogen into ammonia (NH_3). *Bradyrhizobium japonicum* functions exclusively with soybeans and will not fix nitrogen in any other legume. For this relationship to exist, effective nitrogen-fixing bacteria must be present in the soil in relatively high numbers at planting time, especially in fields where soybeans has never been grown. It is thus important to establish rhizobia in soils by a process called inoculation. Nearly all commercial farm business utilise the inoculation process due to a shortage of nitrogen-fixing bacteria or *Bradyrhizobium japonicum* in South African soils (NAMC, 2011). This is important in the sense that it produces nitrogen for both the soybean plant and the subsequent maize crop which reduces the cost for fertiliser and has the potential to increase maize yields.

The value chain study (NAMC, 2011) further mentions that lime and fertiliser represented 23 % of total input expenditure in 2008/2009. Table 26 illustrates the average direct allocated cost for soybean production from the 2006/2007 to 2008/2009 production period. Fertiliser and fuel expenditure together accounted for 32 % of the total variable cost over the identified period. Repairs and maintenance contributed 13 % towards total production expenditure.

Table 26: Soybean direct allocated variable cost (2006/2007–2008/2009)

Variable cost item	Average share of total variable cost 2006/2007–2008/2009
Fertiliser and lime	18 %
Fuel	14 %
Repairs and maintenance	13 %
Seed	12 %
Labour	8 %
Herbicide	7 %
Interest on production credit	7 %
Crop insurance	7 %
All other	14 %

Source: NAMC, 2012

Figure 60 also shows the total variable cost estimate for key producing regions in Mpumalanga for the 2010/2011 production period. It can be observed from the graph that the Piet Retief area was the most expensive in terms of production cost with a total of R3998 per hectare. The Nigel and Delmas region was the second most expensive region with a total estimated variable cost of R3757 per hectare. The average production cost for the key regions in 2010/2011 was R3779 per hectare.

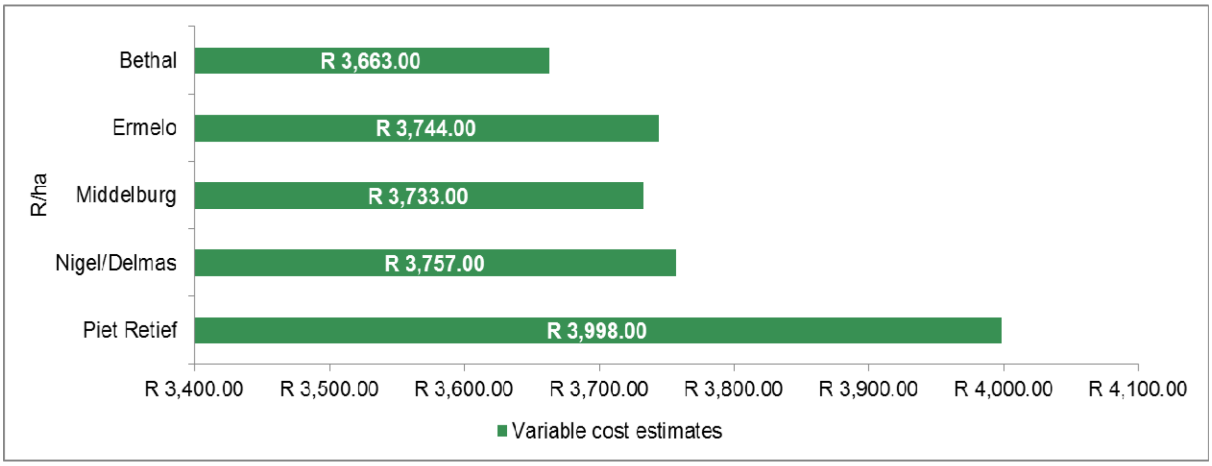


Figure 60: Total soybean variable cost estimate for the 2010/2011 production season

Source: NAMC, 2012

The next section will focus on the current production environment and the respective financial position of the representative farm business in Mpumalanga. The 2010/2011 production season will form the base year from which BFAP projections will be made. The objective of the analysis is to illustrate a typical farm set-up in Mpumalanga which could address the objectives of the study. This includes the analysis of enterprise performance and the financial position of the farm business in order to determine sustainability in the region and whether a shift in hectares can be expected. Finally, the objective is to illustrate the impact of the BFAP sector model on the representative farm business in Mpumalanga.

4.6.2 Current state of the farm businesses

Detailed analysis and discussions will follow on the current and projected yield and commodity price of yellow maize and soybeans. Thereafter, the respective input composition together with gross margin analysis will be discussed. The section will be concluded with an overview of the financial performance of the farm business in Mpumalanga. The BFAP sector model projections are applied to the Mpumalanga representative farm business as illustrated in Table 17 and Table 22.

4.6.2.1 Current and projected yields and commodity price levels

The respective enterprise yield levels for the Mpumalanga farm business are presented in Figure 61 below. The figure illustrates the current (2010/2011) and projected yield levels for dryland and irrigation yellow maize and soybean production. It can be observed from the figure that Mpumalanga indicated particular good yields for both yellow maize and soybean production. The average reported yield in 2010/2011 was 6.5 tons per hectare for yellow maize and 1.8 tons per hectare for soybeans. Yellow maize production under irrigation performed extremely well, with an average yield of 12 tons per hectare. The yield for soybeans under irrigation was 39 % higher than dryland soybean production, at 2.5 tons per hectare in 2010/2011 (irrigation).

It was stated in the farm background section that the region gets a relatively high annual rainfall (648 millimetres), but that sufficient rain is considered a natural restriction, which indicates that insufficient water at important biological growth stages of maize and soybeans might reduce yields substantially. The key objective therefore is sufficient water throughout the entire growth process. The only way to overcome inadequate rainfall is by introducing irrigation. However, since the average rainfall is high, only supplementary irrigation is necessary throughout the year and this implies a significant decrease in the cost of electricity. This therefore decreases production risk substantially due to water availability in years where lower precipitation occurs. Since production risk is a major driver in the decision making environment of farm businesses, supplementary irrigation will remain an absolute advantage in the region and throughout South Africa. The assumption can therefore be made that if sufficient own farm capital is available and that water is available on the farm, irrigation practises will increase over the medium and long term.

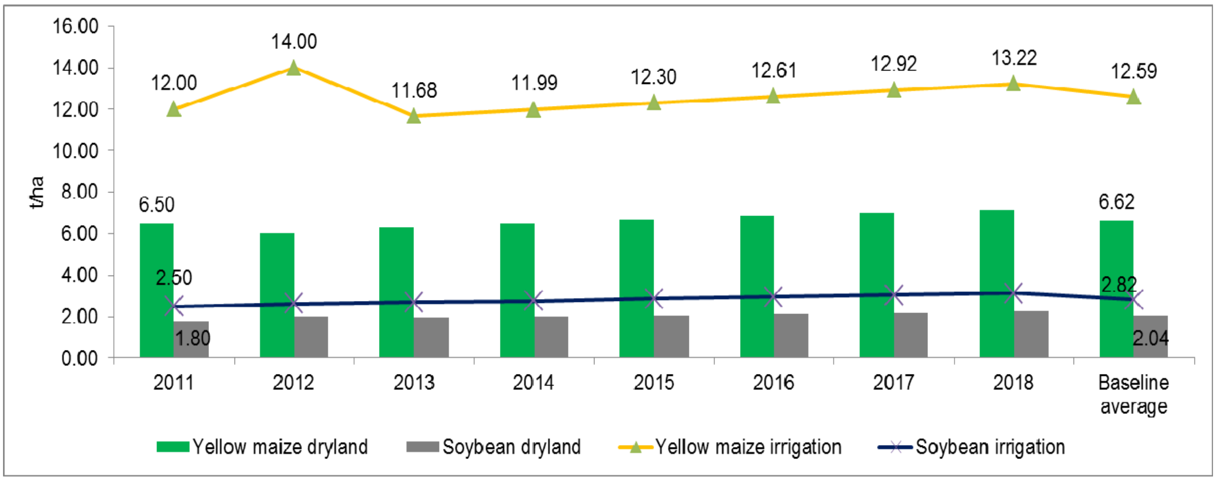


Figure 61: Enterprise yield levels for Mpumalanga (2011–2018)
Source: Own calculations

Figure 61 also shows that the average projected yield over the baseline period for dryland yellow maize is 6.62 tons per hectare. The average projected yield for dryland soybean production is 2.04 tons per hectare. It was stated in the analysis of the eastern Free State farm business that it is essential to increase soybean yield levels in order to ensure sustainability of the farm business and to compete with a maize enterprise. It can be observed from the figure that higher yields occur in Mpumalanga than in the eastern Free State. Furthermore, the average projected yield over the baseline period for yellow maize under irrigation is 12.59 tons per hectare and 2.82 tons per hectare for soybeans. Soybean production under irrigation can easily increase to over three tons per hectare, thus the anticipated yield under irrigation is relatively conservative. Finally, the analysis of the Mpumalanga farm business follow the assumption that maize will benefit from soybean production due to rotational advantages as was mentioned in 4.6.1.

The farm gate price projections stipulated in Figure 62 are based on the assumptions and projections of the BFAP sector model illustrated in Table 17 and Table 22. In addition, it was stated that one of the strategies of the farm business is to increase the effectiveness of marketing skills by means of hedging strategies. Figure 62 illustrates the farm gate price and projections for yellow maize and soybean production from 2011 to 2018.

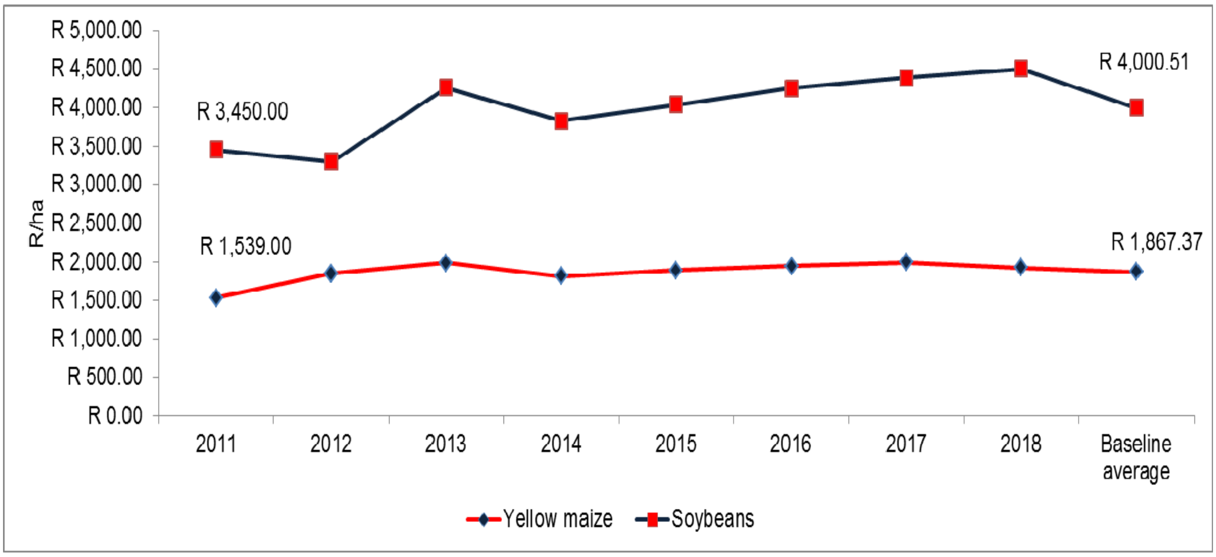


Figure 62: Farm gate price projections for Mpumalanga representative farm (2011–2018)

Source: Own calculations

The average yellow maize farm gate price in 2011 was R1539 per ton. It is expected that an upward shift in the yellow maize price will occur from 2012 towards then end of 2013 backed by the effect of the US drought in 2012 which placed severe pressure on stock levels. A similar trend can be observed when considering the soybean farm gate price. The average reported soybean farm gate price in 2011 was R3450 per ton. Under current assumptions, it is projected that the soybean price could range in the region of R4256 per ton in 2013. The average baseline projected prices for soybeans and yellow maize are R4000 and R1867 per ton respectively. The higher anticipated commodity prices imply higher gross margin levels, which increase the profitability of the farm business. This will be illustrated later in the section.

4.6.2.2 Selective input expenditure and composition for yellow maize and soybean production

Selective input composition and expenditure for yellow maize and soybean production will be illustrated in the subsequent section. Since fertiliser and fuel are the key and most expensive input cost variables, it is important that farm businesses should carefully manage these two inputs. Figure 63 and Figure 64 represent the cost of fertiliser and fuel for yellow maize and soybean under dryland and irrigation production in Mpumalanga.

In the 2010/2011 season, the cost of fertiliser and fuel for dryland yellow maize production was R1592 and R420 per hectare respectively. These two expenditures combined account for approximately 53.56 % of total production cost. It is projected that the cost of fertiliser and fuel (dryland) could range in the region of R1701 and R585 per hectare respectively by 2018.

The cost of fertiliser and fuel for soybean production was R855 and R560 per hectare respectively in 2010/2011 and is expected to increase to R925 and R788 per hectare by 2018. In 2010/2011, fertiliser and fuel made up 60 % of the total production cost. This emphasises the fact that management of these two input variables is extremely important since a major input shock such as in 2008 (Figure 17 and Figure 18) could result in substantial increases in the total cost of production.

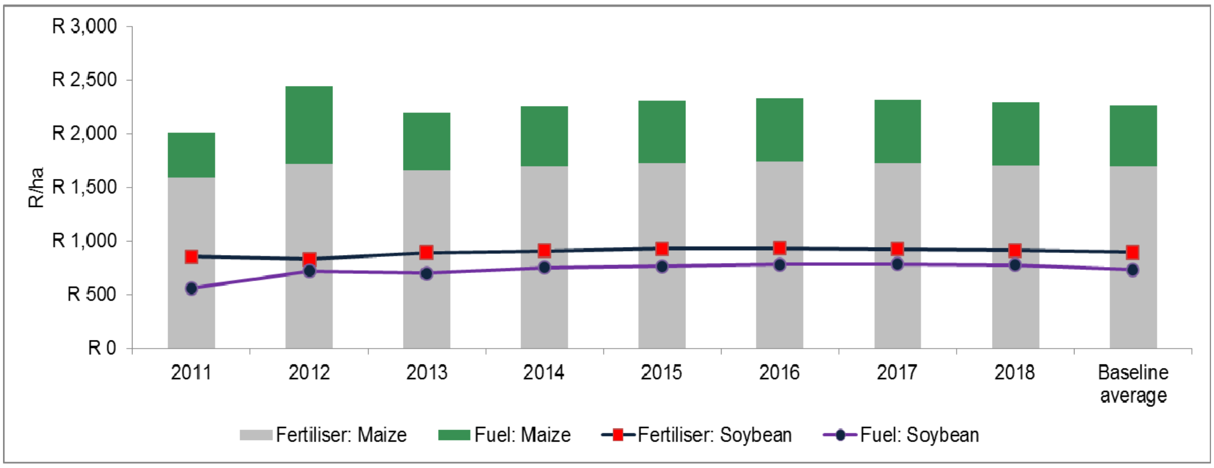


Figure 63: Dryland maize and soybean selective input expenditure (2011–2018)

Source: Own calculations

Figure 64 illustrates the cost of fertiliser and fuel for yellow maize and soybean production under irrigation. In the 2010/2011 season, the total costs of fertiliser and fuel for yellow maize production were R2818 and R720 per hectare respectively. When combining these two inputs, the contribution towards the total cost of production was approximately 49.46 %. For the same period, the costs of fertiliser and fuel for soybean production under irrigation were R1236 and R560 per hectare respectively and made up 34.01 % of the total cost of production.

It is projected that the cost of fertiliser for maize and soybean production could range at R3011 and R1320 per hectare respectively in 2018. For the same period, the cost of fuel for the respective commodities is projected at R1003 and R780 per hectare. The analysis and projections thus indicate that the cost of fertiliser will shift relatively sideways over the baseline period. The cost of fuel, however, is expected to increase substantially from 2011 to 2012 and thereafter move relatively sideways towards the end of the baseline period. It should be stated again that if the input shock of 2008 reoccurs, the figures will change drastically and farm business should therefore plan and manage fertiliser and fuel expenditure at all times, which includes monitoring international price trends and buying inputs at exactly the right time.

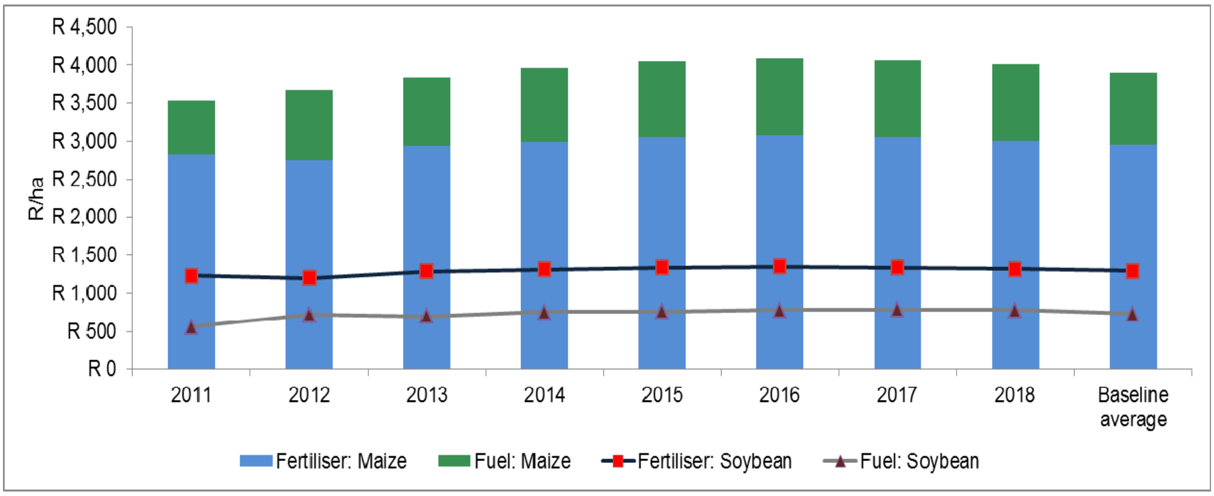
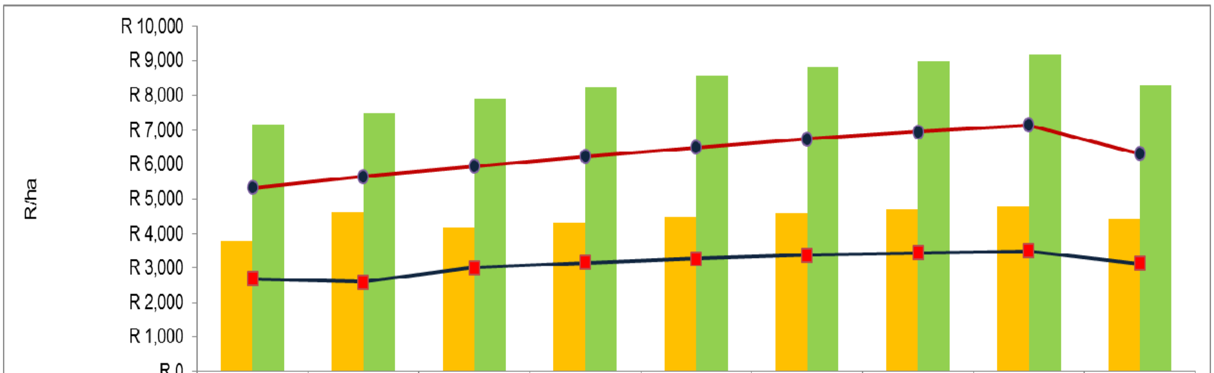


Figure 64: Irrigation maize and soybean selective input expenditure (2011–2018)
Source: Own calculations

The total costs of production for dryland yellow maize and soybeans and irrigation yellow maize and soybeans are presented in Figure 65 below. The x-axis illustrates the actual production cost and projections for the above mentioned enterprises.



	2011	2012	2013	2014	2015	2016	2017	2018	Baseline average
Dryland maize	R 3,757	R 4,615	R 4,143	R 4,315	R 4,469	R 4,600	R 4,691	R 4,766	R 4,420
Irrigation maize	R 7,153	R 7,495	R 7,898	R 8,236	R 8,544	R 8,810	R 9,008	R 9,177	R 8,290
Dryland soybeans	R 2,684	R 2,592	R 3,014	R 3,157	R 3,267	R 3,367	R 3,438	R 3,492	R 3,126
Irrigation soybeans	R 5,321	R 5,654	R 5,945	R 6,236	R 6,497	R 6,740	R 6,949	R 7,137	R 6,310

Figure 65: Total cost of production: Yellow maize and soybeans (2011–2018)
Source: Own calculations

It is expected that production costs will gradually increase over the baseline period and for some input variables inflation will occur at a faster rate. The average baseline production cost estimate for dryland yellow maize is R4420 per hectare and R8290 for irrigation. The average production cost for dryland and irrigation soybean production is projected at R3126 and R6310 per hectare respectively.

Input composition and expenditure are key drivers in the decision making of farm businesses. A major shock in any input variable could cause a reduction in area under production in any specific year. This refers specifically to the financial and cash flow position of farm businesses and the ability to obtain a production loan facility. In years where an input shock occurs, such as in 2008, a farm business might decide to produce less of a specific commodity due to the associated input composition and expenditure of that commodity. In Chapter Five, the risk position of farm business will be illustrated by constructing sensitivity analysis and break-even levels.

4.6.2.3 Gross margin analysis and projections

The dryland gross margin analysis for yellow maize and soybean production for the Mpumalanga representative farm business is illustrated in Figure 66. It was stated on numerous occasions that profit maximisation is a key driver in the decision making of farm business and thus forms a key assumption in the study. However, production advantages such as rotational systems as was explain in the beginning of this section are also an important factor to consider when interpreting gross margins, area utilisation and decision making. Thus, one cannot make the assumption that farm businesses will base area utilisation merely on profit maximisation criteria, which can be demonstrated by observing Figure 66.

If profit maximisation was the only and most important approach that farm businesses pursue, one could argue from Figure 66 that the area under production will shift towards yellow maize production due to its higher profitability over soybeans. However, if a shift occurs towards the monoculture production of maize, the respective yields will decline due to the exclusion of the legume crop and increased fertiliser expenditure on maize production. This can change the figures drastically, since a reduction in yield and an increase in input expenditure implies a lower gross margin. Secondly, an increase in market risk occurs due to the absence of diversification and risk dispersion. In the case where the yellow maize commodity price declines substantially, gross margins will reflect differently, which implies that the sustainability of farm businesses is in danger. It is therefore essential to maintain a healthy trade-off between financial and production approaches and strategies by integrating profit maximisation techniques with risk management and other production factors such as rotational benefits.

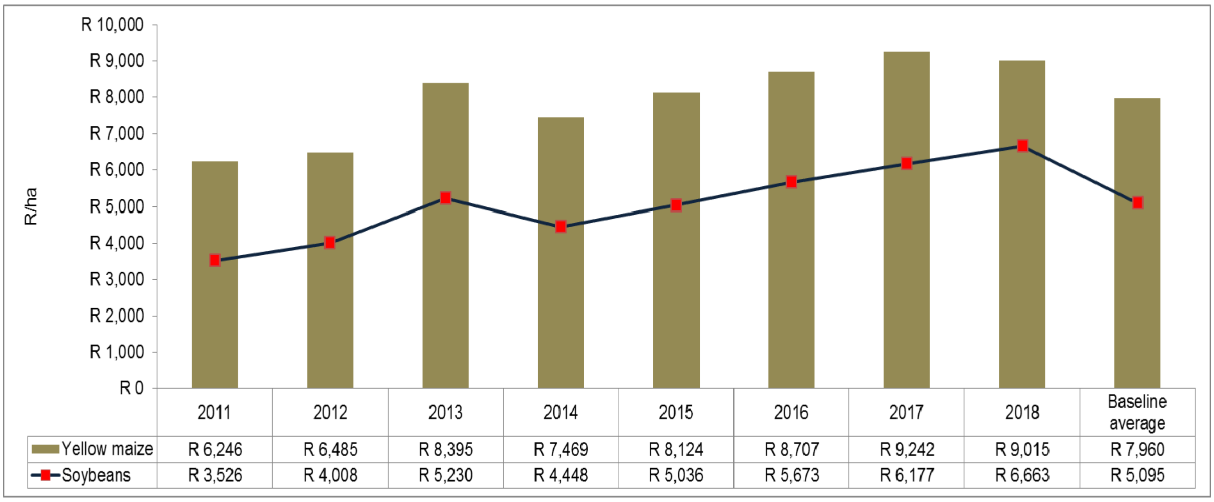
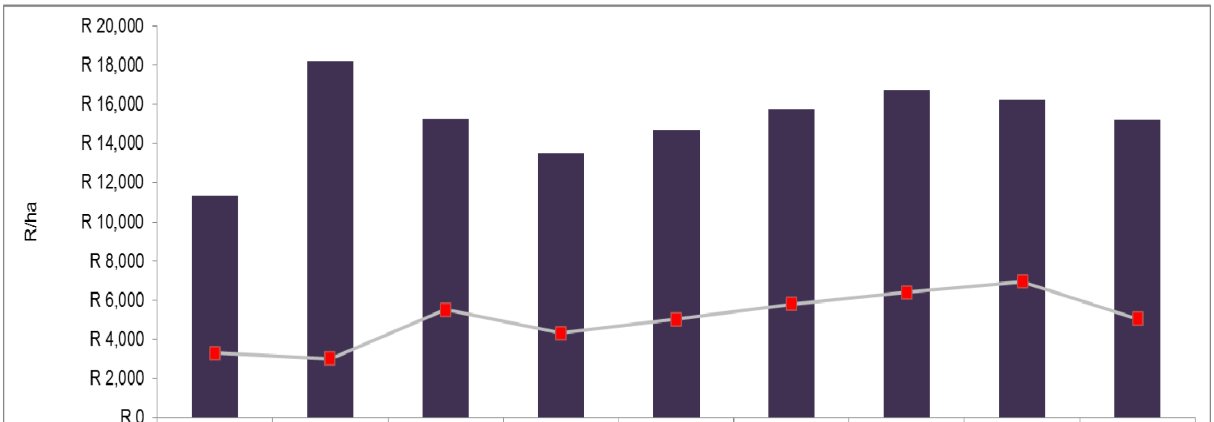


Figure 66: Dryland gross margin analysis for Mpumalanga farm business (2011–2018)

Source: Own calculations

In general, gross margin for both yellow maize and soybean production reflected particularly well when compared to other provinces. This is due to the high anticipated yield levels of the Mpumalanga representative farm business. Farm practice and production techniques thus play a crucial role in yield levels which impacts gross margin positively. The average gross margin projection over the baseline period for yellow maize production is R7960 per hectare and soybeans, R5095 per hectare. This indicates a difference of R2865 per hectare between yellow maize and soybeans, which is large gap from a financial point of view. However if one assumes a farm gate price of R2000 per ton for yellow maize, a reduction of 1.43 tons per hectare in the yellow maize yield will cause the gross margin level of yellow maize to correspond with soybean profitability. From a production point of view and a high anticipated yield level in Mpumalanga, 1.43 tons per hectare reduction could easily be achieved in the region, especially when compared to producing maize on a monoculture basis. Given the current structure, it thus makes sense to produce maize and soybeans in rotation, since both commodities illustrate relatively high gross margins and simultaneously benefit each other from both a production and financial perspective.

Figure 67 presents the gross margin analysis and projections for maize and soybean production under irrigation from the period 2011 to 2018. It can be observed that the yellow maize gross margin was exceptionally good due to high yields supplemented by good production conditions, a high maize farm gate price and a lower input expenditure composition compared to other irrigation regions. It should be kept in mind that supplementary irrigation is applied throughout the year, which substantially reduces the cost of the electricity used in production. In addition, lower fertiliser expenditure due to the rotational effect with soybeans (nitrogen fixation) implies a higher gross margin. The yellow maize gross margin in 2011 was calculated at R11 315 per hectare, 242 % higher than the soybean gross margin. It is projected that the yellow maize gross margin could increase to R18 195 in 2012 due to the effect of the US drought in 2012 which caused the commodity price for yellow maize to increase significantly. The average projected gross margin over the baseline period is R15 215 per hectare.



	2011	2012	2013	2014	2015	2016	2017	2018	Baseline average
Yellow maize	R 11,315	R 18,195	R 15,249	R 13,519	R 14,706	R 15,756	R 16,714	R 16,264	R 15,215
Soybeans	R 3,304	R 3,021	R 5,506	R 4,327	R 5,035	R 5,814	R 6,405	R 6,966	R 5,047

Figure 67: Irrigation gross margin analysis for Mpumalanga farm business (2011–2018)

Source: Own calculations

Soybeans on the other hand, did not do that well under irrigation when observing the projected gross margins, mainly due to a conservative approach regarding projected yield levels. As was stated before, soybeans under irrigation can comfortably exceed three tons per hectare which will put the graph into a different perspective. The average projected gross margin for soybean production is estimated at R5047 per hectare, approximately 0.94 % lower than dryland soybean margins. The farm businesses should therefore adopt certain strategies and techniques in order to exceed three tons per hectare.

In observing the anticipated irrigation gross margin levels of the Mpumalanga representative farm business, it should be kept in mind that erecting an irrigation pivot is an expensive exercise. It includes the pivot structure, pipelines, electric cables and computerised equipment for irrigation scheduling. The availability of water from rivers, dams or boreholes is essential for irrigation. Thus, the financial position largely determines whether a farm business can expand its current operations by including the necessary irrigation infrastructure.

4.6.2.4 Overview on the financial performance and projections

The overall financial performance refers to the inclusion of all enterprise profitability, overhead component, financing cost and the asset replacement structure. The net farm income (NFI) can be interpreted as a proxy for farm profitability. The ending cash surplus or deficit can be considered as proxy for the respective cash flow position of a farm business. Table 27 and Table 28 represent the income statement and a summary of the financial position of the farm business in Mpumalanga.

The gross margin analysis in the preceding section indicated that given current yield levels, commodity prices and input composition, yellow maize and soybean production on both dryland and under irrigation reflected exceptionally well. The indicated profitability levels were further supplemented by the anticipated livestock enterprise which indicates a healthy return. The profitability of these enterprises is illustrated in Table 27 by observing the income statement of the Mpumalanga representative farm business.

Table 27: Income statement of the Mpumalanga farm business (2011, 2015 and 2018)

Description	2011	2015	2018
Cash farm income			
Grains	R5 408 025	R6 963 316	R7 960 875
Other farm income: Livestock	R1 553 665	R1 955 905	R2 266 348
Total cash farm income	**R6 961 690**	**R8 919 221**	**R10 227 223**
Cash farm expenses			
Grains	R2 233 956	R2 686 137	R2 879 993
Auditor	R20 612	R25 948	R30 067
Bank charges	R24 265	R30 547	R35 396
Farm utilities	R94 604	R119 097	R138 000
Fuel and lubricant (unallocated)	R346 142	R472 961	R482 210
Full-time labour	R719 692	R906 018	R1 049 823
Land rented	R103 500	R130 296	R150 977
Licenses	R9 808	R12 347	R14 307
Membership fees	R18 934	R23 836	R27 619
Other cash expenses	R100 022	R125 917	R145 903
Repairs and maintenance	R286 678	R360 898	R418 180
Short term insurance	R115 497	R144 167	R165 780
UIF	R13 706	R17 254	R19 993
Total cash farm expenses	**R4 087 416**	**R5 055 424**	**R5 558 248**
Farm gross margin	**R2 874 274**	**R3 863 797**	**R4 668 976**
Interest			
Interest long term debt	R67 500	R67 082	R59 563
Interest medium term debt	R42 899	R61 072	R65 301
Interest operating loan	R258 529	R362 373	R406 150
Total interest	**R368 928**	**R490 527**	**R531 015**
Net cash farm income	**R2 505 346**	**R3 373 270**	**R4 137 961**
Depreciation	R61 050	R64 360	R80 728
Net farm income	**R2 444 296**	**R3 308 910**	**R4 057 233**

Source: Own calculations

The NFI in the 2010/2011 was R2.44 million and is projected to increase by approximately 35.37 % towards the end of 2015. The NFI in 2018 is projected at R4.05 million, an increase of 22.61 % from 2015 and 65.98 % from 2011. If one considers the objective of the study to determine the level of intermediate and long term sustainability of the farm business, one will agree that given the projected profitability levels, sustainability will prevail on the identified farm business. It should be kept in mind that the assumption of the BFAP farm-level model is that farm businesses will annually re-invest available cash after family living expenses back into the business.

Table 28: Financial summary of the Mpumalanga farm business (2011, 2015 and 2018)

Financial indicators	2011	2015	2018
Farm gross margin	R2 874 274	R3 863 797	R4 668 976
Net cash farm income	R2 505 346	R3 373 270	R4 137 961
Net farm income	R2 444 296	R3 308 910	R4 057 233
Return to family living	R4 507 952	R10 798 798	R16 177 291
Ending cash surplus/deficit	R3 907 193	R10 042 504	R15 300 957
Total assets	R6 267 826	R12 837 500	R18 406 016
Total liabilities	R1 566 371	R1 667 636	R1 661 070
Net worth	R4 701 455	R11 169 864	R16 744 946
Debt to asset ratio (total debt/total assets)	25 %	13 %	9 %

Source: Own calculations

Table 28 gives a summary of the key financial indicators of the Mpumalanga representative farm business for 2011, 2015 and 2018. It was mentioned earlier that the ending cash surplus or deficit of a farm business reflects the farm business's cash flow position. This plays a key role in the sustainability of a farm business since available funds are required in order to obtain production capital for the subsequent crop. It can be observed from Table 28 that given the current scenario, assumptions, macroeconomic drivers and commodity balance sheets, the cash flow position of the Mpumalanga farm business reflects exceptionally well due to high profitability and the assumption that available cash will be reinvested in the firm. This also refers to that normal weather will prevail over the baseline period. The indicators reflected in Table 28 should not be considered as forecast, however, but rather a benchmark or possible scenario that could prevail under a set of assumptions.

The table also indicates that rapid asset replacement will be done by observing the value of assets. The model is constructed to make provision for asset replacement which is primarily determined by the farm gross margin. In years where more cash is available, a larger number of assets will be replaced. Since the general financial performance of the Mpumalanga farm business reflects well, assets will be replaced more often in order to maintain the farm business's strategy of engaging in productive and efficient production techniques and approaches. Since machinery and implements largely determine the effectiveness of production, the assumption can be made that the above asset replacement trend will continue.

4.6.3 Conclusions and remarks

The preceding section focussed on the representative farm business situated in Mpumalanga. As in the eastern Free State section, the importance and benefits of rotational systems of maize and soybeans were once again emphasised. It was also stated that Mpumalanga is a key soybean producing region which makes a large contribution to total production in South Africa.

The analysed farm business included both dryland and irrigation enterprises, and was supplemented by a livestock component. The importance of utilising harvest residues for livestock feed was emphasised. From a production perspective, yields in Mpumalanga were exceptional, which directly impacts gross margin levels or enterprise profitability. The respective production cost also illustrated that both maize and soybeans could be grown relatively cheaply compared to other regions. Thus, good yields relatively low production costs and higher projected commodity prices establish a perfect profitability combination.

In general terms, the Mpumalanga farm business reflected a healthy position in terms of both profitability and sustainability. This is based on BFAP sector model projections, which includes the key assumption that normal weather will prevail.

The assumption can be made that since profit are maximised by effective and productive production techniques, current yield trends will continue due to the benefits of rotation systems, good enterprise performance and risk diversification and dispersion.

CHAPTER 5

MACROECONOMIC AND PRODUCTION SCENARIOS

5.1 INTRODUCTION

In Chapter Four, the historical trends, current production structure, financial position and the impact of the BFAP sector model projections at farm level were analysed and interpreted. A set of macroeconomic assumptions and drivers are identified in order to evaluate the current state of farm businesses and possible long term. The analysis conducted in Chapter Four thus creates a platform or baseline which explains the current position and anticipated future scenario. However, various assumptions have been made and in order to determine exogenous shocks and impacts at farm level, additional scenarios are necessary to take into account volatility, risk management, production changes and other possible scenarios that could change the farm-level decision making environment and the possible variation in profitability levels.

Chapter Five will thus focus on creating a set of scenarios in order to determine the impact of exogenous drivers at farm level and how they might change from the baseline. By focusing on macroeconomic and production scenarios, one can re-evaluate the key objectives of the study and the respective impact at farm level.

The next section will include a detailed discussion of sensitivity analysis to determine a region's risk profile, the inclusion of soybean production in non-traditional soybean producing regions and a stochastic approach to determine risk and sustainability.

5.1.1 Sensitivity analysis as a risk management tool

Sensitivity analysis was defined in Chapter Four (section 4.3.4.3 on p.86) as a technique used by farm businesses to determine how different values of an independent variable could impact a particular dependent variable under a given set of assumptions (Investopedia, 2012). Sensitivity analysis is therefore used as a risk management tool to identify the level of risk that a specific enterprise may contain. It was further stated that sensitivity analysis determines a specific break-even level of an enterprise which serves as a potential threshold which farm businesses can use to establish a negative profitability scenario. Furthermore, sensitivity analysis is conducted by considering the enterprise's respective yield, commodity farm gate price and input expenditure combination, which determine the profitability under each combination. This thus acts as a risk evaluation and monitoring tool to determine at what yield and price combination a farm business can still make a positive profit.

It was stated earlier that one of the key assumptions in the study is that farm businesses will pursue profit maximisation subject to cost minimisation. Risk management plays an important role in profit maximisation and the overall management of a farm business. There are various types risk identified in this case study, namely production risk (yield and farm practise), market risk (volatility in commodity prices) and input risk (input expenditure) which all affect enterprise profitability.

The question therefore arises of why sensitivity analysis is considered as a potential production and macroeconomic scenario and why it is important to evaluate the risk position of farm businesses. Further, why is it considered an important driver in land utilisation decisions? A realistic answer is that risk management is an important aspect in farm management, especially in an environment where farm management experiences significant volatility in production conditions, commodity markets and international and domestic drivers on the cost of basic inputs and expenditure. This impacts the decision of land utilisation since a basic principle in any business environment is that if an enterprise continues to make a negative profit, the production of that enterprise, commodity or product will not continue.

The next section will focus on the construction of a basic sensitivity analysis on the respective commodities produced in the North West province, northern and western Free State, eastern Free State and Mpumalanga. The output of the sensitivity analysis in the identified regions will be compared in order to determine the risk structure of each province and the respective break-even levels. Thereafter, the assumption will follow that all internal and external drivers will be kept constant in order to give an overview of land utilisation decisions based on risk management. In order to conduct the analysis, white and yellow maize will be considered as maize. Sunflowers and soybeans will be considered as oilseeds. The reason for the interpretation is to allow the respective enterprises to be compared to one another. Finally, the sensitivity analysis will be conducted in such a way that a realistic yield, commodity price and input expenditure are taken into consideration, thus excluding extreme conditions which may have occurred in the past. In addition, the fundamental variables of the 2010/2011 production season have been used for the sensitivity analysis.

5.1.2 Sensitivity analysis in the respective regions

5.1.2.1 North West province

The sensitivity analysis for maize and oilseed production for the North West province is illustrated in Table 29 and Table 30. The respective sensitivity analysis can be considered as the risk profiles for maize and oilseed enterprises.

The table can be interpreted as different profitability levels for different yield and farm gate price combinations. The left-hand column indicates different yield combination from a low (upper level of the table) yield to a high yield (lower level of the table) scenario. The different farm gate price combinations are illustrated in the second row from left (low farm gate price) to right (high farm gate price. The rest of the table illustrates the gross margin level at each price and yield combination. The second last row illustrates the average projected production expenditure for maize production in the North West province. The last row illustrates the break-even farm gate price level for yields obtained in the 2010/2011 production season. This can be further interpreted as the required farm gate price at current yield performance in order to break even or to cover the enterprise production expenditure. The red values/inputs represent a negative gross margin level. In addition, it should be stated that the overhead component has not been included in the sensitivity analysis. The above explanation of the sensitivity tables will be the same for the remainder of the section.

Finally, each gross margin level (content in the centre of the table) is calculated as follows:

Gross Margin (R/ha) = Yield (t/ha) x Farm gate price (R/ton) – Direct Allocated Cost (R/ha)

It can be observed from Table 29 that the red areas illustrate a negative gross margin level which indicates that production and price risk are present in maize production in the North West province. In addition, realistic farm gate prices and yield levels for the specific region have been taken into consideration.

Table 29: Sensitivity analysis for maize production in the North West province

Sensitivity analysis	Farm gate price (R/ton)					
Yield (t/ha)	**R 1 100**	**R 1 300**	**R 1 422**	**R 1 600**	**R 1 800**	**R 2 000**
1.70	−R 3 036	−R 2 696	−R 2 489	−R 2 186	−R 1 846	−R 1 506
2.70	−R 1 936	−R 1 396	−R 1 067	−R 586	−R 46	R 494
3.70	−R 836	−R 96	R 355	R 1 014	R 1 754	R 2 494
4.70	R 264	R 1 204	R 1 777	R 2 614	R 3 554	R 4 494
5.70	R 1 364	R 2 504	R 3 199	R 4 214	R 5 354	R 6 494
6.70	R 2 464	R 3 804	R 4 621	R 5 814	R 7 154	R 8 494
Baseline average total production cost (R/ha) (2011–2018)						R 4 906
Break-even price level at 2011 yield (4.7 tons per hectare): R/ton						R 1 044

Source: Own calculations

Table 29 also shows that the farm business has to harvest at least 2.7 tons per hectare in order to be profitable, which is relatively attainable if drought is excluded. The average yield in 2010/2011 season was 4.7 tons per hectare, which indicates that the gross margin can range from R264 to R4494 per hectare based on the respective farm gate prices. The break-even farm gate price for the 2011 harvest season was R1044 per ton. In the scenario that a farm gate price of R1100 per ton is realised, the net margin (overhead component included) will be negative. Generally, the risk position for maize production is low for the North West province due to a low input expenditure, a plausible yield level of at least four tons per hectare and a realistic farm gate price of R1700 per ton. It can therefore be concluded that if all other variables are held constant and that a farm business's primary objective is to minimise risk, maize production will continue in the North West province due to a low risk profile.

Table 30 illustrates the risk profile for oilseed production in the North West province. It can be seen from the table that oilseed (sunflower) production exhibits an exceptionally low risk profile, mainly due to low production expenditure. The only negative gross margin that can realise is at 1.2 tons per hectare and R2700 per ton yield and farm gate price combination. In the 2010/2011 production season, the North West representative farm business indicated an average yield of 1.8 tons per hectare. At this yield level, the gross margin can range from R1235 to R4475 per hectare. Sunflowers are considered a highly drought tolerant commodity, which implies that the crop will perform relatively well in the North West province, which is characterised as a region with low annual precipitation. However, best farm practise is essential in order to achieve yield levels of 1.4 tons per hectare and above. If one considers an average baseline farm gate projected price of R4222 (Figure 26) per ton of sunflowers produced, the assumption can be made that oilseed production in the North West exhibits an exceptionally low risk profile over the baseline period, if normal to best farm practise prevails.

Table 30: Sensitivity analysis for oilseed production in the North West province

Sensitivity analysis	Farm gate price (R/ton)					
Yield (t/ha)	R 2 700	R 3 200	R 3 762	R 3 900	R 4 100	R 4,500
1.20	−R 385	R 215	R 889	R 1,055	R 1,295	R 1,775
1.40	R 155	R 855	R 1 642	R 1 835	R 2 115	R 2 675
1.60	R 695	R 1 495	R 2 394	R 2 615	R 2 935	R 3 575
1.80	R 1 235	R 2 135	R 3 147	R 3 395	R 3 755	R 4 475
2.00	R 1 775	R 2 775	R 3 899	R 4 175	R 4 575	R 5 375
2.20	R 2 315	R 3 415	R 4 651	R 4 955	R 5 395	R 6 275
Baseline average total production cost (R/ha) (2011–2018)						R 3 625
Break-even price level at 2011 yield (1.8 tons per hectare): R/ton						R 2 014

Source: Own calculations

In the scenario that best farm practise does not prevail and that yield levels fall below one ton per hectare, the oilseed enterprise will sustain substantial losses. For example, at a yield of 0.6 tons per hectare, the average loss at all price combinations is R1409 per hectare. Similarly, at a yield level of 0.8 per hectare, the average loss is R670 per hectare. The break-even farm gate price for oilseeds in the 2010/2011 production season was R2014 per ton. Finally, in the event that an input shock occurs and that input expenditure increases to R5500 per hectare (51.72 % increase), the oilseed gross margin in the North West province will remain positive at an average yield of 1.8 tons per hectare and at all farm gate price combinations. However, at an average yield of 1.4 tons per hectare at the increased input expenditure levels, the enterprise gross margin will be −R329 per hectare.

Finally, in order for maize production to compete with the current gross margin of sunflower production in the North West province, the baseline average yield of maize has to increase from 4.87 to 5.1 tons per hectare.

5.1.2.2 Northern and western Free State

Table 31 and Table 32 represent the sensitivity analysis for maize and oilseed production in the northern and western Free State region. What is important to note when comparing the two sensitivity analyses with the North West province is that maize production in the northern and western Free State exhibits a lower risk profile than in the North West province. This is mainly due to higher yield potential in the northern and western Free State. On the other hand, oilseed production has a lower risk structure in the North West province than in the northern and western Free State due to a lower input expenditure strategy on the North West representative farm business. It can therefore be concluded that a lower risk exists in producing maize in the northern and western Free State and similarly, a lower risk exists in producing sunflowers in the North West province.

Table 31: Sensitivity analysis for maize production in northern and western Free State

Sensitivity analysis	**Farm gate price (R/ton)**					
Yield (t/ha)	**R 1,100**	**R 1,300**	**R 1,554**	**R 1,600**	**R 1,800**	**R 2,000**
2.80	−R 2 920	−R 2 360	−R 1 649	−R 1 520	−R 960	−R 400
3.80	−R 1 820	−R 1 060	−R 95	R 80	R 840	R 1 600
4.80	−R 720	R 240	R 1 459	R 1 680	R 2 640	R 3 600
5.80	R 380	R 1 540	R 3 013	R 3 280	R 4 440	R 5 600
6.20	R 820	R 2 060	R 3 635	R 3 920	R 5 160	R 6 400
6.70	R 1 370	R 2 710	R 4 412	R 4 720	R 6 060	R 7 400
Baseline average total production cost (R/ha)(2011–2018)						R 6 000
Break-even price level at 2011 yield (5.8 tons per hectare): R/ton						R 1 034

Source: Own calculations

Table 31 reflects the sensitivity analysis for maize production in the northern and western Free State region. The table indicates that a yield level of at least 3.8 tons per hectares should be obtained in order for the enterprise to be profitable, which is realistic when drought is excluded. At an average yield of 5.8 tons per hectare, the gross margin can vary between R380 to R5600 per hectare, depending on the respective farm gate price. The table further illustrates that the break-even farm gate price for maize in the 2010/2011 production season was R1034 per ton, which can be considered an exceptionally low risk position. In the scenario that production expenditure increases by 25 %, the break-even farm gate price at a yield of 5.8 tons per hectare will increase from R1034 to R1293 per ton of maize produced. Similarly, the average gross margin at different price combinations will decrease from R3042 to R1483 per hectare, if the identified input expenditure increase occurs.

The sensitivity analysis for oilseed production for the northern and western Free State is illustrated in Table 32 below. At a yield combination of 1.2 and 1.4 tons per hectare and a farm gate price of R2700 per ton, the gross margin of oilseed production in the northern and western Free State will be negative. At an average yield of 1.8 tons per hectare, the gross margin of oilseed production can range between R913 to R4153 per hectare. The average projected sunflower price over the baseline period is R4128, which indicates a positive gross margin at all yield levels as stipulated in Table 32. Even at a price of R3762 per ton, all yield combinations in the table indicate positive levels. The break-even farm gate price in the 2010/2011 production period was R2193 per ton. It should be noted that the gross margin levels as indicated in the table only includes all direct allocated expenditure and not the overhead cost component of the farm business.

Table 32: Sensitivity analysis for oilseed production in northern and western Free State

Sensitivity analysis	Farm gate price (R/ton)					
Yield (t/ha)	**R 2 700**	**R 3 200**	**R 3 762**	**R 3 900**	**R 4 100**	**R 4 500**
1.20	−R 707	−R 107	R 567	R 733	R 973	R 1 453
1.40	−R 167	R 533	R 1 320	R 1 513	R 1 793	R 2 353
1.60	R 373	R 1 173	R 2 072	R 2 293	R 2 613	R 3 253
1.80	R 913	R 1 813	R 2 825	R 3 073	R 3 433	R 4 153
2.00	R 1 453	R 2 453	R 3 577	R 3 853	R 4 253	R 5 053
2.20	R 1 993	R 3 093	R 4 329	R 4 633	R 5 073	R 5 953
Baseline average total production cost (R/ha)(2011–2018)						R 3 947
Break-even price level at 2011 yield (1.8 tons per hectare): R/ton						R 2 193

Source: Own calculations

Table 31 and Table 32 thus indicate a relatively low risk for maize and oilseed production in the northern and western Free State, which indicates that if all external variables are held constant, production of the specified crops will continue when one considers land utilisation decision making from a risk management perspective.

5.1.2.3 Eastern Free State

The sensitivity analysis for maize and oilseed (soybeans) production for the eastern Free State farm business is presented in Table 33 and Table 34. The content of the table/sensitivity analysis has been adjusted in order to compensate for the realistic situation in the eastern Free State.

Table 33 illustrates the risk position of the farm business and the red data variables reflect a negative gross margin at a specific farm gate price and yield combination. The table indicates that the farm business should harvest at least 2.5 tons per hectare to indicate a positive gross margin level. If one considers the overhead cost component, the required yield level can easily increase to over three tons per hectare. At a yield level of 4.98 tons per hectare (2010/2011 production season), the gross margin for the representative farm business can range between R939 and R5421 per hectare, depending on the farm gate price. The farm gate break-even price level in the 2010/2011 production season was R911 per ton, which illustrates a safe environment for the production of maize in the eastern Free State.

Table 33: Sensitivity analysis for maize production in the eastern Free State

Sensitivity analysis	**Farm gate price (R/ton)**					
Yield (t/ha)	**R 1 100**	**R 1 300**	**R 1 427**	**R 1 600**	**R 1 840**	**R 2 000**
1.80	−R 2 559	−R 2 199	−R 1 970	−R 1 659	−R 1 227	−R 939
2.50	−R 1 789	−R 1 289	−R 972	−R 539	R 61	R 461
3.50	−R 689	R 11	R 456	R 1 061	R 1 901	R 2 461
4.98	R 939	R 1 935	R 2 567	R 3 429	R 4 624	R 5 421
5.85	R 1 896	R 3 066	R 3 809	R 4 821	R 6 225	R 7 161
6.50	R 2 611	R 3 911	R 4 737	R 5 861	R 7 421	R 8 461
Baseline average total production cost (R/ha)(2011–2018)						R 4 539
Break-even price level at 2011 yield (4.98 tons per hectare): R/ton						R 911

Source: Own calculations

Furthermore, the average baseline farm gate price is projected at R1840 per ton, which illustrates that the farm business should harvest at least 2.5 tons per hectare to be profitable. When considering a yield of 4.98 tons per hectare at a R1840 per ton farm gate price, a gross margin of R4624 per hectare is projected.

The sensitivity analysis for oilseed production is reflected in Table 34 below. What is important to note is the respective risk profile of soybean production vs. the risk profile of sunflower production in the North West and northern and western Free State. Soybean production in the eastern Free State exhibits a greater risk exposure than sunflower production, especially when weather conditions and natural restrictions are taken into consideration. A more detailed discussion will follow later in the section.

Table 34: Sensitivity analysis for oilseed production in the eastern Free State

Sensitivity analysis	Farm gate price (R/ton)					
Yield (t/ha)	**R 2 400**	**R 2 600**	**R 2 873**	**R 3 200**	**R 3 400**	**R 3 639**
0.80	−R 1 488	−R 1 328	−R 1 110	−R 848	−R 688	−R 497
1.00	−R 1 008	−R 808	−R 535	−R 208	−R 8	R 231
1.20	−R 528	−R 288	R 40	R 432	R 672	R 959
1.44	R 48	R 336	R 729	R 1 200	R 1 488	R 1 832
1.80	R 912	R 1 272	R 1 763	R 2 352	R 2 712	R 3 142
2.00	R 1 392	R 1 792	R 2 338	R 2 992	R 3 392	R 3 870
Baseline average total production cost (R/ha)(2011–2018)						R 3 408
Break-even price level at 2011 yield (1.44 tons per hectare): R/ton						R 2 367

Source: Own calculations

Table 34 indicates that oilseed (soybean) production will be unprofitable at yield levels of 0.80, 1.00 and partially 1.2 tons per hectare. This indicates that the production of soybeans in the eastern Free State has a relatively medium to high risk profile when considering historic yield levels of 1.08 tons per hectare in 2007/2008 and 1.02 tons per hectare in 2010/2011. Even at a yield level of 1.44 tons per hectare (four year historic average), soybean production will indicate unprofitable levels at R2400, R2600 and R2873 per ton when the overhead component is included in the exercise.

Furthermore, the break-even farm gate price at a yield level of 1.44 tons per hectare is R2367 per ton which can be considered as a relatively low farm gate price risk. The average SAFEX soybean price from Jan 2010 to Dec 2011 was R3169.48 per ton. At this price level, the gross margin at 1.44 tons per hectare will be R1155.36 per hectare.

5.1.2.4 Mpumalanga

The sensitivity analysis for dryland grain and oilseed production in Mpumalanga is presented in Table 35 and Table 36. Table 37 and Table 38 illustrate the sensitivity analysis for maize and oilseed under irrigation. The general observation that can be made is the respective risk profiles of each enterprise, which is relatively low for both maize and oilseed (soybean) production.

It can be observed from Table 35 that the only negative gross margin will occur at a yield and farm gate price combination of 3.5 tons per hectare and R1100 per ton respectively which provides an indication that maize production and price risk is exceptionally low (given normal rainfall prevails). The table further illustrates that at a yield of 6.5 tons per hectare (2011), gross margin can range from R2730 to R8580 per hectare, depending on the farm gate price spread. In the 2010/2011 production season, the break-even farm gate price level at a yield of 6.5 tons per hectare was R680 per ton.

Table 35: Sensitivity analysis for dryland maize production in Mpumalanga

Sensitivity analysis	**Farm gate price (R/ton)**					
Yield (t/ha)	**R 1 100**	**R 1 300**	**R 1 539**	**R 1 600**	**R 1 840**	**R 2 000**
3.50	−R 570	R 130	R 967	R 1 180	R 2 020	R 2 580
4.50	R 530	R 1 430	R 2 506	R 2 780	R 3 860	R 4 580
5.50	R 1 630	R 2 730	R 4 045	R 4 380	R 5 700	R 6 580
6.50	R 2 730	R 4 030	R 5 584	R 5 980	R 7 540	R 8 580
7.50	R 3 830	R 5 330	R 7 123	R 7 580	R 9 380	R 10 580
8.50	R 4 930	R 6 630	R 8 662	R 9 180	R 11 220	R 12 580
Baseline average total production cost (R/ha)(2011–2018)						R 4 420
Break-even price level at 2011 yield (6.5 tons per hectare): R/ton						R 680

Source: Own calculations

In addition, Table 35 illustrates that dryland gross margin levels could increase to R12 580 per hectare, given a yield of 8.5 tons per hectare and a realistic farm gate price of R2000 per ton. The general assumption that can be made is that given the gross margin values as stated in the table, production of yellow maize will continue in Mpumalanga due to exceptional enterprise performance, relatively low production cost and other farm strategies.

Table 36 indicates the sensitivity analysis for dryland oilseed (soybean) production in Mpumalanga. There is a marginal production risk in the production of soybeans and a negative gross margin will only occur at a yield of 0.8 tons per hectare for all price combinations as stated in the table.

Furthermore, at an average yield of 1.8 tons per hectare, the gross margin level can vary from R1194 to R3624 per hectare, which proves that soybean production can exhibit good returns, especially when one compares the gross margin levels of oilseed production in the eastern Free State.

Table 36: Sensitivity analysis for dryland oilseed production in Mpumalanga

Sensitivity analysis	Farm gate price (R/ton)					
Yield (t/ha)	**R 2 400**	**R 2 600**	**R 3 450**	**R 3 550**	**R 3 650**	**R 3 750**
0.80	−R 1 206	−R 1 046	−R 366	−R 286	−R 206	−R 126
1.00	−R 726	−R 526	R 324	R 424	R 524	R 624
1.40	R 234	R 514	R 1 704	R 1 844	R 1 984	R 2 124
1.80	R 1 194	R 1 554	R 3 084	R 3 264	R 3 444	R 3 624
2.00	R 1 674	R 2 074	R 3 774	R 3 974	R 4 174	R 4 374
2.20	R 2 154	R 2 594	R 4 464	R 4 684	R 4 904	R 5 124
Baseline average total production cost (R/ha)(2011–2018)						R 3 126
Break-even price level at 2011 yield (1.8 tons per hectare): R/ton						R 1 737

Source: Own calculations

In the 2010/2011 production period, a farm gate price of R1737 per ton was required in order to break even. If one considers an average projected soybean farm gate price of R4001 over the baseline period, the assumption can be made according to Table 36 that soybean profitability will remain positive and farm businesses will favour soybean production, especially considering rotational advantages as explained earlier. In addition, when one refers to profitability of soybean production in Mpumalanga, the projected area increase as stated in Figure 1 is plausible from a farm business perspective.

Table 37 indicates the profitability levels for maize production under irrigation, which generally reflects well. It should be kept in mind that only supplementary irrigation is provided during the season, which decreases the cost of production. The most important observation that can be made from Table 37 is the exceptionally low risk that the enterprise exhibits. Since production and yield risk are already limited due to availability of water, the only major risk involved in maize production under irrigation is market and price risk. In addition, the table states that a farm gate price of R691 per ton is required to cover all direct allocated or production costs.

Table 37: Sensitivity analysis for irrigation maize production in Mpumalanga

Sensitivity analysis	Farm gate price (R/ton)					
Yield (t/ha)	**R 1 100**	**R 1 300**	**R 1 539**	**R 1 600**	**R 1 840**	**R 2 000**
8.00	R 510	R 2 110	R 4 022	R 4 510	R 6 430	R 7 710
9.00	R 1 610	R 3 410	R 5 561	R 6 110	R 8 270	R 9 710
10.00	R 2 710	R 4 710	R 7 100	R 7 710	R 10 110	R 11 710
12.00	R 4 910	R 7 310	R 10 178	R 10 910	R 13 790	R 15 710
12.50	R 5 460	R 7 960	R 10 948	R 11 710	R 14 710	R 16 710
13.00	R 6 010	R 8 610	R 11 717	R 12 510	R 15 630	R 17 710
Baseline average total production cost (R/ha)(2011–2018)						R 8 290
Break-even price level at 2011 yield (12.00 tons per hectare): R/ton						R 691

Source: Own calculations

The gross margin can range between R2710 and R11710 per hectare at a yield of ten tons per hectare. Thus, given the output of Table 37, the conclusion can be drawn that irrigation will continue due to the low risk that can be attributed to the enterprise and secondly, remarkably good profitability levels. However, it should be kept in mind that the overhead cost of irrigation is expensive due to the high capital cost of introducing irrigation infrastructure. Secondly, production under irrigation is subject to water availability.

Finally, the sensitivity analysis for oilseed production under irrigation is presented in Table 38 below. It can be observed that at a yield level of 1.8 tons per hectare and price combinations of R2400 and R2600 per ton, irrigation gross margins for oilseed production will be negative. Furthermore, at an average yield of 2.5 tons per hectare, the gross margin can range between R953 and R4328 per hectare.

Table 38: Sensitivity analysis for irrigation oilseed production in Mpumalanga

Sensitivity analysis	**Farm gate price (R/ton)**					
Yield (t/ha)	**R 2 400**	**R 2 600**	**R 3 450**	**R 3 550**	**R 3 650**	**R 3 750**
1.80	−R 727	−R 367	R 1 163	R 1 343	R 1 523	R 1 703
2.00	−R 247	R 153	R 1 853	R 2 053	R 2 253	R 2 453
2.20	R 233	R 673	R 2 543	R 2 763	R 2 983	R 3 203
2.50	R 953	R 1 453	R 3 578	R 3 828	R 4 078	R 4 328
2.80	R 1 673	R 2 233	R 4 613	R 4 893	R 5 173	R 5 453
3.00	R 2 153	R 2 753	R 5 303	R 5 603	R 5 903	R 6 203
Baseline average total production cost (R/ha) (2011–2018)						R 5 047
Break-even price level at 2011 yield (2.5 tons per hectare): R/ton						R 2 019

Source: Own calculations

The break-even farm gate price at 2.5 tons per hectare is R2019 per ton. In a scenario where input expenditure increases by 25 %, the break-even farm gate price will increase to R2524 per ton.

The general conclusion that can be drawn from the representative farm business in Mpumalanga is that relatively low production and price risk is present, given current yield levels and projected farm gate prices for both maize and soybeans. The assumption can therefore be made that current production trends will continue in the future since risk is both minimised and profit levels are maximised. This refers to a combination of factors which include current farm practise, yield levels, projected farm gate commodity prices and the respective risk position of each enterprise.

5.1.3 Break-even levels and gross margin benchmarking

The next section will focus on sensitivity and break-even comparisons between the identified regions and provinces. Thus, an attempt will be made to explain the risk position as a whole in order to identify in what regions farm business decision making might be more complex which could lead to land utilisation shifts or new trends. In order to conduct this exercise, the respective risk position will be considered as the dependent variable where all other drivers and variables will be held constant. Other drivers refer to those variables that influence decision making, such as profit maximisation, cost minimisation and other external drivers.

The rest of the section will focus on the respective break-even farm gate price comparisons that can be used as a proxy for the input/output ration, which in addition serves as a risk indicator. Further, the different gross margin levels in each province will be compared in order to determine what commodity will be the most profitable in what province. The first part of the section will focus on maize and soybean production separately and the section will be concluded by evaluating all commodities simultaneously.

Maize production

Figure 68 illustrates a maize break-even farm gate price comparison for the different representative farm businesses in the respective regions. The break-even farm gate price can be used to interpret two key components. Firstly, the break-even price illustrates the input/output ratio which provides an indication if yield levels are justified by the amount spend on agricultural inputs or direct allocated expenditure. Secondly, the break-even farm gate price can be used to define the enterprise's respective risk position. Thus, given the current yield and input expenditure, what the required farm gate price should be in order to break even or to cover all direct allocated expenses. The figure thus illustrates where maize will exhibit the lowest risk profile, given the average projected baseline yield and input expenditure.

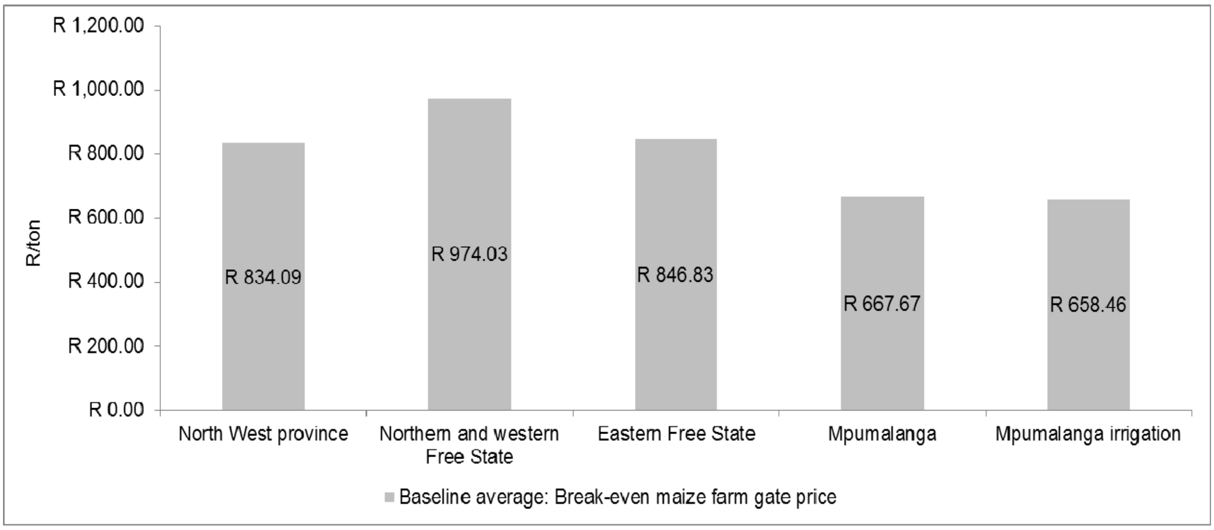


Figure 68: Break-even maize farm gate price provincial comparison (baseline average)

Source: Own calculations

It can be observed from Figure 68 that the northern and western Free State indicate the highest risk profile of all regions with a break-even farm gate price of R974.03 per ton, which is mainly due to higher input expenditure, especially the cost of fertiliser per hectare. The eastern Free State shows the second highest risk due to lower anticipated yield levels. The North West province ranks third with a break-even level of R834.09 per ton. Maize production in Mpumalanga indicates the lowest risk in terms of input/output ratio, mainly due to higher yields in the region. From a farm business decision-making perspective, the risk structure of an enterprise will remain an important factor, especially because of extreme volatility in both weather conditions and market mechanisms. In order to test or illustrate the method, in a scenario where production expenditure increases by 25 %, the northern and western Free State's break-even farm gate price will increase from R974.03 to R1217.53 per ton.

In Figure 69, the break-even maize farm gate price has been combined with the average projected gross margin over the baseline period for the different production regions. As stated earlier, this exercise is conducted in order to determine where maize production will be the most profitable, given the anticipated risk position. Thus, if all other variables are held constant and farm businesses' land utilisation decisions are primarily based on profitability, what can be expected in the intermediate to long term and where will maize production be the most profitable?

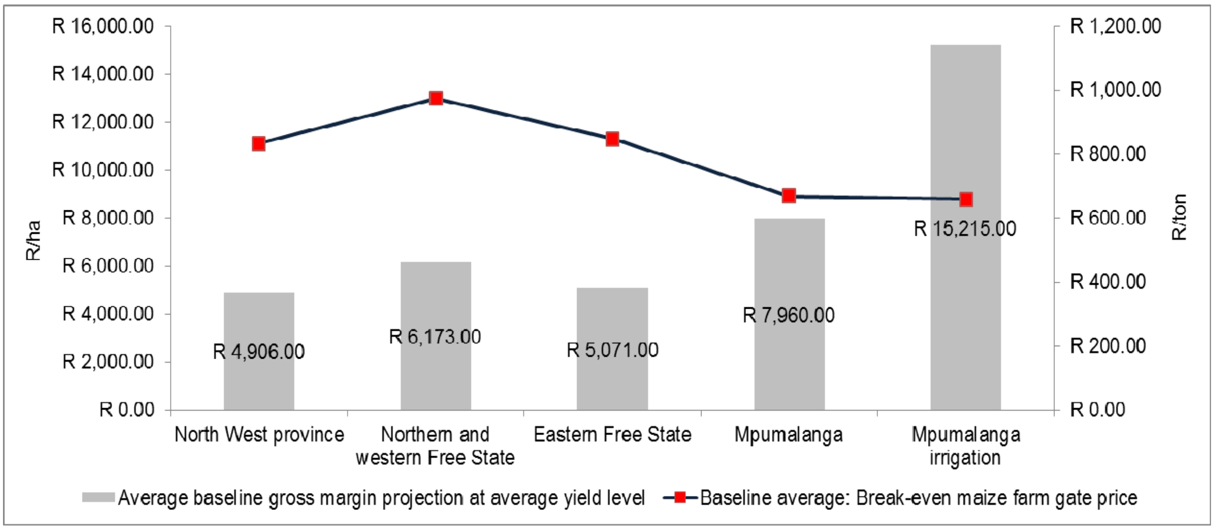


Figure 69: Maize gross margin/profitability provincial comparison
Source: Own calculations

It can be seen from Figure 69 that maize production is projected to be most profitable in Mpumalanga. In addition, Mpumalanga exhibits the lowest risk in terms of break-even farm gate prices. The average projected dryland gross margin for maize production in Mpumalanga is R7960 per hectare, given current projections on farm gate price, yield and input expenditure combination. Furthermore, the northern and western Free State is ranked second (if one excludes irrigation in Mpumalanga) in terms of enterprise profitability with a gross margin level of R6173 per hectare, approximately 22.44 % lower than the Mpumalanga dryland region. However, the northern and western Free State indicated the highest risk position of all regions. Thirdly, eastern Free State maize production will be more profitable (R5071 per hectare) than the North West province (R4906 per hectare), and these are ranked third and fourth respectively. This is due to improved yield levels in the eastern Free State.

The above analysis should be combined with oilseed production in order to understand the competition for land better, which will follow later in the section.

Oilseed production

For the purpose of the exercise, soybean and sunflower production are simultaneously interpreted as oilseed production in order to demonstrate the competition between these two commodities. Figure 70 reflects the various break-even farm gate prices of oilseeds.

In section 4.5.3.3136, it was stated that the production of soybeans in the eastern Free State exhibits a relatively large risk due to lower yields that were realised over a four-year period, as reflected in Figure 70. Oilseed (soybean) production in the eastern Free State indicates the highest risk when one considers the break-even farm gate price of R2350 per ton. Secondly, it can be observed from the figure that soybean production in the eastern Free State (R2350 per ton) and Mpumalanga irrigation (R2238 per ton) region requires a higher break-even price level than sunflower production in the North West province (R1686) and northern and western Free State region (R1819 per ton). However, dryland soybean production in Mpumalanga requires a lower break-even price level than sunflower production in the North West and northern and western Free State.

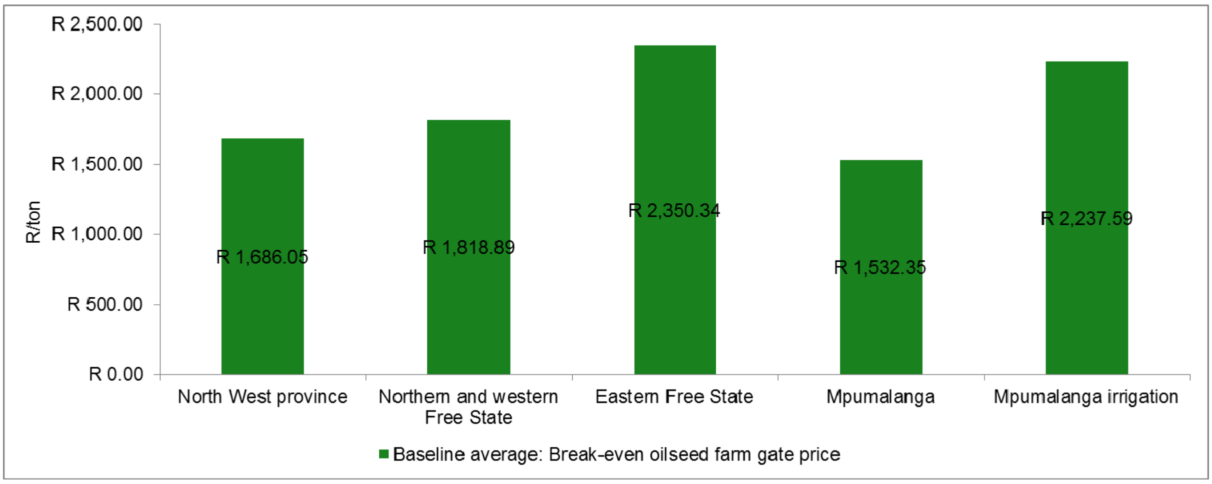


Figure 70: Break-even oilseed farm gate price provincial comparison (baseline average)

Source: Own calculations

Thus, oilseed production under irrigation in Mpumalanga and dryland production in the eastern Free State are more risky than oilseed production in the North West, northern and western Free State and Mpumalanga region. If all variables are held constant, it can be assumed that given the current risk position or from a risk perspective as reflected in Figure 70, a reduction in oilseed area could occur in the eastern Free State and Mpumalanga irrigation region.

The oilseed gross margin projections for the various production regions are illustrated in Figure 71 below. The purpose of the exercise is to illustrate where oilseed production will be the most profitable, given the output of the BFAP sector model projections and assumptions.

It can be observed that the profitability projections are very similar in the North West province, northern and western Free State and Mpumalanga dryland and irrigation regions. However, as mentioned earlier, the respective risk positions differ in the regions. Firstly, oilseed production on a per hectare basis will be most profitable in the North West province, with a projected gross margin of R5356 per hectare. The Mpumalanga dryland region is ranked second with a gross margin of R5095 per hectare and with the lowest risk position of all regions. The northern and western Free State and eastern Free State regions rank last with a gross margin level of R5037 and R1766 per hectare respectively. The figure clearly indicates that there is an exceptionally high risk in soybean production in the eastern Free State, given both profitability and the required farm gate price break-even level.

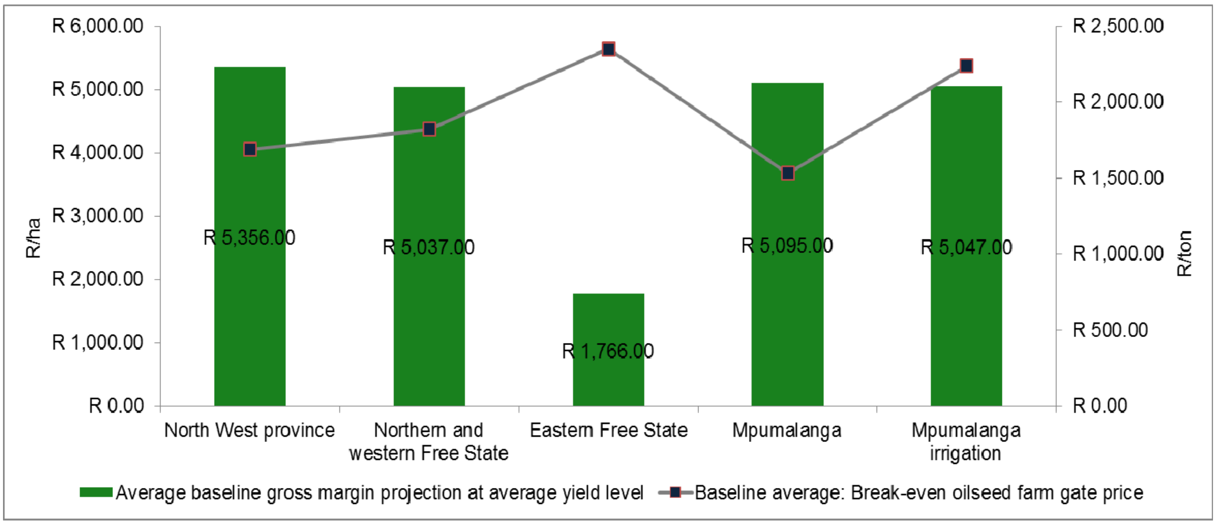


Figure 71: Oilseed gross margin/profitability provincial comparison
Source: Own calculations

Finally, the figure clearly shows that if farm businesses in the eastern Free State do not manage to drive yield levels higher, the area planted to soybeans could be substantially reduced in the long term, based on the assumption that farm businesses will pursue profit maximisation and risk minimisation. However, the fact that soybean production impacts maize yield levels should be kept in mind and further studies will have to be conducted to illustrate the precise economic advantage of maize/soybean rotation.

5.1.4 The competition for arable land from a profitability perspective

Figure 72 illustrates a graph of the different gross margin levels for the various commodities in the summer rainfall region. It was stated in earlier sections that a gross margin reflects a farm business's enterprise profitability, which can be further defined as the end product or objective of why farm businesses engage in agricultural production. In any firm, the general strategy of the business will not be to indicate a financial loss. Thus, profitability will remain the key driver and consistent adjustments in the business structure will occur in order to keep up with changing drivers and other factors which influences profitability. The management of farm businesses will pursue the exact same approach. The gross margin of a farm business further refers to the interaction between the respective yield, farm gate price and input structure. This can be further interpreted in a way that the strategy of the farm business will be to minimise risk, maximise profit and conquer a productive and efficient farm practise in order to increase yield. Thus, the outcome of Figure 72 represents the competition between the respective commodities in the summer rainfall region. By observing the figure, the question can thus be answered of where and what type of agricultural production will be the most profitable? Finally, if the assumption is made that profitability is the key variable and all other drivers are kept constant, where can a shift in hectares be expected?

From Figure 72 it can be seen that the various commodities have been ranked from most profitable to least profitable. The commodity projected to be the most profitable is yellow maize production in Mpumalanga followed by white maize production in the northern and western Free State. This is mainly due to higher yield levels in the two regions. The third ranked commodity is sunflower production in the North West province, mainly due to high anticipated yield levels and a relatively low input expenditure. The assumption can thus be made that a shift in area away from these commodities is highly unlikely due to their respective profitability positions. A major shift in markets and/or yields has to occur in order to discourage production of these commodities in the above regions. Fourthly, dryland soybean production in

Mpumalanga is ranked fourth and given the advantage that soybean production has for a crop rotation, a shift away from this type of production is highly unlikely.

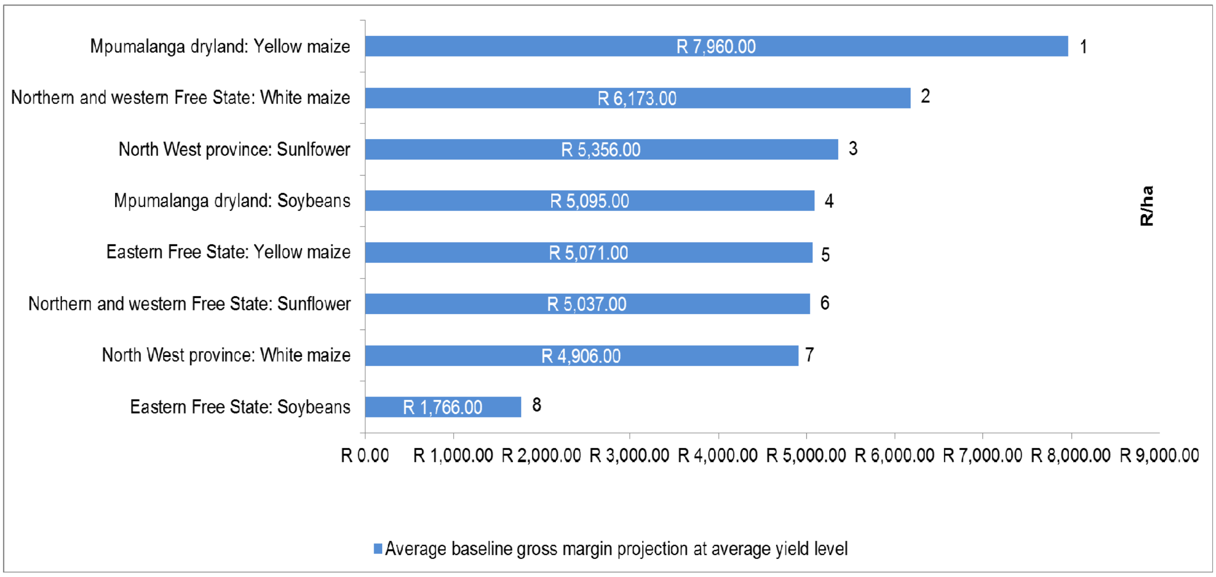


Figure 72: The competition for arable land from a profitability perspective (gross margin)

Source: Own calculations

Furthermore, yellow maize production in the eastern Free State and sunflower production in the northern and western Free State are ranked fifth and sixth respectively with nearly identical gross margins levels. White maize production in the North West province and soybean production in the eastern Free State are ranked lowest in the analysis.

However, it is evident from the figure that the competition between grain and oilseed commodities is exceptionally high from the third to seventh commodity rankings, which shows that volatility in these commodities will continue.

Given the output of Figure 72 the assumption can be made that if soybean yield levels do not increase in the long run, an area reduction can be expected in the eastern Free State. In order to compete against the mid-range commodities (gross margin level of R5000+), soybean yields in the eastern Free State have to increase to 2.4 tons per hectare which is a highly complex task in dryland production and natural restrictions. In addition, if marketing strategies of the farm business can improve and the farm business is able to increase the respective farm gate price by R500 per ton, the required yield level will be two tons in order to compete with mid-range commodities. The final approach will be to marginally increase yields and to reduce the respective input expenditure by at least R400 per hectare in order to remain competitive from a land utilisation perspective. The preceding arguments state that various complex factors have to be overcome in order to compete against other grain and oilseed production and area.

5.1.5 Conclusions and remarks

The introduction stated that sensitivity analysis can be used to determine the enterprise risk position, which is simply an output of the yield, farm gate price and input expenditure combination. Break-even farm gate price levels under anticipated long-term projected yields thus illustrate the lowest possible farm gate price in order to cover all production expenditure. In addition, sensitivity analysis assists with the overall risk position by illustrating the gross margin level at a given farm gate price and yield combination. Thus, the section focused on two major elements that influence the farm business's decision-making environment which could further influence land utilisation decisions. These two elements can be defined as risk management and enterprise profitability which are part of the drivers and assumptions in the study.

Furthermore, the term risk includes various types which can be identified as production, price and input risks. This includes yield levels subject to farm practice and weather, price volatility based on market interaction and other drivers and, lastly, the impact of increasing input expenditure.

The risk position in the North West reflected relatively low for maize production given current yield, farm gate price projections and input expenditure. Sunflower production indicated an even lower risk, given that best farm practise will prevail. North West sunflower profitability ranked third out of eight commodities in the region. However, white maize production ranked penultimate in the summer rainfall region.

In the northern and western Free State, maize yields should exceed 3.8 tons per hectare with a farm gate price higher than R1600 per ton in order to give a positive gross margin. This implies that a higher risk is involved in the production of maize in the northern and western Free State; especially when one consider historic price trends and the national average maize yield of 4.2 tons per hectare. However, at current yield and projected farm gate price levels, the risk position reflects better. On the other hand, oilseed yields in the northern and western Free State should exceed 1.2 tons per hectare at a farm gate price of R3200 per ton in order to break-even. At a farm gate price of R2700 per ton, the yield level should exceed 1.4 tons per hectare in order to compensate for production expenditure. White maize production in the northern and western Free State is the second ranked crop in the summer rainfall region in terms of enterprise profitability. Sunflower production ranks sixth out of eight commodities.

The maize farm gate break-even price level in the 2010/2011 production season in the eastern Free State representative farm business was R911 per ton, which illustrates a safe environment for the production of maize in the eastern Free State. Soybean production on the other hand imposes a relatively high risk, which can be mainly contributed to lower anticipated yield levels. It was stated at the end of the section that a yield level at current farm gate price and input expenditure of 2.4 tons per hectare is required in order to compete with other grain and oilseed enterprises in the region. Soybean profitability in the eastern Free State is the lowest in the sample space.

Dryland maize production in Mpumalanga should exceed 3.5 tons per hectare at a farm gate price of R1100 per ton in order to break even. The overall risk position for both maize and soybean dryland and irrigation reflected exceptionally low. At a soybean farm gate price of R3450 per ton, the required yield level is one ton per hectare in order to break even. Irrigated maize illustrated that at a farm gate price of R1539 per ton, the required yield is 5.38 tons per hectare in order to break even. Similarly, a yield level of 1.45 tons per hectare is required for soybean production to be profitable at a farm gate price of R3450 per ton. Finally, dryland maize and soybean production rank first and fourth respectively in enterprise profitability in the summer rainfall area.

The section was concluded by illustrating the respective break-even levels as a risk identification tool. Secondly, gross margin levels of the respective enterprises in the various regions were ranked according to their profitability levels. If one considers the output and illustration in Figure 1 which identified the anticipated and projected area increases and decreases, various assumptions can be made when compared to Figure 72. If the assumption is made that the output of Figure 1 will prevail, the anticipated decrease in white maize area will occur in the North West province, given the ranking that white maize production obtained in terms of profitability in the region. However, an increase in the production of sunflower can be expected due to its exceptional performance in terms of profitability. The replacement of sunflowers with soybeans is thus highly unlikely in the North West province, especially when one considers the situation in the eastern Free State, which showed the impact of low soybean yields and gross margin levels. This will be verified in the subsequent section where a soybean enterprise will be included in the farm business's structure. Thereafter, profitability levels will be compared in order to illustrate what commodity will be more profitable.

Furthermore, the anticipated increase in the soybean area will most likely occur in the Mpumalanga region. However, competition between soybean and yellow maize production will remain robust and a shift away from a 50/50 production rotation between these commodities will most likely not occur. This is due to high gross margin of yellow maize production in the region and the respective impact of soybean nitrogen fixing on yellow maize yield levels. If an upward shift in soybean area occurs in the Mpumalanga region, there will have to be a reduction in other enterprises such as sorghum, pastures and white maize. However, further studies are required to test the profitability and production structure of the other commodities.

The rest of the area interpretation will follow in the next section where soybean production is introduced in the North West province and the northern and western Free State.

5.2 THE SOYBEAN RUSH

5.2.1 Background

The Protein Research Foundation (PRF) in South Africa expressed the need in 2009 to understand the potential of protein for animal feed from 2008 to 2017 (BFAP and PRF, 2009). In response to this, the Bureau for Food and Agricultural Policy (BFAP) conducted a study to evaluate the current trends in the animal feed industry and oilseed production in South Africa. In the study, a combination of scenarios and models were utilised to quantify various future outcomes with regard to the demand for, and supply of, protein for animal feed. The PRF's perspective of winning the protein game in the long run implies replacing imported protein such as soybean meal with locally produced protein for animal feed (BFAP & PRF, 2009). Various strategies have been identified in order to achieve this objective. To summarise, the first strategy is to expand current soybean hectares without replacing hectares from other key grain commodities such as maize, except within a rotational cropping system. The second strategy is to increase the domestic soybean yield potential and the use of locally grown soybeans in animal feed. This will be done by means of improved technology and innovation in soybean varieties and seed availability which will also provide incentives for local oilseed crusher to use locally grown soybeans. Oilseed crushers normally refine the crude oil or sell it to oil refiners. The remaining oilcake is sold to the animal feed industry.

The BFAP study also highlighted the importance of rotational systems, although the profitability and risk of soybean production versus maize production were also identified. It was stated in the report that the combination of relative yield levels, yield variability, prices, input expenditure and synergetic advantages determines the profit, risk and attractiveness of soybeans and maize in terms of production. Hence, substitutability between maize and soybeans is determined by the combination of these factors.

Finally, according to the report it is expected that soybean yields will increase by between 1.5 and 2 % per annum due to genetic improvement over the next ten years. In conjunction with genetic improvements, it is expected that soybean production practices will change rapidly and become more efficient in the future. Production will become less energy and fertiliser dependent as a result of minimum tillage practises and biological farming. This will decrease the cost of production of soybeans relative to maize. In addition, the downside risk is reduced by genetic improvements. Thus, the profitability and risk of soybean production are expected to improve relative to maize, which could lead to more production incentives for farm businesses (BFAP & PRF, 2009).

The question arises of what the above expectations imply for farm businesses in the respective producing regions in South Africa. Secondly, given current market and production conditions and trends, what is the future scenario likely to be? Hence, is the expected increase in the production of soybeans plausible at farm level? The next section will therefore focus on the expected increase in soybean production and what the long-term scenario might be. A brief overview will be provided on the current structure and production potential of the soybean market and area in South Africa, according to the Bureau for Food and Agricultural Policy's (BFAP) 2012 projections and a study conducted by Blignaut and Taute (2010). Thereafter, soybean enterprises will be introduced in the North West and northern and western Free State representative farm business production and farm business structure. The relative enterprise profitability will be compared with the baseline scenario, as presented in 0. Various assumptions will be made in order to evaluate the overall performance of the farm business, given rotational advantages and the reduction of other on-farm commodities. Finally, an attempt will be made to explain the inclusion of soybean enterprises in traditionally non-soybean producing regions.

5.2.2 Current and projected soybean market and area overview

An overview of the South African soybean market is illustrated in Figure 73 with specific reference to production, area, cake imports and crushing activities from the period 1994 to 2021 (BFAP sector model, 2012). The blue bars represent the historical and projected area under production. The red line illustrates the historic and projected soybean production in thousand tons. The green and purple lines represent soybean oilcake imports, mainly from South America and the historic and projected crushing activities in South Africa.

It can be observed from the figure that soybean area, production and crushing are expected to increase substantially from 2012 to 2021. The reason for this is mainly that South Africa is currently a net importer of soybean meal (oilcake) which creates a positive margin between locally produced soybean (export parity) and imported soybean meal (import parity). Market opportunities therefore exist in the crushing industry and this leads to the establishment of crushing plants. It is therefore expected that a new market or expansion will be created for raw soybeans due to the demand for current and upcoming crushing plants.

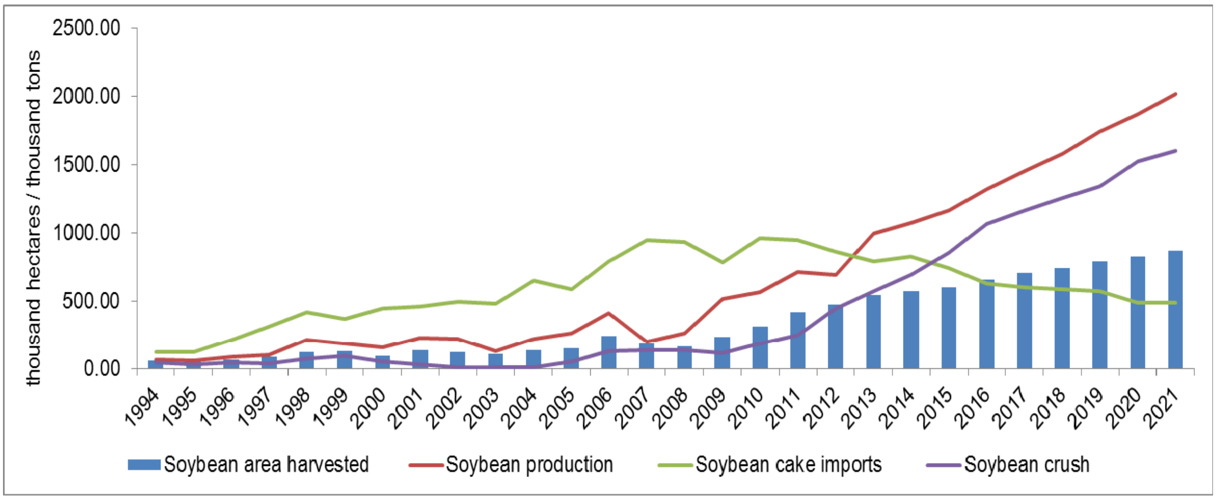


Figure 73: South African soybean industry
Source: BFAP sector model, 2012

Figure 73 further illustrates that the area under soybean production is projected to increase from 418 000 hectares in 2011 to 870 000 hectares by 2021, an increase of approximately 108 %. Furthermore, soybean cake imports mainly from South America are expected to decrease over the baseline period due to an increase in domestic crushing activities and therefore, an increase in the local supply of soybean meal, primarily intended for the animal feed market. Soybean production and crushing are therefore expected to increase from 710 000 and 247 000 tons in 2011 to two and 1.5 million tons respectively by 2021. It is therefore evident from Figure 73 that a substantial increase in soybean production is necessary in order to meet demand from soybean crushers, according to the BFAP sector model (2012). Finally, the figure states that in 2011, the average soybean yield was 1.69 tons per hectare. It is projected that the average yield will increase to 2.31 tons per hectare by 2021.

The previous paragraph indicated that it is projected that an area increase of 452180 hectares or 108 % from 2011 to 2021 might occur under current assumptions, market conditions and drivers. One of the key questions is in what producing region the increase will occur and/or whether it is plausible from a farm-level perspective. If the projections prevail, the outcome under the assumption that land availability is a binding constraint can be illustrated as follows:

- The North West representative farm business will have to decrease either the area under white maize or sunflower production in order to make way for soybean production. This implies that production risk can increase due to the drought resistant nature of sunflowers relative to soybeans. In addition, if the white maize area decreases, the advantages of utilising crop residues as animal feed decreases. However, the advantage of utilising soybeans with maize in a rotational system increases maize yields and decreases production expenditure due to nitrogen fixing by soybeans. The historic conditions of soybean production as was stipulated in the eastern Free State case study should be kept in mind. The sensitivity of soybean production to poor rainfall may impose additional risk on the farm business since in years where lower rainfall occurs, the soybean yield may decrease substantially and impact farm profitability.

- The inclusion of soybean production in the northern and western Free State will result in a decrease in the area under white maize and/or sunflower production. A similar scenario can be expected in the region as was stipulated in the North West province in the previous paragraph. The only advantage that the northern and western Free State has relative to the North West province is the presence of water table soils in the northern and western Free State, This gives higher yields that may reduce the risk of soybean production, which is particularly sensitive to drought.

- The case study and interpretations in the preceding sections indicated that current soybean production in the eastern Free State imposes a major production risk since insufficient rainfall may lead to negative farm profitability as was the case in the 2007/2008 and 2010/2011 seasons. It was further stated from a financial perspective that soybean production cannot currently compete with other commodities such as yellow maize production in the eastern Free State. Thus, higher soybean yields are required to justify soybean production from an enterprise profitability perspective. In the scenario that the maize commodity price shifts back to traditional levels and/or higher soybean yields are realised due to variety improvement or drought resistant soybean seed, the most likely outcome in the eastern Free State will be that yellow maize production will decrease in order to make way for soybean production as part of a rotational system.

- It was stated in Chapter Four that soybean production in Mpumalanga was exceptionally good due to higher obtainable yield levels. It was further stated that soybean production as part of a rotational system with yellow maize benefits the overall farm business in the sense that higher maize yields are realised simultaneously with lower maize production expenditure. However, the current profitability of maize indicates that a high level of competition between these two commodities will remain and may cause a stagnant or slower rate of substitution in the intermediate term. However, additional studies are required in order to determine the economic value of maize given a soybean rotational system in Mpumalanga. This should be compared to conventional maize production (maize on maize) to determine the most profitable production system given current market conditions, which implies a higher maize commodity price. For the purpose of this exercise, the assumption can be made that an increase in soybean area can be expected in Mpumalanga due to its current profitability and the rotational benefit for maize production.

- It is currently expected that the production of soybeans in the Eastern Cape region will increase due to its expected potential in the identified region. Since the Eastern Cape region falls beyond the scope of the study, no further interpretations will follow in this section.

The following section will focus only on the introduction and establishment of soybean production in non-traditional producing regions such as the North West province and the northern and western Free State. As in the case of the eastern Free State and Mpumalanga regions, the assumptions made in Chapter Four and partially in Chapter Five remain and price scenarios will be created later in the chapter in order to determine a potential tipping point that will encourage substitution between yellow maize and soybean production.

Before farm-level analysis is conducted to benchmark the inclusion of soybean production with conventional production systems, one has to consider potential soybean producing regions. A study was conducted by Blignaut and Taute (2010) to develop a map that indicates the soybean producing and potential regions in South Africa.

Figure 74 is a map that identifies soybean producing regions (Blignaut and Taute, 2010). The raster graphics image or green areas illustrate the soybean producing points or regions, and includes both existing and potential dryland and irrigation production. The study shows that a total of 2 992 993 hectares are suitable for soybean production. It further indicated various factors that influence the annual cultivation of soybeans. These factors include rotational production systems, the price ratio between maize and soybeans as a substitution factor, plant diseases such as schlerotina as an oil-specific plant disease, alternative utilisation of soybeans such as production of biofuels, global drivers such as imports from South America and existing demand and market structures.

Finally, the total area of 2.9 million hectares suitable for soybean production can be subdivided into the following sections:

- Existing dryland and irrigation (Total): 2 610 346 hectares
- Existing and potential dryland and irrigation (Total): 2 992 993 hectares
- Existing irrigation: 161 092 hectares
- Existing and potential irrigation: 218 226 hectares
- Existing dryland: 2 449 254 hectares
- Existing and potential dryland: 2 774 767 hectares

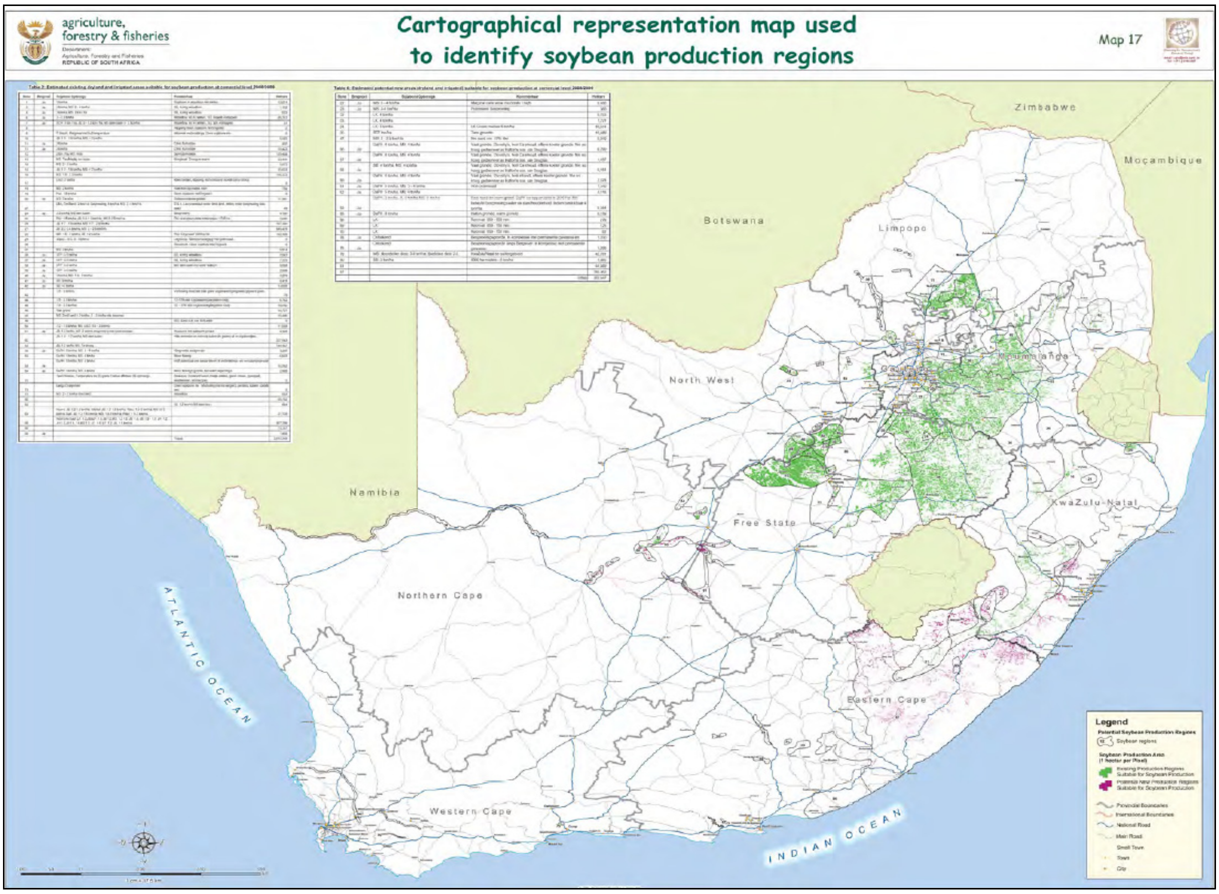


Figure 74: Soybean production potential in South Africa
Source: Blignaut & Taute, 2010

The above summary and map thus show that soybean production has significant growth potential. The question remains, however, whether the proposed increase in soybean production will be plausible in the long term from a farm-level decision-making environment and financial perspective? This refers to whether the incentive will be sufficiently profitable for a shift to occur away from other commodities to soybean production? The remainder of the section will focus on these questions by analysing farm-level results.

5.2.3 The impact of the inclusion of soybean production in non-traditional producing regions: a profitability benchmark

This section will analyse the financial effect and outcome of introducing and replacing existing on-farm production with soybean production. In order to conduct this exercise, various assumptions have to be made which will be discussed throughout the section. Firstly, a test will be conducted in order to illustrate how soybean profitability compares with sunflower production in the respective regions and whether a shift can be expected away from sunflowers. Secondly, soybean production will be included as part of a maize rotation, thus decreasing the area under maize. Assumptions will be made on increased maize yield levels and a reduction in the cost of fertiliser due to the inclusion of soybean production. Finally, enterprise and whole farm analysis and benchmarking will be conducted in order to illustrate the financial effect of including soybean production in the non-traditional oilseed regions. An attempt will be made to determine whether a shift in hectares can occur in the North West region and northern and eastern Free State.

5.2.3.1 The inclusion of soybean production in the North West province

Sunflower versus soybean profitability in the North West province

A comparison is made in Figure 75 between the gross margin levels and production expenditure for soybean and sunflower production in the North West province from 2011 to 2018. The grey and yellow bars illustrate the current and projected gross margin levels for soybean and sunflower production respectively. The red and blue lines represent the total production expenditure for sunflowers and soybeans respectively. The blue triangles illustrate a commodity price scenario where the sunflower farm gate price decreases by 30 % in 2013. The assumption thereafter is that the sunflower farm gate price will continue to remain under pressure for the remainder of the baseline period. This only provides an indication of the extent to which the farm gate price of sunflowers has to decline in order to indicate profitability levels corresponding to soybean production.

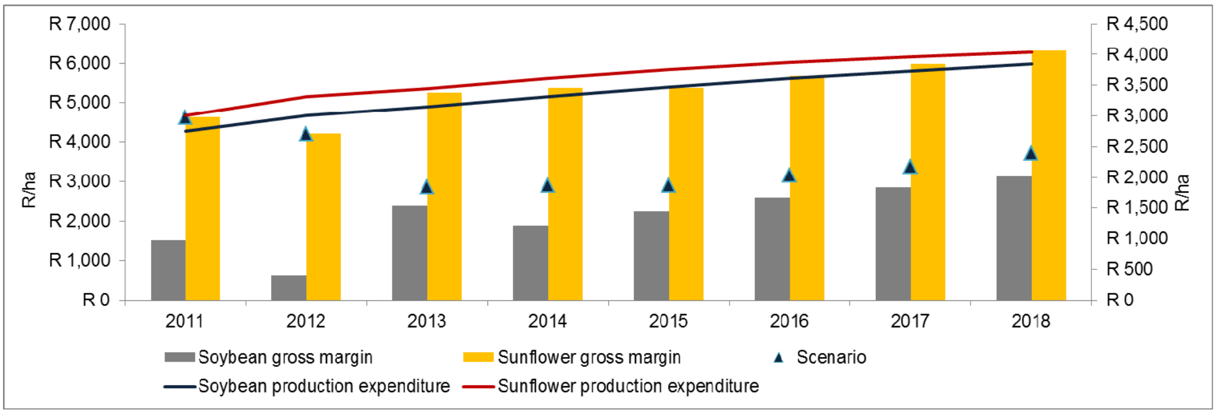


Figure 75: Gross margin and production cost comparison: Sunflower vs. Soybeans (North West)

Source: Own calculations and soybean budgets provided by the Protein Research Foundation (PRF), 2012

It is evident from Figure 75 that under current baseline assumptions and projections according to the BFAP sector model, sunflower profitability is substantially higher than soybean profitability. The data states that on average, the sunflower gross margin will be R3201 per hectare higher than soybean profitability. Furthermore, sunflower production expenditure will be on average only R265 per hectare more expensive than soybean production. Additionally, a higher risk is imposed on the farm business due to the nature of underperformance of soybean production in drought conditions, as can be seen in 2012 where drought badly affected yield levels. The scenario states that the sunflower farm gate price has to decline by more than 30 % in order for soybean production to become financially feasible or competitive in the production structure.

The assumption can thus be made that, under current market conditions, projections and the non-existence of enhanced soybean seed varieties such as drought-resistant cultivars, soybean production will not replace sunflower production in the North West province due to current profitability margins between these two commodities and the proposed risk approach of the farm business. The two key drivers that may change the picture in the future are firstly, the development of drought-tolerant soybean varieties which may give higher yields, and secondly, a downward price shift in other commodities such as sunflowers.

Soybeans as part of a maize rotational system

As stated earlier, the assumption in this section is that soybean production will be included in the farm enterprise structure as part of a maize rotational system, giving higher maize yields and a reduction in the cost of fertiliser. However, a reduction in the maize area is necessary to create room for soybean production.

The following assumptions are made in order to conduct the exercise:

- A 65:35 rotation between maize and soybeans production is anticipated.
- Sunflower production will remain part of the enterprise structure.

- The inclusion of soybeans in the rotational system will increase maize yield levels by 15 % (as only 35 % of total maize area will be part of the soybean rotation).
- A reduction of 10 % in the fertiliser expenditure for maize is anticipated (only 35 % of total maize area will be part of the soybean rotation).
- Harvesting cost is included as a direct allocated expenditure, thus the farm business will utilise a contractor instead of purchasing a new combine header.

The above assumptions will be adjusted in the BFAP farm-level model by allocating 35 % of current maize area to soybean production. The base year (2010/2011) yield level of maize will be adjusted upwards by 15 %. Fertiliser expenditure in the base year will be deflated by 10 %. The gross margins of these two commodities will then be compared, followed by a comparison of the overall financial performance of the farm business and the NFI results obtained in Chapter Four (Figure 31).

Figure 76 below indicates the various gross margins and can be interpreted as follows: The grey bars illustrate the gross margin of maize before soybean production is included in the enterprise structure. The orange bars indicate how soybean production could benefit the maize enterprise in terms of higher yields and reduced fertiliser costs. The green line illustrates the gross margin or profitability level for soybean production. Finally, the blue triangles indicate a scenario where the maize price decreases by 20 % (+−R1500 per ton). The price scenario and gross margin exercise was conducted on a rotational enterprise budget, thus higher yields and lower fertiliser costs for maize production have been taken into consideration.

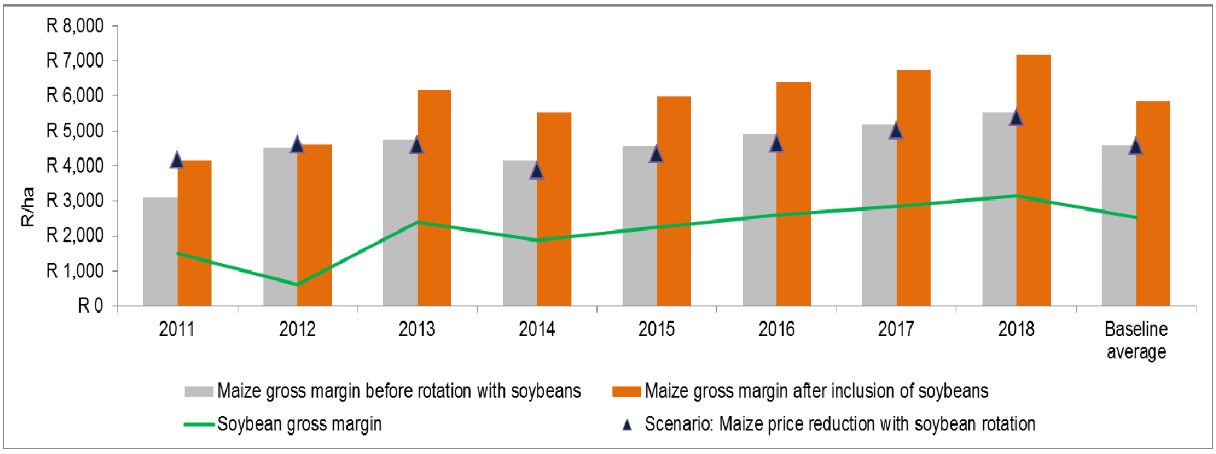


Figure 76: Gross margin analysis between conventional maize, rotational maize and soybeans

Source: Own calculations and soybean budgets provided by the Protein Research Foundation (PRF), 2012

Firstly, it can be observed from the figure that maize profitability significantly outperforms soybean profitability. However, if the assumptions made earlier prevail, introducing soybeans into a rotational system with maize production could increase the average maize gross margin over the baseline period by R1254 per hectare (conventional maize production to rotational system). Secondly, if a scenario is introduced where the maize farm gate price decreases by 20 %, the gross margin for maize production in the North West will closely correspond with gross margin levels prior to the introduction of soybeans into the production system. Yet, even with a substantial decrease in the maize farm gate price, the profitability of maize will still be significantly higher than soybean production.

The NFI with and without soybean production is compared in Figure 77 below. The red line represents the baseline NFI stipulated in Figure 31 and the blue line the NFI after introducing soybean production in the farm enterprise structure in the North West province.

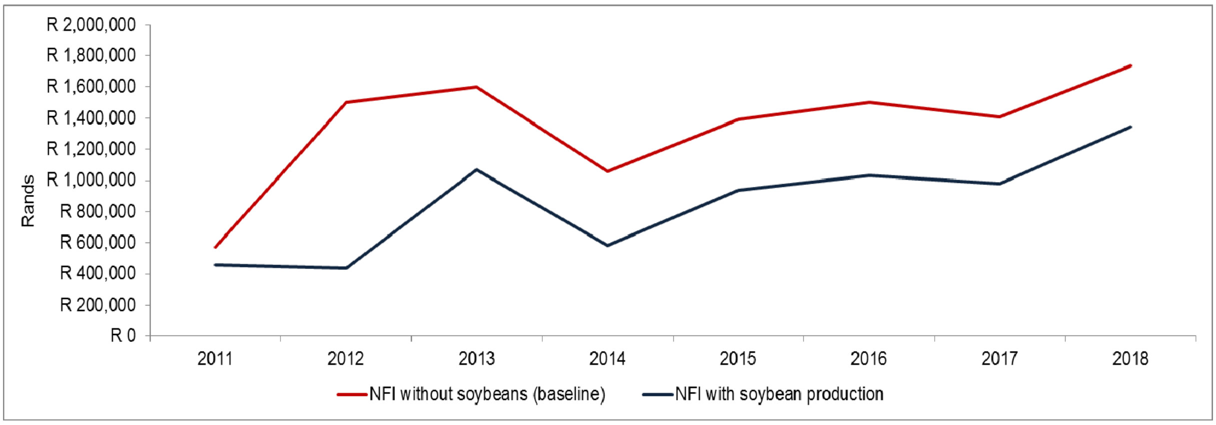


Figure 77: Net farm income (NFI) comparison

Source: Own calculations and soybean budgets provided by the Protein Research Foundation (PRF), 2012

Figure 76 and Figure 77 clearly show that the farm business is worse off by introducing soybean production into the farm production system, based on the assumptions, projections and macroeconomic drivers made by the BFAP sector model. The replacement of current hectares under production is thus highly unlikely to occur in the North West province as soybean production is less profitable than either maize or sunflowers and also imposes higher production and financial risks on the farm business due to the sensitivity of soybeans to drought.

In the scenario that the maize farm gate price decreases by 20 % and yield levels of soybeans increase from 1.44 to 2.1 tons per hectare, the production of soybeans in the North West will be financially feasible. The average baseline gross margin for maize and soybean production in this scenario will be R4629 and R4235 per hectare respectively. The overall conclusion that can be drawn is that the respective commodity prices for maize and sunflower are currently too high for a shift to soybean production to occur. In addition, soybean yields are currently not sufficient to make soybean production financial feasible in the region.

5.2.3.2 The inclusion of soybean production in the northern and western Free State

Sunflower versus soybean profitability in the northern and western Free State

A gross margin comparison is made between soybean and sunflower production in the northern and western Free State region in Figure 78 below. It can be observed from the figure that soybean production expenditure in the region correspond with sunflower production cost. The specified region is recognised for the presence of water availability in their soils, thus the assumption can be made that higher soybean yield levels will prevail and a similar production input approach to the eastern Free State will occur.

Sunflower profitability nevertheless is more profitable than soybean production, even if one anticipates a higher soybean yield, as can be seen in Figure 78. The red line shows that a reduction of 30 % in the sunflower farm gate price is necessary in order for soybean production to become profitable relative to sunflowers. The assumption can thus be made that soybeans cannot compete financially against sunflower production in the northern and western Free State and that an area increase in soybean production to the expense of sunflower area is very unlikely.

However, one should consider the bigger picture since looking only at soybean production, profitability and comparisons will not make sense. One should evaluate the over-all performance of the farm business when soybeans are included in a rotational system with maize, and this will be done in the following section.

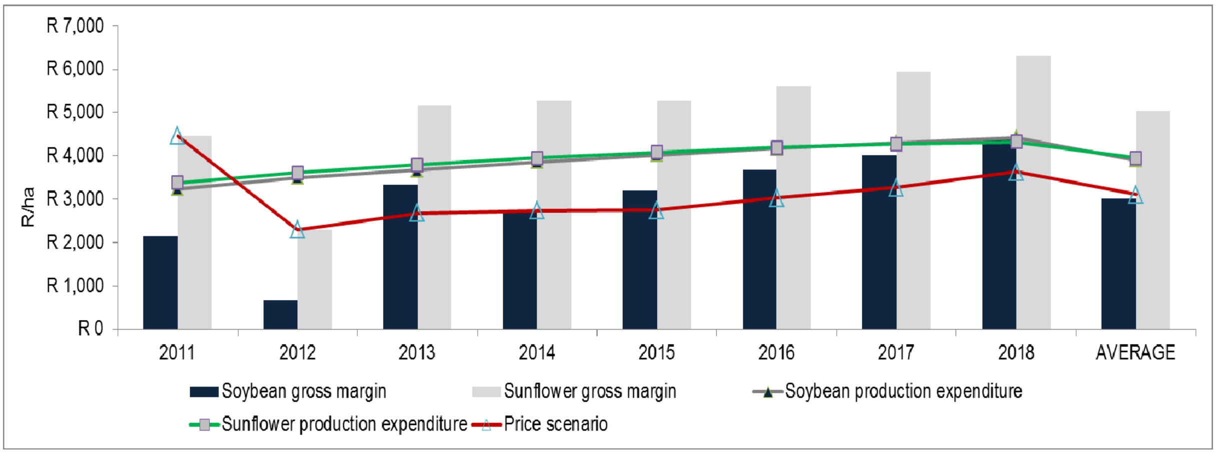


Figure 78: Gross margin and production cost comparison: Sunflower vs. Soybeans (northern and western Free State

Source: Own calculations and soybean budgets provided by the Protein Research Foundation (PRF), 2012

Soybeans as part of a maize rotational system

In order to illustrate a different scenario, the assumptions stated in the North West soybean rotational system will be adjusted and revised.

The following assumptions will be adjusted in the BFAP farm-level model:

- The scenario will be based on a 50/50 maize/soybean rotation. Thus, annually 515 hectares will be utilised for maize and 515 hectares for soybean production.
- Sunflower production will remain part of the production system.
- The scenario will include the assumption that maize yields increase by 20 % due to the inclusion of soybeans as a legume crop.
- Fertiliser expenditure for maize will decrease by 15 %.
- Soybean harvesting cost is included as a direct allocated cost.

Figure 79 compares the respective gross margin levels of maize production before the inclusion of soybeans with maize production which benefits from soybean nitrogen fixation and the soybean enterprise. The blue bars represent the gross margin levels for traditional maize production in the northern and western Free State (baseline). The green bars illustrate the profitability of soybean production in the same region. Finally, the red line indicates the gross margin increase when soybean production is included in the rotational system. The yield and fertiliser assumptions that were made in the beginning of this section should be kept in mind.

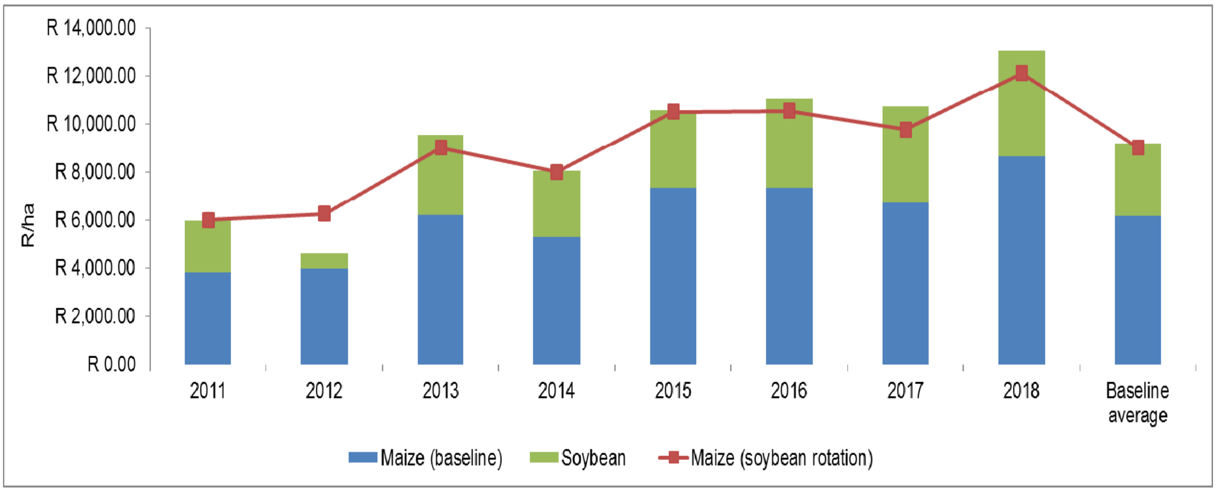


Figure 79: Gross margin analysis for maize (baseline), maize (soybean rotation) and soybeans

Source: Own calculations and soybean budgets provided by the Protein Research Foundation (PRF), 2012

It can be observed from Figure 79 that inclusion of soybean production in rotation with maize nearly compensates for lower soybean gross margins when compared to traditional profitability levels of maize. This can be done by adding the gross margin of traditional maize and soybean production and then comparing it to the gross margin level of maize, which has be adjusted by a 20 % increase in yield and a 15 % decrease in the cost of fertiliser. The average baseline gross margin projection for maize production as part of a rotation system is approximately R9021.55 per hectare. When one adds the gross margins of traditional maize and soybeans together, the average projected gross margin over the baseline period will be R9192.29 per hectare. This is only done to illustrate whether the benefits of soybean in a production system justify profitability levels. Before any conclusions can be drawn, one should consider the over-all performance of the farm business in the northern and western Free State illustrated in Figure 80 below.

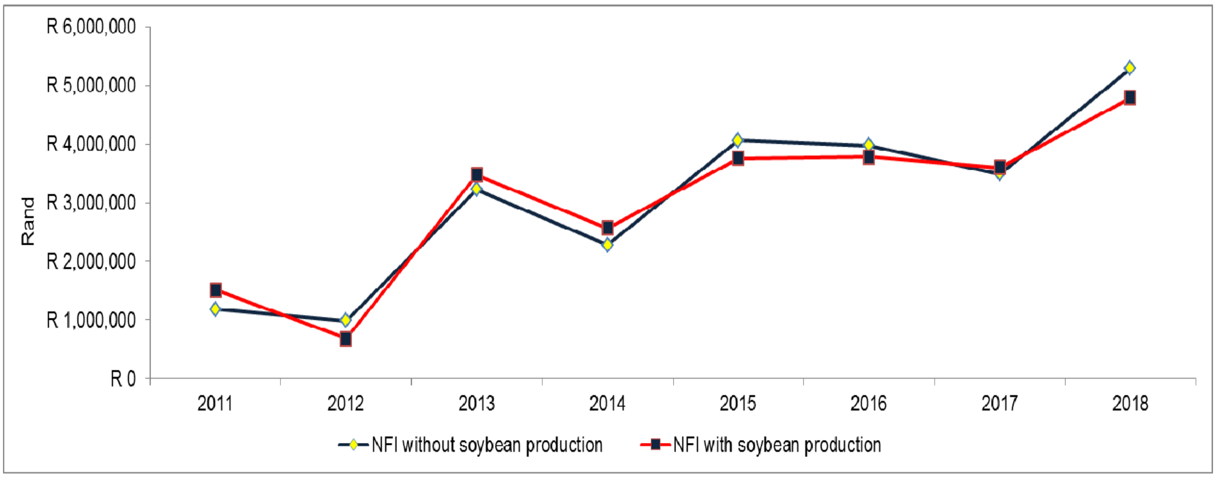


Figure 80: NFI comparison between a soybean rotational systems and non-soybean benefits

Source: Own calculations and soybean budgets provided by the Protein Research Foundation (PRF), 2012

It can be observed from the figure that the baseline and scenario nearly correspond, which implies that soybean production can be justified in the northern and western Free State if there is a 20 % increase in maize yields together with a decrease of 15 % in fertiliser costs. The respective risks should be taken into consideration, which include both production and market risks. Either of these could benefit or harm the financial position of the farm business. In a scenario where insufficient rainfall occurs, soybean profitability may decline substantially due to the sensitive nature of soybean production to drought. However, in a scenario where the maize price declines and a shift occurs back to traditional levels, soybean production and as part of a rotational system may benefit the overall performance of the farm business.

Figure 81 illustrates a scenario where the maize farm gate price decreases to R1500 per ton in 2014, R1300 per ton in 2016 and R1100 per ton in 2018. The scenario assumption is that all other variables remain constant, only the farm gate price changes in the specified years. Thereafter, soybeans as part of a rotational system are compared with traditional maize production without soybeans in the northern and western Free State.

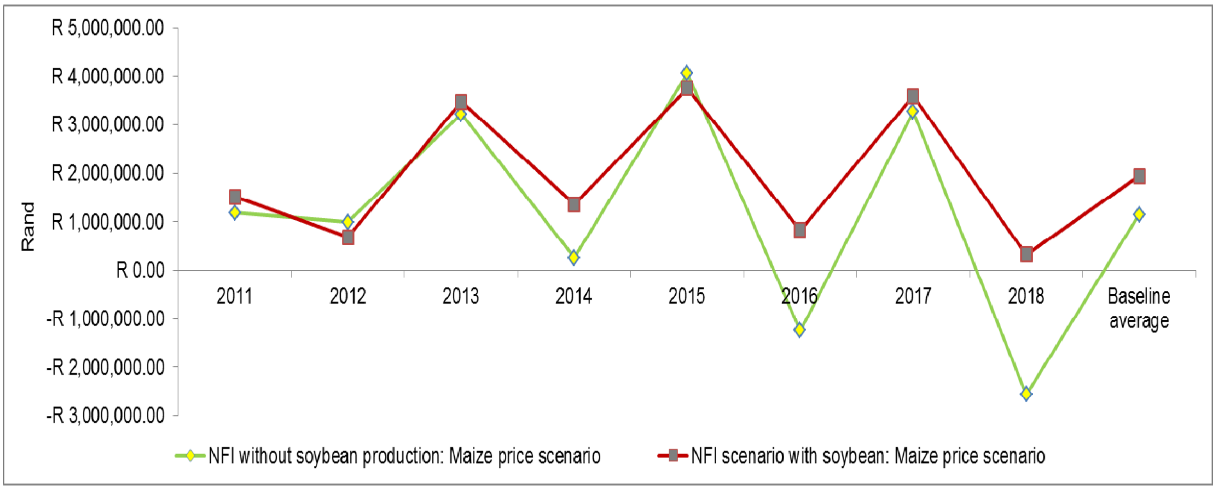


Figure 81: A maize price scenario: Soybean rotation vs. conventional production

Source: Own calculations and soybean budgets provided by the Protein Research Foundation (PRF), 2012

It can be observed from the figure that if previous assumptions prevail, the inclusion of soybean into a farm business's structure might make it better off in years where the maize price decreases substantially. Thus, including soybeans can decrease market risk due to differentiation.

The conclusion can be drawn that a yield increase of 20 % due to the introduction of soybeans might be a complex task. Thus, a shift in hectares from maize to soybeans is plausible, but will occur at a slow rate in the intermediate to long term. Improved soybean seed varieties may increase yields, which could increase the rate of area replacement. The above scenarios indicate that soybean production should not just be rejected due to low yield performance, but should be considered as an overall advantage of the production system and thus the financial position of the farm business and could decrease the risk to the farm business through differentiation and risk dispersion.

5.2.4 Conclusions and remarks

It was stated in the background section that the Protein Research Foundation (PRF) expressed the need in 2009 to understand the potential for animal feed in the long term in South Africa which led to a study conducted by BFAP on the animal feed game and the respective drivers behind it. In the study, a combination of scenarios and models were used to quantify various future outcomes with regard to the demand for, and supply of, protein for animal feed. Numerous strategies were defined, which include the potential of an area increase together with enhancements in the production of soybeans.

The BFAP 2012 baseline projections for the soybean industry provided trends on the expected production and area increases in the intermediate and long term due to current market drivers, which can refer to the existing gap between the import parity price of soybean meal and the export parity nature of raw soybeans.

The question thus arise what the above mentioned projections and animal feed game entail for farm businesses in the respective producing regions in South Africa. In addition, given current market and production conditions and trends, how will the future scenario comprehend?

The map drawn up by Blignaut and Taute (2010) illustrates the soybean production potential of the regions that fall into the scope of the study. From this, soybean profitability was compared to existing production trends in the North West and northern and western Free State.

In both regions, it was indicated that soybean profitability is substantially lower than sunflower profitability, which led to the assumption that if current market conditions continue as stipulated in the BFAP sector model, soybean production will most likely not replace sunflowers in the North West province and northern and western Free State in the intermediate to long term.

The analysis conducted on the North West farm business structure to demonstrate the replacement of white maize area with soybeans indicated similar results as was obtained in the benchmark of soybean profitability versus sunflower profitability. The assumptions in the exercise indicated that a yield increase of 15 % can be anticipated due to the inclusion of soybean in a rotational system with maize. Additionally, the cost of fertiliser was assumed to decrease by 10 %. The results indicate that the increase in maize yield and reduction in the cost of fertiliser are still insufficient from a profitability perspective to justify soybean production at the expense of maize.

On the other hand, the assumptions were marginally adjusted in order to conduct a similar exercise in the northern and western Free State. The assumptions were that maize yield will increase by 20 % and fertiliser expenditure will decrease by 15 % due to inclusion of soybean production in the farm enterprise structure. The results indicated that due to the increase in yield and decrease in fertiliser, together with higher anticipated yield levels for soybeans due to water availability in the region, soybean production may increase in the region if all assumptions prevail. This will most likely only occur in the intermediate to long term due to current high maize prices. In a scenario where the maize price shifts back to traditional levels, soybean production will be more profitable in the region. Thus, soybean production in the region might impose additional risk on the farm business due to sensitivity to drought conditions which impact profitability. Simultaneously, the introduction of soybeans into the farm structure may decrease market risk due to diversification and risk dispersion.

5.3 FARM-LEVEL RISK ANALYSIS: A STOCHASTIC APPROACH TO MEASURING SUSTAINABILITY

5.3.1 Introduction and background

The introduction to this study stated that the South African agricultural and food production environment and corresponding macroeconomic drivers have experienced renewed volatility in the past five years due to tight supplies, macroeconomic drivers, changing demand patterns and other factors that influence the food and agricultural environment. This means that farm businesses experienced a period of rapid changing agricultural commodity prices, simultaneously with increased input inflation.

The overall management of farms given these consistent changes in markets and other farm-related decisions is thus a difficult task since agricultural is normally characterised as a seasonal activity, which implies that the result of a decision at a specific point of time may influence the farm business in the medium term. The reduction of risk and general risk management are therefore a critical sustainability requirement which could assist a farm business's decision-making environment.

The next section will give a case study of a risk management tool that farm businesses in the northern and western Free State can use to evaluate risk at any given time. The results obtained from the exercise could provide an indication of the level of sustainability that a farm business exhibits. Simultaneously, high risk enterprises can be identified which enhance the overall risk management of the farm business. In a scenario where new production and/or macroeconomic drivers occur, a farm business will be able to evaluate the respective impact of the new driver(s) on the farm business. Since profit maximisation, cost minimisation and risk management are the key assumptions of the study, it is important to combine these factors to determine and illustrate the sustainability and the associated risk position of a farm business. The section will include a detailed stochastic analysis of the measurement of farm business risk(s) for the northern and western Free State representative farm business.

5.3.2 The stochastic approach and assumptions

A stochastic model contains the random nature or most likely impact, meaning that the random variables and relationships in the model will allow the output to enclose random elements or probability distributions (Strauss, 2005:15). The functioning of stochastic models and the random nature thereof incorporate risk by allocating probability distributions to specific exogenous and endogenous variables. Probability and cumulative distributions represent a simulation of key output variables in stochastic surroundings which quantify and compare risks that are associated with different scenarios and decisions (BFAP, 2012).

It was stated in Section 3 on p.36 that two basic approaches form part of farm-level modelling and simulation which is a normative and a positive type of approach. The normative approach can be identified as optimisation of a system, or quantifying "what ought to happen" in a system. A positive approach implies the most likely impact of a system and its quantification (Strauss, 2005).

The BFAP farm level model developed by Strauss (2005) is a deterministic (normative) and stochastic (positive) model, which is linked and integrated into the BFAP sector model (van Zyl, 2010:81). A deterministic model is a model where the probabilities of the key output variables are equivalent to one and where the system relationships are constant. The results of the key output variables are thus definite. According to Richardson (quoted in Strauss, 2005), deterministic models do not incorporate the environment of risks due to the fixed nature of the interaction of the variables. Thus, deterministic models simulate a specific outcome given a set of particular inputs (Strauss, 2005).

A stochastic model contains the random nature or most likely impact, meaning that the random variables and relationships in the model will allow the output to contain random elements or probability distributions (Strauss, 2005:15). Stochastic models and the random nature thereof incorporate risk by conveying probability distributions to specific exogenous and endogenous variables or key output variables (KOVs). Probability and cumulative distributions represent the simulation of key output variables in stochastic surroundings which quantify and compare risks associated with different scenarios and decisions.

The next section will thus focus on the evaluation of the risk position of the northern and western Free State farm business by identifying key output variables (KOVs) which will be made stochastically (random). The proposed exercise should determine the risk position of the farm business from a statistical, random and stochastic perspective which takes into account historical trends, the current position and the most likely output given a combination of drivers. It should be stated that a stochastic approach does not entail a forecast, but rather a benchmark under a certain set of assumptions and drivers that could determine the sustainability in the intermediate and long term. The term, stochastic approach, will be explained throughout the remainder of the section.

The following variables have been defined as the KOVs of the northern and western Free State:

- White maize farm gate price
- Sunflower farm gate price
- Fuel as a volatile input (refer to Figure 17)
- Fertiliser as a volatile input (refer to Figure 18)
- White maize yield
- Sunflower yield

The above KOVs will be included into the BFAP farm-level model as stochastic variables, which implies that both the historic and projected trends and scenario will be combined in order to determine certain thresholds and/or the most likely scenario in the future. The rest of this section will focus on the case study from the northern and western representative farm business by analysing the risk position through a stochastic approach.

Before the output is presented, a brief explanation will follow on the stochastic process in order to convert the deterministic output to stochastic variables. The full interpretation of stochastic modelling is discussed in Richardson, Schumann, and Feldman (not dated).

- **Identifying nominal values** (KOV values which are most likely to change) Identification of KOVs values that have not been deflated or adjusted for inflation.

- **Adjust nominal values to real values**
  Adjustment for inflation or allows nominal KOVs to be deflated by the GDP deflator.

- **Conducting a simple regression**
  A simple regression on the KOVs will be conducted to determine the regression coefficients. Thereafter, a significant test will be conducted to

determine the significance of T-values or identify whether trends are visible in the KOVs.

- **Trend adjustment**

  If T-values are insignificant, trend adjustments are necessary only for those KOVs where trends exist. This exercise is conducted by subtracting the residual values calculated by the simple regression from the real values (adjusted for inflation). Thereafter, the original real values will be divided by the new values obtained from the calculation as stated above

- **Summary statistics**

  The summary statistics are simply an exercise where the mean values, standard deviation, confident intervals, minimum values, median values and maximum values are calculated.

- **Absolute deviations**

  Absolute deviations are obtained by subtracting the summary statistics' mean values from the trend adjusted values.

- **Rank correlation matrix**

  A rank correlation matrix is calculated in order to determine the exact correlations between the KOVs.

- **Relative deviation**

  The relative deviation is obtained by dividing the absolute deviation values by the mean values obtained from the summary statistics.

- **f(X)**

  The step allows for the introduction of a mathematical function for the selected KOVs. The function is a relation between the inputs and output which assigns certain values which will determine or influence the output of that particular variable.

- **Independent Standard Normal Deviates** (ISNDs)
  The Independent Standard Normal Deviates are calculated in Simetar by using the NORM function in Excel.

- **Correlated Uniform Standard Deviations (CUSDs)**
  The ISNDs are transformed into Correlated Uniform Standard Deviations (CUSDs) by using the CUSD function in Excel. This utilises the rank correlation matrix and the ISND values to calculate the CUSD output.

- **Inclusion of mean values**
  The mean values refer to the baseline projected values of those KOVs stipulated by the BFAP sector model.

- **Stochastic values**
  The final step is to use the CUSD values to calculate the empirical percentage deviations from the selected CUSDs by using the empirical (EMP) function in Excel. Thereafter, the selected stochastic variables will be included in the calculation sheet for each commodity, from where the most likely output will be calculated by using various Simetar functions.

5.3.3 Gross margin analysis

The next section will compare the risk position of the respective enterprises on the northern and western Free State representative farm business by allowing the above KOVs to run as random or stochastic variables. This will be done by simply replacing the deterministic BFAP sector model projections with stochastic variables and allowing the model to simulate the most likely output at 500 iterations (repetitions). It should be noted that the model is made stochastic only from 2013 onwards.

White maize

Figure 82 illustrates the gross margin stochastic simulation output by indicating the minimum (red line), mean (yellow) and maximum (green) gross margin levels for white maize production in the northern and western Free State region. Combining the interpretation with Table 39, it can be observed that the overall risk position is relatively low. The mean gross margin over the baseline period illustrates the most likely output given historic and projected trends. The stochastic output indicates that the most likely gross margin for white maize production could range in the region of R6312 per hectare. The model simulation indicates an average minimum and maximum gross margin of R535 and R11863 per hectare which provides an indication that even when one considers the minimum level, the gross margin will still be profitable.

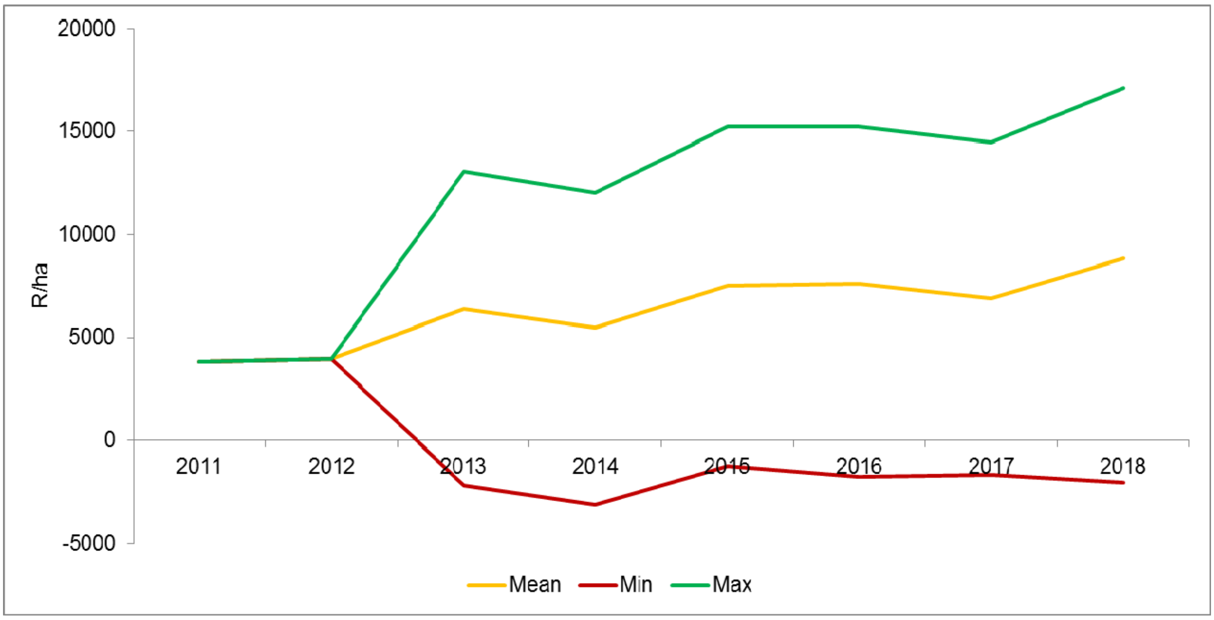


Figure 82: Gross margin stochastic output for white maize production (2011–2018)

Source: Own calculations

Table 39 also shows the total production cost and various returns on investment (ROI) indicators. Investopedia (2012) refers to ROI as a performance measure used to evaluate the efficiency of an investment. Thus, the ROI can be considered as a profitability indicator where the total production cost is the investment and the gross margin (which is total grain receipts minus total expenditure) is the profit. A calculation can be formulated to determine the ROI, which is simply the gross revenue (gross margin) divided by the initial investment (production expenditure). Various benchmarks can be used to determine the relative performance against other type of investments. The most familiar investments or criteria to benchmark the enterprise ROI are 1) financial investments such as fixed deposits at a financial institution and 2) a typical benchmark to the inflation rate, which can be argued if the enterprise or investment beats inflation.

Table 39: Summary of maize gross margin stochastic output: Baseline average (2011–2018)

Indicator	Unit	Value
Mean gross margin	R/ha	R6 312.24
Minimum gross margin	R/ha	R535.18
Maximum gross margin	R/ha	R11 863.31
Total production cost	R/ha	R5 801.98
Return on Investment (ROI) on minimum value	Percentage	−8 %
Return on Investment (ROI) on mean value	Percentage	108 %
Return on Investment (ROI) on maximum value	Percentage	201 %

Source: Own calculations

In Table 39, the minimum, mean and maximum stochastic output were utilised to determine the three respective ROI levels. Firstly, the minimum value (baseline average) is minus 8 % which indicates that the lowest simulated data point average implies a loss of 8 %. One has to keep in mind that the probability of a minimum value is relatively low, therefore the minimum level can be considered almost as the worst case scenario given a certain set of assumptions and drivers. Secondly, the mean or average simulated ROI rate is 108 %, which indicates a particularly good enterprise performance with an exceptionally low risk position. This implies that it is projected that the farm business will on average earn 108 % above what has been invested. It should be stated again that the assumption of normal weather, bullish commodity price projections and high yields due to water table soils significantly favour the ROI levels. The event of a drought year and/or a decrease in grain prices will clearly change this level significantly. Finally, the maximum simulation output was calculated at 201 %.

It should be noted, however, that the above calculations are only conducted on the gross margin levels and that the overhead component is excluded. Later in the section, the general and overall performance will be calculated in a similar context.

Sunflowers

Figure 83 and Table 40 indicates the stochastic simulation output for sunflower production in the northern and western Free State. Figure 83 illustrates the minimum, mean and maximum gross margin value based on historical values and projected trends stipulated by the BFAP sector model. The general observation that can be made is the upside profit potential of sunflower production simultaneously with minimum downside risk. This is indicated by the margin between the minimum (red line) and mean (yellow line) gross margin and in addition, between the minimum (red line) and the maximum (green line) stochastically calculated gross margin levels.

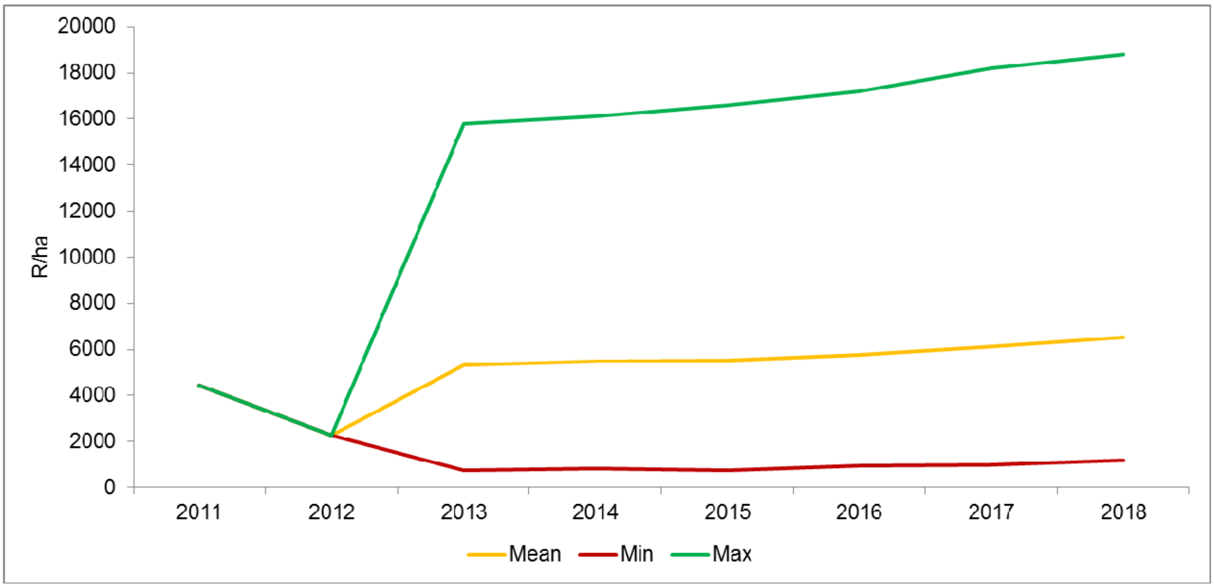


Figure 83: Gross margin stochastic output for sunflower production (2011–2018)
Source: Own calculations

The stochastic simulation output is further compared to the white maize output as was calculated in the preceding section. It can be observed from Table 40 that the mean gross margin of maize production is projected to be higher than sunflower production in the region. However, the minimum gross margin, which reflects the downside risk, is significantly higher than that of maize, which provides an indication that based on historic yields, farm gate price and expenditure and the projected levels of these variables, sunflower production exhibits a lower risk position than white maize in the northern and western Free State. Similarly, the upside profitability opportunities of sunflower production are substantially higher, which is also evident when one considers the maximum ROI levels.

Table 40: Summary of sunflower gross margin stochastic output: Baseline average (2011–2018)

Indicator	Unit	White maize	Sunflower
Mean gross margin	R/ha	R6 312.24	R5 185.76
Minimum gross margin	R/ha	R535.18	R1 531.16
Maximum gross margin	R/ha	R11 863.31	R13 688.25
Total production cost	R/ha	R5 801.98	R4 048.03
Return on Investment (ROI) on minimum value	Percentage	−8 %	41 %
Return on Investment (ROI) on mean value	Percentage	108 %	128 %
Return on Investment (ROI) on maximum value	Percentage	201 %	331 %

Source: Own calculations

The minimum ROI of sunflower production is 41 % which illustrates that even at the lowest stochastically output, sunflower production will indicate a substantial return, which in reality is not really possible when one considers the volatile agricultural environment. The preceding section should thus be combined in order to illustrate the overall performance and profitability of the farm business, which takes into account the overhead component such as labour, office and other capital expenses. In addition, in reality the preceding scenario and stochastic output should be tested in order to take into account drought years, a bearish market environment, input-related shocks and other market and policy related exogenous variables that will influence the output significantly.

Finally, the purpose of the preceding calculations and approach is to determine the level of risk present in the various commodity enterprises. These indicated that sunflower production exhibits lower production, market and input expenditure risk when one considers a profitability and growth context.

The subsequent section will analyse the overall farm business performance by utilising the net farm income (NFI) as a proxy for farm profitability.

5.3.4 The overall farm profitability and risk position

The overall farm profitability and risk structure of the northern and western Free State representative farm business can be analysed using the same approach identified in the gross margin stochastic simulation section. Figure 84 reflects the simulation output for the NFI as a proxy for farm profitability. The green line illustrates the maximum NFI for the baseline period and the yellow line the most likely NFI based on the assumptions stipulated by the BFAP sector model and the historic trends of the farm business.

It can be observed from the figure that the mean value remains positive over the period, which provides an indication that a relatively low risk is currently present. However, the red line indicates that the simulation output could result in deficits in certain years given a combination of bearish markets, lower than anticipated yield levels and input-related shocks. The interpretation of Figure 84 should be combined with Table 41 in order to illustrate the approximate values.

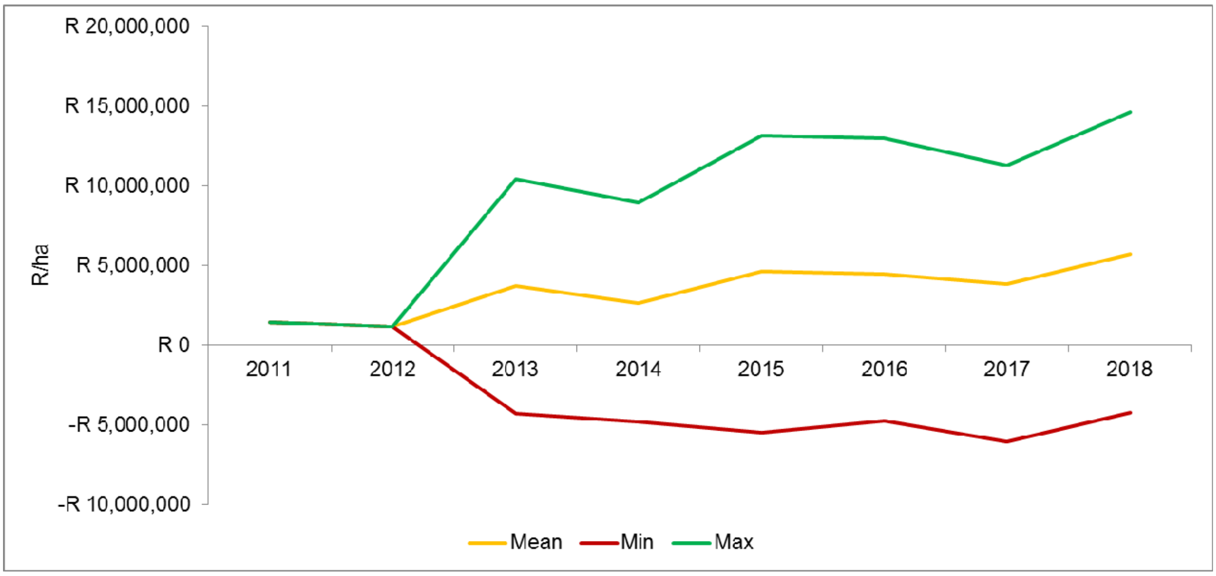


Figure 84: Net farm income (NFI) stochastic simulation output (2011–2018)
Source: Own calculations

A summary of the simulation output of farm profitability is presented in Table 41 below. An important factor that should be kept in mind is that the overhead component is included in the NFI interpretation. The illustration in Table 41 thus provides the general performance of the firm from a profitability perspective, which can be compared to any type of investment. This could serve as a benchmark for the relative performance of the business against other types of investments. Opportunity cost is thus an important driver since a lack of performance by the farm business could imply that the owner of the farm business might quit production in order to engage in better investment opportunities. This can therefore assist in the determination of sustainability in the agricultural environment and/or farm businesses in South Africa.

Table 41: Summary of net farm income stochastic simulation output: Baseline average

Indicator	Unit	Baseline average
Mean NFI	R	R3 448,216
Minimum NFI	R	−R3 375,905
Maximum NFI	R	R9 246,799
Real net worth	R	R17 258,029
Return on Investment (ROI) on minimum value	Percentage	19.29 %
Return on Investment (ROI) on mean value	Percentage	−17.68 %
Return on Investment (ROI) on maximum value	Percentage	50.68 %

Source: Own calculations

The stochastic output simulated a mean NFI of R3.4 million on average over the baseline period, which reflects a positive picture for the northern and western Free State farm business. The high NFI is mainly supported by relatively stable commodity prices, the high yield potential in the region and cost structure of the farm business. The model further indicates that income levels above R9.0 million are plausible given a set of bullish factors. On the other hand, an income deficit of R3.3 million is not impossible. However, the general sustainability given the simulation output remains positive.

Furthermore, the net worth of a business refers to the amount by which the total assets exceed the total debt or liabilities. The total assets include fixed, moveable and current assets. The real net worth refers to the amount by which assets exceed liabilities, which accounts for inflation. This is calculated by converting the net worth into the current value or in other words, dividing the net worth by the GDP deflator. The real net worth in the study is utilised as a proxy for investment, thus, the total value that the farm business invested in order for the business to operate. It should be stated that the value of land is excluded in the calculation since many farms have been in the possession of families for several generations.

The ROI is calculated by dividing the total farm income (NFI) by the real net worth in order to determine the overall performance of the farm business. Table 41 states that an average ROI over the baseline period of 19.29 % is plausible. A 60 months' fixed deposit at a financial institution can earn up to 7.38 % effective interest per annum (FNB, 2012). A short-term investment (12 months) at the same financial institution can earn up to 3.75 % effective interest per annum (FNB, 2012). Government bonds in South Africa can currently earn up to 7 % annual interest on a five-year fixed rate (RSA Retail Savings Bond, 2012).

When one compares these returns from financial institutions, one has to take the respective risk into consideration. The above financial and government bond investments exhibit a relatively low risk. However, agricultural production may encounter medium to high risks as was stated throughout the study. The rate of return, the respective risk coefficients and a combination of risk determinants (alpha, beta, standard deviation and correlation) therefore determine whether an investment is good or not. This is not included in the scope of the study and the general assumption that can be made is that on average, a ROI of 19.29 % reflects well, which entails a relatively risk averse position. It should be kept in mind that the stipulated ROI is the baseline annual average. Investment and sustainability from a financial perspective thus indicate that agricultural remains a good investment in the northern and western Free State farming region. Finally, Table 41 illustrates that the ROI can exceed 50.68 %, but in addition can be as low as −18 %, given the interaction between market and production variables.

5.3.5 Probability and return on investment

The last section will include a brief analysis on the probability of a range of earnings or returns. This will be supplemented by a scenario in order to determine the risk position of changing agricultural variables. This analysis will be conducted and interpreted by utilising stochastically stoplight charts which assign probabilities for each range of output level. Firstly, the baseline stoplight will demonstrate the current probability distribution of achieving a certain ROI. Secondly, a market scenario will be compared to the baseline position in order to demonstrate how agricultural risks may impact returns.

The baseline stoplight chart

The baseline simulation, probabilities and stoplight chart are based on the assumption of achieving a ROI between 7 % and 14 %. For the purpose of this exercise, the objective of the farm business is to earn a higher return than government bonds and fixed investments at financial institutions. It should be noted that the exercise only includes the future position, which in this case is from 2013 to 2018 (baseline period).

In order for an ROI of between seven and 14 % to realise, one has to determine the NFI that will ensure the stipulated ROIs. This was conducted by means of calculating the average projected real net worth over the baseline period as was simulated by the baseline stochastic run. The simulated real net worth value was R18 659 609. In order to determine the upper (14 %) and lower (7 %) cut-off values to calculate the stoplight chart, one can use the following formulas:

1) NFI ÷ Real Net Worth = Return on Investment

$$X \div R18\,659\,609 = 0.07 \text{ (or 7 \%)}$$

$$X = R18\,659\,609 \times 0.07$$

$$X = R1\,306\,172.63$$

2) NFI ÷ Real Net Worth = Return on Investment

$$X \div R18\,659\,609 = 0.14 \text{ (or 14 \%)}$$

$$X = R18\,659\,609 \times 0.14$$

$$X = R2\,612\,345.26$$

The above formulas determine the NFI range needed to obtain a ROI between 7 % and 14 %, which is a requirement for the calculation of the stoplight chart. Figure 85 illustrates the stoplight chart for the probability of generating a ROI between 7 % and 14 %. The green areas illustrate the probability of generating a ROI that exceeds 14 % or an NFI of R2 612 345.26. The yellow areas represent the probability of generating an ROI between 7 % and 14 % (R1 306 172.63 and R2 612 345.26). The red probabilities indicate an ROI lower than 7 %.

It can observe from the figure that, in 2013 and 2014, the probability of generating an ROI of 14 % was 61 % and 52 % respectively. The reduction in the probability from 2013 to 2014 is mainly due to an expected supply response of agricultural commodities in 2014 which lowers the market equilibrium farm gate prices. The probability of generating an ROI between 7 % and 14 % for the above years is 11 % and 12 %. The figure also indicates that in 2014, there will be a 36 % chance that an ROI of 7 % will not be met.

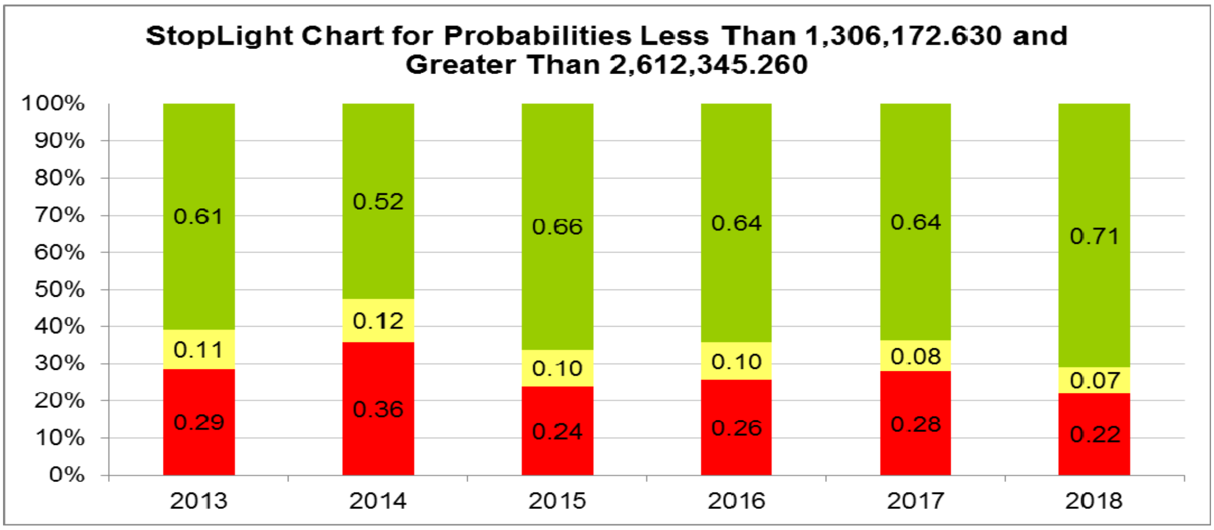


Figure 85: Stoplight chart for the probability of generating an ROI between 7% and 14% (Baseline)

Source: Own calculations

If one considers the entire baseline period (2013 to 2018), the model simulation states that on average there is a 63 % chance in any year that the ROI will exceed 14 %. Similarly, a 10 % probability exists for the ROI to range between 7 % and 14 %. Finally, in any stipulated year, a 27 % probability exists of generating an ROI less than 7 %. Thus, if one adds the green and yellow probabilities, which entail at least an ROI of 7 %, the general risk position of the farm reflects low. On average there is a 73 % chance that the ROI will exceed 7 %.

Scenario 1 – Farm gate prices decrease by 20 % in 2015 and 2018

Scenario 1 contains the assumption that both white maize and sunflower commodity prices decrease by 20 % in 2015 and 2018 due to market mechanisms and over-supply internationally. The effect can be observed in Figure 86 by comparing the 2015 and 2018 years with the baseline stoplight chart.

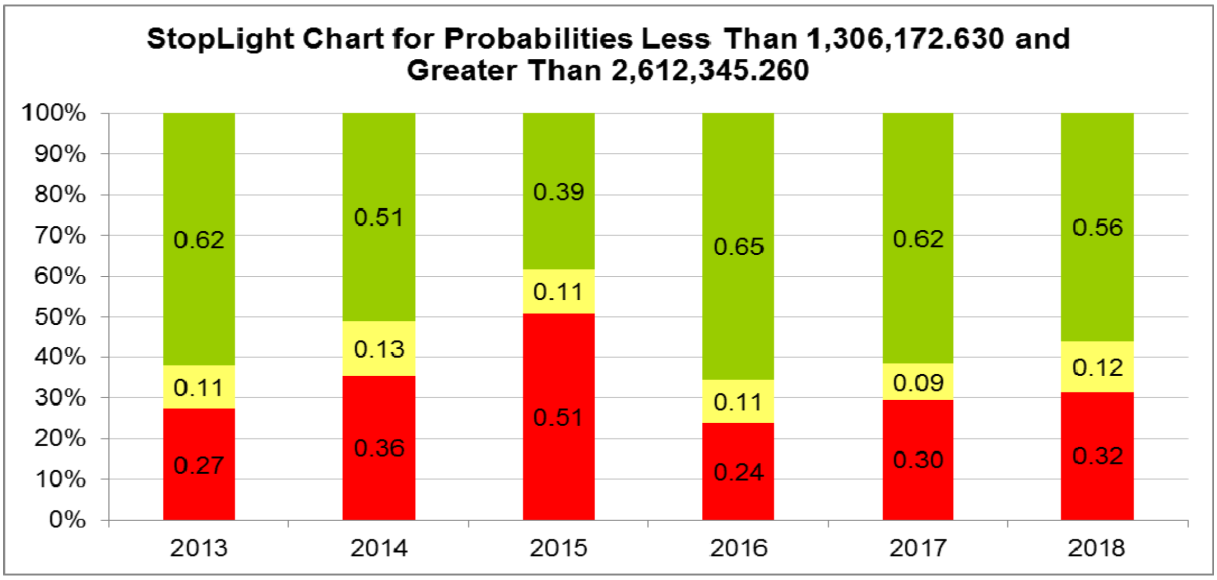


Figure 86: Stoplight chart for the probability of generating a ROI between 7% and 14% (Scenario 1)

Source: Own calculations

When comparing the 2015 baseline stoplight chart with scenario 1, it can be observed that the probability of generating an ROI that exceeds 14 % decreases by 27 % due to lower anticipated farm gate prices for white maize and sunflower. Thus, the total probability of earning more than 14 % in 2015 is only 39 %. The probability of generating an ROI of lower than 7 % is 51 % for the same period. A similar trend in 2018 can be observed due to the market shock. The probability decreases from 71 % to 56 % in order to generate an NFI that exceeds R2612345.

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

The agricultural and food production systems in South Africa have experienced renewed volatility and changing market conditions during the past five years, with both macro-economic as well as climatic conditions playing a vital role in the direction of agricultural markets. These changing market conditions included various macro-economic drivers, natural conditions, changing consumer behaviour, input inflation, energy related drivers and the continuous impact of global role-players in both the demand and supply side of agricultural goods.

These volatile drivers have a relentless effect on the primary production of agricultural goods and more specifically on strategic decision-making at farm-level. The decision making environment of a farm business has thus become a delicate space due to simultaneous interactions of a range of volatile drivers. Yet, this study clearly illustrates that despite all of these simultaneous interactions, a few basic principles still determine the future of a farming operation.

As in other developing countries in the world, the demand for food is increasing rapidly in South Africa. However, it is not only the rate of increase in food demand that is a cause for concern and applying more pressure on the South African farmers to produce more food, but also the changing nature of consumption patterns as income is increasing. For example, meat consumption experienced the highest rate of increase over the past decade and this trend is expected to continue in future. The rate of increase in consumption of bread, rice and potatoes is outpacing the increase in consumption of maize meal and South Africa is already a net importer of wheat and rice.

The problem statement identified for this study is grounded in the basic principle of overlaying production and consumption trends. Although this old principle has been applied by researchers at BFAP for many years, it has only been applied within a sector-wide application, and more specifically the sector model. The sector model uses aggregate elasticities to project the long term shift in area under production.

Although these supply-response elasticities have been statistically estimated, they present an aggregate view of the total area under production for a specific crop and do not give a detailed picture for a specific region. Hence, this study set out to test whether the long term shifts in the areas under production of the various grains and oilseeds are in fact economically sustainable at farm level, taking into consideration the range of drivers that influence the farmer's decision. This study can thus be viewed as a disaggregate approach to understanding plausible long term supply response in South Africa.

The need was to conduct a stock-take of the current position of farm businesses in South Africa and to evaluate the respective impact of changing agricultural drivers. The objectives stated that it was necessary to identify representative farm businesses in the key summer producing regions in South Africa and to determine the current production and financial environment of these typical farm businesses. It was further stated that it is necessary to determine whether long-term projections are plausible from a production perspective and whether land utilisation patterns might change in the intermediate and/or long term. By evaluating the current position and impact of long-term projections at farm level, one can determine and revise the various drivers of the farm business's decision-making environment. Finally, it was stated that it is important to determine the impact of selective macro-economic and production scenarios that could occur in the future.

The annual Bureau for Food and Agricultural Policy (BFAP) baseline report published a graph in 2012 which illustrates what the most likely effect on hectare utilisation may be given a certain set of macro-economic and exogenous drivers. The projected South African crop area is illustrated in Figure 1. According to these simulations, the total area under white maize production will decline from 2012 towards 2020 (BFAP, 2012). The figure further indicates a relative shift in the crop mix, with the total soybean area increasing significantly towards 2020, mainly due to the demand for soybean oilcake and existing opportunities in the soybean crushing industry.

The question arises whether the anticipated shift in the area that is driven by macro-economic factors is realistic from a producer's perspective. Stated differently, can a relative shift in hectares of the various field crops be expected over the intermediate or long term in South Africa based on an in-depth farm analysis?

On-farm validations in the North West province, northern and western Free State, eastern Free State and Mpumalanga key producing regions were conducted using the methodology of Agribenchmark's standard operating procedure to define typical farm businesses and the BFAP farm-level model. This was used to determine and evaluate the financial position of these farm businesses in order to determine the long-term sustainability, given changing macro-economic drivers and projections based on the BFAP sector model.

Firstly, the study indicated that farm businesses in the stipulated areas will be sustainable in the long term, given the current BFAP sector model balance sheet and area projections for the major grain and oilseed commodities. This was indicated through positive gross margins in all regions, which shows that the net farming income for these farm businesses will remain positive in the future. It was further indicated that the projected profitability will exceed historic levels which means that projections made by the sector model will be plausible at farm level. However, the mentioned sustainability is subject to various drivers and assumptions. The reality is that farm businesses should continue to pursue a profit maximisation strategy. Secondly, farm businesses should aim to maintain and increase productivity levels in order to be sustainable. The study indicated that increased productivity could be obtained through availability of technology and improved production techniques.

Secondly, the study unpacked the financial environment of farm businesses in each key producing region and focused on the specific crops, their characteristics and relative performance. This addresses the issue of whether traditional crop mixture patterns will continue in the future or can a shift in land utilisation trends be expected. These historical patterns and performance were compared to projected profitability in order to determine whether a more favourable future scenario is plausible given the outcome and projections of the BFAP sector model.

The North West analysis indicated that the BFAP sector model projections impose a better financial position when measured to historic levels. Anticipated white maize area reduction as reflected by the BFAP sector model is thus a plausible scenario at farm level, since the financial performance of yellow maize will continue to remain robust in the long term scenario due to increasing demand for animal feed. However, the performance of sunflower production reflected way better than maize, which entails that a shift away from sunflower production will most likely not occur. Similarly, the sideways projected area of sunflower production in the North West is plausible at farm level. It was stated earlier that the financial performance of sunflower performed way better than those of maize production, mainly due to exceptionally high sunflower yield levels. Since the methodology was used to identify a representative farm business in a specific region, it is extremely difficult to construct one farm for a province. The recommendation can therefore be made to conduct the same analysis, but using provincial yield averages. Secondly, BFAP sector model projections could create more value when provincial estimates are used instead of national projections.

The financial performance of white maize and sunflower production in the northern and western Free State indicated similar trends as the North West province. It is further expected that the enterprise performance will remain competitive in the long term, thus illustrating that the competition for arable land in this province will remain robust. It is therefore unlikely that major structural and area changes will occur, given already healthy performance of existing commodities. The existence of water table soils imposes an advantage for the region, which entails higher obtainable yield levels, especially maize production. The analysis indicates that maize production will perform better than any other commodity in the intermediate to long term.

The analysis conducted in the eastern Free State and Mpumalanga illustrated the effect of rotating soybean and maize production. It was stated that there exists a relative advantage to including soybean production as part of a rotational system with maize. However, the study indicated that there are production and financial risks in the eastern Free State when soybean production is included, since low yield levels could imply that a farm business could experience negative income. Thus, the assumption can be made that farm businesses in the eastern Free State should adopt a strategy to consistently improve soybean yield levels since only a marginal increase in yield could lead to profitability levels that can compete with yellow maize production. Land utilisation decisions regarding yellow maize and soybean production will depend on the relative offset between having the advantages of higher maize yield levels and the respective risk profile of soybean production.

The Mpumalanga farm business reflected a healthy position in both profitability and crop mixture trends. From a production perspective, yields in Mpumalanga were exceptionally good, which indicates higher enterprise profitability. The respective production cost in addition illustrate that both maize and soybean could be produced relatively cheap when compared to other regions. Thus, good performance of yield, relatively low production expenditure and higher projected commodity prices establish a perfect profitability combination and the assumption can therefore be made that the current crop mixture of yellow maize and soybeans will continue in the future. It should be mentioned that the effect of mine prospecting in the Mpumalanga region imposes a major concern for the agricultural industry. This implies that agricultural production area is converted to mining activities, creating concerns for the food security status of South Africa. It is estimated that more than 200 000 hectares of agricultural land may be lost due to current mining activities and prospecting in the region. It is therefore recommended that a detailed study should be conducted to determine the overall impact of mining on the agricultural environment and food security strategy of South Africa.

The study also indicates that in any firm, the general strategy of the business will not be to indicate a financial loss. Thus, profitability will remain the key driver and consistent adjustments in the business structure will occur in order to keep up with changing drivers and other factors which influence profitability. The management of farm businesses will pursue the same approach. Figure 72 illustrates the competition between the respective commodities in the summer rainfall region. The commodity projected to be the most profitable is yellow maize production in Mpumalanga, followed by white maize production in the northern and western Free State. The third ranked commodity is sunflower production in the North West province. The assumption can thus be made that a shift in area away from these commodities is highly unlikely due to its respective profitability positions. A major shift in markets and/or yields has to occur in order to discourage production of these commodities in the above regions. Fourthly, dryland soybean production in Mpumalanga is ranked fourth and given the advantage that soybean production has in crop rotation, a shift away from this type of production is highly unlikely.

Furthermore, yellow maize production in the eastern Free State and sunflower production in the northern and western Free State are ranked fifth and sixth respectively, with nearly identical gross margins levels. White maize production in the North West province and soybean production in the eastern Free State ranked in the bottom section of the analysis.

However, it is evident from the figure that the competition between grain and oilseed commodities is exceptionally high from the third to seventh commodity rankings, which indicates that volatility in these commodities will continue.

Given the output of Figure 72 the assumption can be made that if soybean yield levels do not increase in the long run, an area reduction can be expected in the eastern Free State. In order to compete against the mid-range commodities (gross margin level of R5000+), soybean yields in the eastern Free State have to increase to 2.4 tons per hectare, which is a highly complex task in dryland production and natural restrictions. In addition, if marketing strategies of the farm business can improve and the farm business is able to increase the respective farm gate price by R500 per ton, the required yield level will be two tons in order to compete with mid-range commodities. The final approach will be to marginally increase yields and to reduce the respective input expenditure by at least R400 per hectare in order to compete for arable area. The preceding arguments state that various complex factors have to be overcome in order to compete against other grain and oilseed production and area.

The financial stock take of farm businesses in selective producing regions illustrated a possible scenario under a set of various assumptions and drivers. However, the study further indicated the most likely effect when one has to shift away from anticipated assumptions, such as normal rainfall in any specific year. The study also mentioned that the approach to risk will remain an important factor. These types of macro-economic scenarios were tested in Chapter Five, which mainly focused on the impact of the risk approach in the decision-making environment of farm businesses.

It was indicated that the BFAP sector model anticipates a significant increase in soybean production, mainly driven by demand patterns of meat consumption which increase the demand for animal feed. The scenario was tested by introducing soybean enterprises in non-traditional soybean producing regions.

The analysis conducted on the North West farm business structure in order to demonstrate the likely outcome of replacement of white maize production with soybeans indicated that maize will remain more competitive than soybean production, even when one anticipates higher yield levels of maize due to the rotational effect and a decrease in the cost of production. A rapid shift in the intermediate term away from maize and sunflowers to soybean production is thus unlikely. However, as stated earlier, it is recommended that a detailed study and analysis is conducted where the entire province is considered, thus taking average yield levels into consideration.

Similarly, the analysis conducted on the northern and western Free State farm businesses indicated that soybean production may increase in the region due to the increase in yield and decrease in fertiliser use, together with higher anticipated yield levels for soybeans due to water availability. This will most probably only occur in the intermediate to long term due to current high maize prices. In a scenario where the maize commodity price shifts back to traditional levels, soybean production will be more profitable in the region. However, soybean production might impose additional risk on the farm business due to its sensitivity to drought conditions, which impacts profitability. On the other hand, the introduction of soybeans into the farm structure may decrease market risk due to diversification and risk dispersion.

The study further highlighted farm-level risk, where enterprise gross margins for white maize and sunflower were interpreted from a stochastic perspective. The stochastic output for both white maize and sunflower production reflected extremely well under the current baseline projections, assumptions and underlying factors. The mean white maize gross margin was simulated and projected at R6312 per hectare. The mean sunflower gross margin was simulated at R5185 per hectare. The stochastic output of the overall farm profitability and rate of return as an important investment indicator were compared to other investments in the financial and government sectors.

It is recommended that external drivers and their respective impact on land utilisation patterns should be further analysed. Increasing mining activities will have a significant impact on the availability of arable land leading to a larger concern of the impact on grain- and oilseed's balance sheets given the exclusion of highly potential arable land in current and prospected mining areas such as Mpumalanga. Additionally, land degradation in South Africa will remain an important issue in terms of land utilisation patterns.

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maize+rotation+production+ syst em&source=web&cd= 30&cad=rja&ved=0 CFc QFjAJ O BQ&ur l=http %3A%2F%2F www .agronomy.ks u.edu%2 Fextens ion%2FDesktopM od ules%2FViewD ocument.a spx%3FD ocu mentID%3D302 2&ei=U7hlU LmwH uHM2A Wq0ICICg&usg=A FQjCNF Mh Qu3l89A4rK5Ks 5U6BU7G-rLgg [Accessed on: 2012-09-28].

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APPENDIX A

- 1st draft of data collection instrument(s) -

BFAP/Agribenchmark cash crop Questionnaire 2011

Details:	
Farm name	
Basis year	

Additional information:

1.) For more information, please see **comments** in selected areas mark in the top right corner of the cells. This makes the data more accurate.

2.) Cells which is coloured **turquoise**, is automatically calculated.

3.) Please contact Divan vd Westhuizen for further enquiries or assistance.

ENQUIRIES:

Divan van der Westhuizen

TEL: 082 843 5381

E-MAIL: divan.vanderwesthuizen.up.ac.za

FARM & LAND DATA

Farm Name: 0 **Year:** 0

1.1 Farm Data:	Description	
Type of dataset: (Tick only)	Individual Farm Typified	x
	Prepanel Typical Farm	
	Full Panel Typical Farm	
Total Acreage (ha)		
Region (Letter code)		
Region		
Main enterprise (crops, livestock etc)		
Farm info (Irrigation, rainfall etc)		
Tillage system: (Tick only)	No Till (Direct seeding)	x
	Conservation Tillage (Mulch seed)	
	Intensive Tillage (Plough)	
	N.a	
Policy (Support)		
Strategy		
Legal Status		
Does the farm represent top management' (Tick only)	Yes	x
	No	

1.2. Land Use:	Description:				
Total farm acreage	0.00				
1.2.1 Arable area:	Arable land owned (ha)	Arable land rented (ha)	Total (ha)		
Acreage arable land (ha)			0		
1.2.2 Arable area description & acreage:	Double cropping (ha)	Irrigation (ha)	Perennial crops (ha)	Pasture cropping (ha)	Fallow (ha)
Acreage (ha)					
1.2.3 Grassland area:	Grassland owned (ha)	Grassland rented (ha)	Total grassland (ha)		
Acreage grassland (ha)			0		
Details:				Cross Check	
				0	
				0	
1.2.4 Other land	Acreage (ha)	Description			
Acreage & Soil type					
1.2.5 Land use details:	Description:		Description:		
Elevation (m)		Climate			
Ave market distance (km)		Ave rainfall per annum			
Ave field size (ha)		Rainfall distribution			
Ave distance farm field (km)		Natural restrictions			

1.3 Land Costs		
Descrpition	Arable land	Grassland
Land price (ZAR / ha)		
Rent old contracts for land (ZAR / ha)		
Rent new contracts for land (ZAR / ha)		

CROPPING SYSTEMS DATA

Farm name: 0 Year: 0

NB: 1.) ARROWS ARE EXPLAINED IN THE "COMMENT" SECTION. 2.) SEED INPUT @ CELL A234 (BOTTOM OF WORKSHEET)

1. Rotations

Name of rotation	Turnaround time (years):	Type of Rotation (Tick only)					
		Monoculture	Annual cropping rotation	Annual cropping rotation with pasture	Annual cropping rotation with double cropping	Double cropping rotation	Perennial crop
1.		X					
2.		X					
3.		X					
4.		X					
5.		X					
6.		X					

2.1 Crops: Rotation 1										
Name of rotation:	1.									
	Acreage		Yield				Prices (ZAR / t)			
Name of crops:	Crop acreage	Previous crop	Crop yield main product (t / ha)	Sh. Dried product (%)	Sh. Stored product (%)	Crop yield by product (t / ha)	High crop price	Ave crop price	Low crop price	Ave byproduct price
1.										
2.										
3.										
4.										
5.										
6.										

	Name of crops:						Application (eg: KAN - 260kg/ha)
Direct cost manual input cnt	1.	2.	3.	4.	5.	6.	
Nitrogen input (kg / ha)							
Nitrogen cost (ZAR / ha)							
Phosphate input (kg / ha)							
Phosphate cost (ZAR / ha)							
Potassium input (kg / ha)							
Potassium cost (ZAR /ha)							
Lime input (kg / ha)							
Lime cost (ZAR / ha)							
Organic input (kg / ha)							
Organic cost (ZAR / ha)							

NOTE: Please carefully consider the ter
has no own storage facility on the farm
one realized during harvest season. In
grains on his/her farm the average selli
marketing strategy and the evolution of
period. Again, it's crucial to capture the

	Name of rotation:					
Other direct cost manual input	1.	2.	3.	4.	5.	6.
Herbicide (Application(s))						
Herbicide cost (ZAR / ha)						
Fungicide (Application(s))						
Fungicide cost (ZAR / ha)						
Insecticide (Application(s))						
Insecticide Cost (ZAR / ha)						
Other ch. Cost (ZAR / ha)						
Other fertilizer cost (ZAR / ha)						

FERTILIZER INPUT & CALCULATIONS

Farm name: 0 Year: 0

1. Fertilizer Input

Type of fertilizer	Min / Org?		N (%)	P (%)	K (%)	Mg (%)	S (%)	CaO (%)	Fe (%)	Mn (%)	Zn (%)	Cu (%)	Mo (%)	Cl (%)	Bo (%)
1.		%													
		ZAR / kg													
2.		%													
		ZAR / kg													
3.		%													
		ZAR / kg													
4.		%													
		ZAR / kg													
5.		%													
		ZAR / kg													
6.		%													
		ZAR / kg													
7.		%													
		ZAR / kg													
8.		%													
		ZAR / kg													
9.		%													
		ZAR / kg													
10.		%													
		ZAR / kg													
11.		%													
		ZAR / kg													

3. Seed Input

Type of seed	Seed price (ZAR / kg)	Treatment cost (ZAR / kg)	Tech - fee cost (ZAR / kg)	Share certified seed (%)
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

MACHINERY & BUILDING DATA

Farm name: 0 **Year:** 0

1. Tractors Input

Type of tractor:	Number of tractors	Engine Power (kW)	Hp	Utils hours per year	Historic Price (ZAR)	Repairs per annum (ZAR)	Purchase year	Depreciation year(s)	Salvage value (ZAR)	Repurchased? Yes / No	Repurchased price (ZAR)	Allocation (Cashcrop etc)
1.			0									
2.			0									
3.			0									
4.			0									
5.			0									
6.			0									
7.			0									
8.			0									
9.			0									
10.			0									

2. Towed Machinery & Equipment

Type of towed machine:	Number of towed machinery & equipment	Width (m)	Utilisation (ha / year)	Repairs per annum (ZAR / year)	Historic price (ZAR)	Purchased year	Depreciation year(s)	Salvage value (ZAR)	Repurchased? (Yes / No)	Repurchased price (ZAR)	Allocation (Cashcrop etc)
1.											
2.											
3.											
4.											
5.											
6.											
7.											
8.											
9.											
10.											
11.											
12.											
13.											
14.											
15.											
16.											
17.											
18.											
19.											
20.											
21											
22.											
23.											
24.											
25.											

3. Selfpropelled machinery & other vehicles														
Type:	No.	Engine Power (kW)	Hp	Width (m)	Load (t)	Utilisation (Ha / year)	Repairs per annum (ZAR)	Historic price (ZAR)	Purchased year	Depreciation year(s)	Salvage value (ZAR)	Repurchased ? Yes / No	Repurchased price (ZAR)	Allocation (Cashcrops etc)
1.			0											
2.			0											
3.			0											
4.			0											
5.			0											
6.			0											
7.			0											
8.			0											
9.			0											
10.			0											
11.			0											
12.			0											
13.			0											
14.			0											
15.			0											

4. Buildings							
Type of building:	Construction year	Historical price (ZAR)	Depreciation period year	Repurchased ? Yes / No	Repurchased price (ZAR)	Allocation (Cashcrops etc)	Repairs per annum (ZAR)
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							
9.							
10.							
11.							
12.							
13.							
14.							
15.							

FARM STORY & PRODUCTION SYSTEM

Farm name: 0 Year: 0

NB: IF THE FARM CROPPING SYSTEM HAS MORE THAN ONE ROTATION, THEN YOU NEED TO SCROLL DOWN TO CELL A148 ETC & MAKE THE INPUT FOR THE OTHER CROPS. IT IS VERY IMPORTANT TO SCROLL DOWN & MAKE SURE THAT ALL DATA IS ENTERED IN THE PRODUCTION SYSTEM FOR ALL CROPS!

Name of crop:	Month	Period	Operation	Tractor Used	Towed Implement	Selfpropelled	Capacity (ha / h)	Work depth (cm)	Fuel (l / ha)	Operator	Operator quantity	Contractor (ZAR / ha)	Seed	Input (kg / ha)	Type of fertilzer input (KAN, 3:2:1 etc)	Ammount of input (Kg / Ha)	Herbicide (ZAR / ha)	Fungicide (ZAR / ha)	Insecticide (ZAR / ha)	Other pest (ZAR / ha)	Irrigation (l / ha)	Variable cost (ZAR / ha)	Info

PRICES & OVERHEADS DATA

Farm name: 0 Year: 0

1. Energy Input

	Diesel	Petrol
Fuel price / Farm price (ZAR / L)		
Total fuel quantity used per year (l)		
Total fuel cost per year	0	0

Please note: This section is to desribe the typical options to dry crops. The last datafield "drying energy cost" is essential for further calculations.

Drying of cops	Value
Type drying energy input	
Unit of drying energy	
Quantity of drying energy used per year	
Drying energy cost (ZAR)	

2. Labour Force

Category: Choose between Hired labour or Family labour:	Labour type (Please specify for example permanent, manager etc)	Quantity	Total hours / year	Total labour cost (ZAR / worker / year)	Allocation (Cahcrops etc)
1.					
2.					
3.					
4.					
5.					

3. Overhead costs

Description:	ZAR value
Land improvements	
Overhead machinery repairs	
Overhead building repairs	
Contractor	
Diesel	
Petrol	
Oil / Lubricants	
Gas	
Electricity	
Water	
Farm insurance	
Accident insurance	
Farm tax	
Farm advisory	
Farm accountancy	
Farm office	
Other	

4. Finance

Description	Current assets (%)	Fixed assets (%)
Equity assets (%)		
Interest rates (for short term loan = < 1 year)		
Duration long term loan	n.a	

Financing details:	Value
Average annual percentage of overdraft facility used	
Average annual percentage of production loan facility used	
Interest rate on cash reserves	
Interest rate on overdraft facility	
Interest rate on overdue liabilities	

Description	Value (%)
Interest rate short term deposit	
Interest rate long term deposit	

Information about financial strategy: →

5. Asset Replacement

5. Asset Replacement	Average utilisation before replacement (years)
Machinery & Equipment	
Vehicles	

KEY DATA (FINANCIAL & OTHER)

Farm name: 0 **Year:** 0

1. STATEMENT OF ASSETS AND LIABILITIES

ASSETS	Value
Co-operative member funds	
Debtors	
Deposits	
Equipment and tools	
Implements and machinery	
Land and fixed improvements	
Office equipment	
Other investments (shares etc.)	
Other properties	
Production means	
Savings account	
Surrender value on policies	
VAT receivable	
Vehicles	

LIABILITIES	Value
Long-term liabilities	
Annual payment	
Interest rate	
Medium-term liability (1)	
Annual payment	
Interest rate	
Medium-term liability (2)	
Annual payment	
Interest rate	
Medium-term liability (3)	
Annual payment	
Interest rate	
Medium-term liability (4)	
Annual payment	
Interest rate	
Medium-term liability (5)	
Annual payment	
Interest rate	
Medium-term liability (6)	
Annual payment	
Interest rate	
Medium-term liability (7)	
Annual payment	
Interest rate	
Medium-term liability (8)	
Annual payment	
Interest rate	
Medium-term liability (9)	
Annual payment	
Interest rate	
Medium-term liability (10)	
Annual payment	
Interest rate	
Medium-term liability (11)	
Annual payment	
Interest rate	
Medium-term liability (12)	
Annual payment	
Interest rate	
Short-term liabilities	
Credit card	
Production loans	
Monthly accounts	
Creditors	
Carryover debt	
Tax provision	

2. HISTORICAL DATA

	Yield						
Year	**Maize**	**Wheat**	**Soybeans**	**Sunflower**	**Groundnuts**	**Barley**	**Potatoes**
-1							
-2							
-3							
-4							
-5							
-6							
-7							
-8							
-9							
-10							

	Price						
Year	**Maize**	**Wheat**	**Soybeans**	**Sunflower**	**Groundnuts**	**Barley**	**Potatoes**
-1							
-2							
-3							
-4							
-5							
-6							
-7							
-8							
-9							
-10							

INCOME STATEMENT	Value
CASH INCOME	
Insurance payments	
Land rental	
Non-farm income	
Other farm cash receipts	
Subsidies	
CASH EXPENSES	
Accident insurance: employees	
Auditor	
Bank charges (admin costs)	
Family living costs	
Farm utilities (electricity, phone, etc.)	
Fuel and lubricants (unallocated)	
Full-time labour	
Licenses	
Management salary	
Membership fees	
Monthly account	
Other cash expenses	
Professional services	
Provincial government levy	
Rent of moveable assets	
Repairs and maintenance (unallocated)	
Short term insurance	
UIF	
Non-farm expenses	
OTHER INFO	
Full-Time Labour	
Number of labourers	
Monthly remuneration per labourer	
Annual bonus per labourer	
Annual value of in natura remuneration per labourer	
Water cost	
Volume of water (m^3)	
Water cost (R/m^3)	
Land rent	
Number of hectares rented	
Rental cost (Rand/ha)	

APPENDIX B

- Informed consent form -

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA
Faculty of Economic and
Management Sciences

Informed consent for participation in an academic research study

Dept. of Agricultural Economics, Extension and Rural Development

TITLE OF THE STUDY
PRODUCING FOOD STAPLES IN SOUTH AFRICA: THE COMPETITION FOR ARABLE LAND

Research conducted by:
Mr. D van der Westhuizen (4384784)
Cell: 082 843 5381

Dear Respondent

You are invited to participate in an academic research study conducted by Divan van der Westhuizen, a Masters student from the Department Agricultural Economics, Extension and Rural Development at the University of Pretoria.

The purpose of the study is to determine whether the on-farm structure is plausible given a set of long term projections and macroeconomic drivers. In addition, the study will determine what the relative shift in hectares ought to be in the long run considering changing food and energy demands. The study will identify representative farms in the summer rainfall region of South Africa and their relative long term profitability and sustainability.

Please note the following:

- This study involves an anonymous survey. Your name will not appear on the questionnaire and the answers you give will be treated as strictly confidential. You cannot be identified in person based on the answers you give.
- Your participation in this study is very important to us. You may, however, choose not to participate and you may also stop participating at any time without any negative consequences.
- Please answer the questions in the attached questionnaire as completely and honestly as possible. This should not take more than 45 minutes of your time
- The results of the study will be used for academic purposes only and may be published in an academic journal. We will provide you with a summary of our findings on request.
- Please contact my supervisor, Dr. Ferdi Meyer at 082 777 6892 or ferdi.meyer@up.ac.za if you have any questions or comments regarding the study.

Please sign the form to indicate that:

- You have read and understand the information provided above.
- You give your consent to participate in the study on a voluntary basis.

Respondent ______________________ **Date** ______________________