REPORT

AN ASSESSMENT OF THE FOOD SECURITY IMPACT IN SOUTH AFRICA AND THE WORLD DUE TO THE SOUTH AFRICAN BIOFUELS INDUSTRY ROLLOUT

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SUMMARY / ABSTRACT

Grain SA was commissioned by Mabele Fuels to deliver an objective assessment of the impact on food security in South Africa should the biofuels industry in South Africa be successfully rolled out.

The key assumption is that the South African Biofuels Industry will predominantly utilise grain sorghum as feedstock. Grain sorghum is a drought resistant, hardy dryland crop suitable for marginal soils.

The realistic, practical impact of additional sorghum requirements at different ethanol/petroleum blend levels for two likely scenarios on food security is analysed, namely;

1. E2 in the short term (2012 – 2015), E5 in the medium term (2016 – 2020) and E10 in the long term (2021 onward)
2. E2 only

Since the inception of the biofuels industry, the world is taking note of the associated benefits for job creation, poverty alleviation and food security. Generalisations about the impact of the biofuels industry on food security is not acceptable as a lucrative biofuels industry can be a significant asset to a country and its economy.

With regards to the food security debate in South Africa the grain production sector has proven capacity to produce sufficient feedstock without compromising food security and this is already evident if one notes the increase in grain and oilseed exports.

Sorghum is a suitable alternative to maize with promising yield increases according to plant breeders. Sorghum as a biofuel feedstock is also supported by the Food and Allied Workers Union (FAWU) and the Congress of South African Trade Unions(COSATU). The strong public and labour union support in favour of the Industrial Policy Action Plan, underscore government policies in favour of biofuel production, job creation and rural economic development. The current drive to establish a successful domestic biofuel industry also stems from a Cleaner Fuel Policy and need for rural economic development.

The impact of bio-ethanol production on food security in terms of the availability of food derived from grain and oilseed commodities at the 2% and 5% blending rates for bio-ethanol, will not be significant in terms of food availability.

Without the implementation of a mandatory blend for bio-ethanol, the sorghum industry will remain relatively stagnant with marginal growth in the total demand for sorghum. The area under sorghum production is also not expected to expand with yields staying relatively constant. SA is expected to meet its local needs and export small quantities mainly across the borders to neighboring countries. Sorghum prices are also expected to trade at export parity levels.

By increasing the domestic demand for sorghum to meet the E2 blending rate, the additional amount of sorghum required in 2012 is 600 000 tons and grows as the demand for fuel increases. Sorghum prices are expected to sharply increase when the local market moves from export to import parity. It is expected that sorghum will be imported for a number of years. Over time imports

will drop as the local production of sorghum increases. In the outlying years (2018-2020) the local price is projected to break away from importy parity as local production meets local demand and prices are expected to be only R200/ton higher than under the current conditions without mandatory blending.

The total decline in the area under maize amounts to 73 000ha by 2020 and the price impact on both white and yellow maize seems negligible. The impacts on supply and demand fundamentals are relatively small and yellow and white maize prices will remain at export parity levels. The drop in production due to less plantings will mainly be absorbed by less feed demand and lower levels of exports. Feed demand for maize is projected to decline due to the introduction of DDGS from the production of ethanol.

The increase in the area under production of sorghum will not only be driven by significantly higher prices, but also by the introduction of higher yields. Whereas sorghum yields are projected to reach only 3t/ha by 2020 under current conditions, yields are boosted to more than 4t/ha by 2020. It is evident that more than just a growth in yields is required to make sorghum market returns competitive to yellow maize market returns. Once ethanol is introduced on top of improved yields, the market returns for sorghum are higher than for maize and a shift to sorghum production is more likely to occur. Sorghum is inherently more drought tolerant than maize and therefore it can lower the production risk for producers if sorghum becomes economically more attractive to plant.

Although the total area under sorghum production increases by 153 000 ha, only 73 000 ha less maize is planted. Hence, there is a net increase in the total area under summer grains of approximately 80 000 ha due to a boost in profitability of sorghum production.

Where the ethanol blending rate increases from 2% to 5% in 2016 and 10% beyond 2020, it is likely that maize prices do not remain unaffected. By 2020 white and yellow maize prices are projected to increase by 16% and 18% respectively. This implies that one cannot assume that food security, in terms of affordability of maize meal, will not be affected by the introduction of an E5 blending rate. However this assessment is subject to change and should be reassessed at a later stage depending on the success and outcomes of phase one of the biofuels implementation strategy i.e. E2

As food security is based on three pillars namely food availability, food affordability and access to clean and safe food it can be concluded that the introduction of a two percent mandatory blending level will not impact on food affordability with the exemption of sorghum products. With reference to the five percent mandatory blending level it can be concluded that food security may be compromised in terms of the affordability of both sorghum and maize consumer products. However, at both mandatory blending levels, the availability of food will not be compromised.

An analysis on a 10 percent mandatory blending level was not possible.

CHAPTER 1: INTRODUCTION

Grain SA was commissioned by Mabele Fuels to provide Services.

These services entail an objective assessment of the impact on food security in South Africa should the biofuels industry in South Africa be successfully rolled out.

The key assumption is that the South African Biofuels Industry will predominantly utilise grain sorghum as feedstock. Grain sorghum is a drought resistant, hardy dryland crop suitable for marginal soils.

The long term intention is to source the majority,if not all the feedstock, from emerging black farmers in the Former Homeland areas as stipulated by the South African Government's Biofuels Strategy. However the short term reality is that gain sorghum will most likely be imported in the short term, with commercial farmers either switching crops or planting fallow ground to sorghum. The medium to long term goal is for emerging black farmers to supply the full sorghum requirements to the biofuels industry.

The realistic, practical impact of additional sorghum requirements at different ethanol/petroleum blend levels for two likely scenarios on food security is therefore needed:

3. E2 in the short term (2012 – 2015), E5 in the medium term (2016 – 2020) and E10 in the long term (2021 onward)
4. E2 only

An assessment is needed on the impact of realistic sorghum output from emerging farmers with time, assuming measures are taken to encourage plantings such as active skills development and training, outreach programmes, offering firm sorghum off-takes which assist in financing, etc. However, given the time frame for this study it is not possible to make sufficient recommendations. Recommendations are outstanding in terms of measures to sustainably maximise production of grain sorghum from emerging farmers.

An assessment of population growth and food demand is also needed relative to possible supply and price impacts on other food crops due to additional sorghum demand. The supply impact of DDGS, a medium protein bioethanol byproduct, also needs clarification.

CHAPTER 2: LITERATURE REVIEW ON FOOD SECURITY AND THE SOUTH AFRICAN BIOFUELS INDUSTRY

Note: This chapter was compiled by Grain SA

This chapter focus on the food security impact in the world due to the biofuels industry roll out. The key concepts and developments on food security, biofuels and fuel policies are explained. The politically and labour union based views and assumptions with regards to this study, based on literature, meetings and personal communications are discussed. The literature study therefore covers a synopsis of the food security and fuel debate both domestically and internationally since the introduction of the biofuels industry in South Africa. The conclusions reached in this literature, not only for South Africa, but also globally are given.

LITERATURE COVERED ON THE FOOD SECURITY DEBATE

The literature covered on the food security debate aims to give an objective view on the different viewpoints for and against biofuels as far as food security is concerned. At a global level, conclusions by the World Bank (WB), Renewable Fuels Association (RFA), Food and Agriculture Association (FAO), United Nations (UN) and GBEP (Global Bio-Energy Partnership) are shared. At national level the views gained from important meetings are shared.

THE INTERNATIONAL FOOD SECURITY DEBATE

Food prices in the U.S. rose dramatically in 2007 and early 2008. Given the integrationof the world markets for foodstuffs, prices increased around the world as well, leading to riots in a number of countries in early 2008. The popular press has tended to attribute these food price increases to demand for corn by the ethanol industry. Grain prices are one determinant of food prices, but they constitute less than 5% of food costs in the U.S.(a higher percentage elsewhere). Ethanol is responsible for no more than 30-40% of the grain price increases in a period of 18 months (Nov 2006 – Apr 2008). Food prices in the US increased about 16% over a period of five years (2003 – 2007) and 7% over the past 18 months of this same period, but rising grain prices have contributed only about a 3% cost increase over these periods (Perrin, 2008:1).

It is reasonable to conclude that ethanol is responsiblefor increases in US food prices of about 1% during 2007 and 2008 – a relatively small proportion of actual of U.S. food price increases. In food-insecure areas of the world however, the impact of ethanol on food prices has been higher; perhaps as much as a 15% increase, simply because the typical food basket in those areas contains more direct grain consumption (Perrin, 2008:1).

Views of the World Bank on food security

The Development Prospects Group of the World Bank also concludes that "..the effect of biofuels on food prices has not been as large as originally thought, but that the use of commodities by financial investors (the so-called "financialization of commodities") may have been partly responsible for the

2007/08 spike." High energy prices and as noted above, speculation, played significant roles in the non-energy commodity price spikes seen in the recent past (Baffes & Haniotis, 2010:1).

They conclude that a stronger link between energy and non-energy commodity prices is likely to have been the dominant influence on developments in commodity and especially food markets. Demand by developing countries is unlikely to have put additional pressure on the prices of food commodities, although it may have created such pressure indirectly through energy prices.It is unlikely biofuels played a significant role because they do not represent a large percentage of world wide grain and oilseed use (Baffes & Haniotis, 2010:2).

Biofuels account for only about 1,5 percent of the area under grains and oilseeds worldwide. This raises serious doubts about claims that biofuels account for a big shift in global demand. Even though widespread perceptions about such a shift played a big role during the recent commodity price boom, it is striking that maize prices hardly moved during the first period of increase in US ethanol production, and oilseed prices dropped when the EU increased impressively its use of biodiesel. On the other hand, prices spiked while ethanol use was slowing down in the US and biodiesel use was stabilizing in the EU (Baffes & Haniotis, 2010:14).

Adding to the statements made by the World Bank, the Renewable Fuels Association (RFA) in the USA is similarly of the opinion that volatile oil prices, speculation and adverse weather conditions all play far more significant roles in driving commodity prices to record and near record prices and that biofuels play a marginal role in world commodity and food prices.

According to the World Bank the role of energy prices and speculation in commodity prices include the following;

- "Fiscal expansion in many countries and lax monetary policy created an environment that favoured high commodity prices. The depreciation of the US dollar – the currency of choice for most international commodity transactions strengthened demand (and limited supply) from non-US$ commodity consumers (and producers). Other important contributing factors include low past investment especially in extractive commodities; investment fund activity by financial institutions that chose to include commodities in their portfolios and geopolitical concerns, especially in energy markets" (Baffes & Haniotis, 2010:6)
- "We conjecture that index fund activity (one type of "speculative" activity among the many that the literature refers to) played a key role during the 2008 price spike." (Baffes & Haniotis, 2010:20)

According to a follow up report from the World Bank by Timilsina *et al* (2010:2) an expansion of global biofuel production to meet currently articulated and/or even higher national targets in various countries for biofuel use would reduce gross domestic product at the global level. However, the gross domestic product impacts are mixed across countries or regions. The expansion of biofuels would cause significant land re-allocation with notable decreases in forest and pasturelands in a few countries. Except for South Africa, the results in the World Bank report also suggested that the biofuels expansion would cause a reduction in food supply. Although the magnitude of the impact on food supply at the global level is not as large as perceived earlier, it would be significant in developing countries like India and Sub-Saharan Africa. Agricultural commodities such as sugar, corn and oilseeds, which serve as the main biofuel feedstocks, would experience significant increases in their prices in 2020 compared with the prices at baseline due to the expansion of biofuels to meet existing targets (Timilsina *et al*, 2010:2).

All countries with biofuel targets would experience increases in total trade of agricultural commodities, mostly commodities used for biofuel feedstock and which experience the largest price changes. Agricultural commodities such as sugar, corn and oil seeds (as oil), that serve as the main biofuel feedstocks, would experience 1% to 8% price increases in 2020 compared to that in the baseline due to the expansion of biofuels to meet the existing targets (Timilsina *et al*, 2010:43). The export of agricultural commodities, mainly biofuel feedstock would also increase in countries like Brazil, Argentina, Russia and many regions such as Sub-Saharan Africa, MENA (Middle East and North Africa) and South Asia (except India) (Timilsina *et al*, 2010:31).

According to the first World Bank scenario (Timilsina *et al,* 2010:19) which considers the implementation biofuel use targets consistent with what countries already have announced (Table 1 page 21 in Timilsina, 2010), South Africa may, at a current national blending target of 2% (Table 9 page 40 in Timilsina, 2010), experience no impact on food supply even though the world food supply decreases by $14,1 billion or 0,2% from the corresponding food supply in the baseline of the study ((Timilsina *et al*, 2010:39).Considering only cereals, the *global (sic)*expansion of biofuels to meet the existing targets would cause a reduction in a range of 8 – 29 million tons of reduction in food supply in 2020 relative to their reference case

The moderate food price effects has to do with the relative small share of farm values in food processing. Secondly, the increase in the demand for feedstock can be accommodated given the various mechanisms at play via trade in agricultural commodities, land allocation and biofuels production, even under limited land substitution across uses (Timilsina *et al*, 2010:43-44). Dried Distiller's Grains and Solubles(DDGS)has been considered in the analysis as a feed crop substitute. The implied indirect land use effects linked to feed grains are dampened once DDGS is accounted for and food price effects from biofuel expansion are even more moderate (Timilsina *et al*, 2010:44).

All policy parameters were not incorporated. For example, the United States will not subsidise ethanol production after 2015 although several bills have been introduced to extend these subsidies. The current policy in South Africa is to discourage ethanol from maize. In the CGE-model of the World Bank the subsidies are provided to biofuels and are not differentiated across feedstocks. Incorporating this policy (*in South Africa*) would reduce the use of maize for ethanol and therefore could lower maize production and land-use for maize (Timilsina*et al*, 2010:44).

Views of the Food and Agriculture Organisation (FAO) on food security

The following view of the FAO is explained by HeinerThofern who heads FAO's Bio-energy and Food Security (BEFS) project.

Spikes in oil prices and concerns related to energy security, coupled with worries over greenhouse gas emissions from fossil fuels, have been key drivers behind the growth of the bio-energy sector. Another important potential benefit is that investment in bio-energy could spark much needed investment in agricultural and transport infrastructure in rural areas and by creating jobs and boosting household incomes, could alleviate poverty and food security (Thofern, 2011)

Under-investment in agriculture is a problem that handicaps food production in the developing world and coupled with rural poverty, is a key driver of world hunger. When properly carried out and when appropriate, bio-energy developments offer a chance to drive investment and jobs into areas that are literally starving for them. In the future, Europe is likely to emerge as an export market for bio-energy products. Trends like these present farmers in the developing world with new opportunities.FAO studies have also shown that small-scale bio-energy projects not targeting export markets can improve food security and help boost rural economies (Thofern, 2011).

But as interest in bio-energy has grown so too have concerns over its potential negative impacts. Chief among these are the risk that an expansion of bio-energy crops might come at the expense of food production, leading to reduced food availability and higher food prices. Deforestation due to the conversion of new lands to bio-energy crops and impacts on indigenous peoples are also of concern (Thofern, 2011)

However, the potential risks and benefits need to be carefully weighed in light of country and region specific variables. Bio-energy production is not a panacea and will not always be appropriate or viable. In some cases it could even be harmful. That being said, bio-energy production holds great potential to revitalize rural economies, reduce poverty, and improve household food security (Thofern, 2011).

Ultimately whether or not bio-energy development contributes to food security, poverty alleviation and climate change mitigation will depend on how well the sector is managed (Thofern, 2011).

The FAO developed a methodology which offers policymakers a way to evaluate potential benefits of growing energy crops and to avoid pitfalls. The FAO's "Bio-energy and Food security (BEFS) Analytical Framework" was created to help governments evaluate the potential of bio-energy as well as assess its possible food security impacts.

The UN Agency is following up on the above BEFSframework via its Bio-energy and Food Security Criteria and Indicators (BEFSCI) project. This project aims to develop a risk prevention and management tool as well as an impact assessment and policy response toll based on good practice.

Neither a BEFS or BEFSCI-project has been done for South Africa. Nevertheless, it is important to take note of the areas and key questions covered and to include these as completely as possible in this report.

The BEFS Analytical Framework analyse the following areas and key questions:

Diagnosis / Ten Year Outlook

- How will national agricultural markets evolve and what are the likely impacts of bio-energy developments on this evolution?
- Will food security be a problem in the country over the next ten years?

Natural resources

- *What bio-energy crops can be grown and where?*
- *What are current yields and what is the potential for increasing them?*
- *To what extent can water resources meet demands for expansion of bio-energy?*
- *Are there opportunities to increase water use efficiency?*
- *What are the demand, consumption and availability of woody biomass resulting from existing food production?*

Techno-economic and environmental analysis

- *Can biofuels be produced profitably?*
- *To what degree can small-scale farmers compete in the biofuel supply chain?*
- *What are the actual gains, in any, in terms of the overall effect on greenhouse gas emmisions under different production scenarios?*
- *Can biofuel production contribute to savings on greenhouse gas emmissions?*

Socio-economic analysis

- *Economy-wide impacts on household food security and vulnerability*
- *What are the implications of specific biofuel development pathways for poverty, agricultural growth, employment and economic growth?*
- *Will there be price increases in key food staples that may result from expanded bio-energy development?*
- *What impacts might this have on household welfare and which groups are particularly vulnerable?*
- *Would price effects be mitigated by increased rural employment and higher household incomes?*

Oxfam view on food security

According to a briefing note released by Oxfam, biofuels need not spell disaster for poor people in the South (*sic Southern Hemisphere*) – they would instead offer new markets and livelihood opportunities. However the organisation warns that without the right policies in place among companies, producer governments and importing governments, negative social impacts will only worsen as the scramble to supply biofuels intensifies (Bailey, 2007).

CONCLUSION

It is evident from the above that since the inception of the biofuels industry,the world is taking note of the benefits of the biofuels industry for job creation, poverty alleviation and food security. Furthermore generalisations about the impact of the biofuels industry on food security is not acceptable because circumstances between countries differ. For some countries, and if managed well through good management practices and policy, a lucrative biofuels industry can be a significant asset to a country and its economy. It is therefore important that individual countries assess the potential pros and cons of supporting a domestic biofuels industry thoroughly.

With this in mind it is worthwhile to explore the history and development of the biofuels industry in South Africa.

THE FOOD SECURITY DEBATE IN SOUTH AFRICA

The impact of the bio-ethanol industry on domestic food security was debated on different forums since 2005. This section gives a synopsis of the development of the domestic bio-ethanol industry with regards to food security concerns, views of the labour sector and government and most recently the impact of new policy directives on clean fuels and air quality. The latter involved the vehicle manufacturing and petroleum industries with a totally different focus and need for the future development of bio-ethanol production.

Chemin: 2005

As early as July 2005 Grain South Africa invited the South African Chemical Technology Incubator (Chemin) to undertake an economic assessment of the viability of producing fuel ethanol from maize in South Africa.

Draft National Biofuels Industrial Strategy: December 2006

The Draft National Biofuels Industrial Strategy was issued on 15 December 2006, thereby furthering the enabling of a policy framework within which a viable and sustainable bio-fuels industry could be established. The grain industry expected that the development of the biofuels industry would improve food security and would contribute to more stable food prices in the economy.

The main reason supporting this statement is that the current production capacity of grains cannot be fully utilised by the grain production industry. The size of the grain market is limited and decisions regarding production are seldom influenced by production circumstances such as rainfall and the latest advances in production technology, but predominantly by factors related to an insufficient market size. South Africa's rural economics will benefit by these developments in terms of job retention, job creation and development. The development of the biofuel industry will therefore significantly add to the objectives of the Industrial Policy Action Plan (IPAP) by creating jobs and by substituting soy oilcake imports because of the domestic production of Dried Distillers Grain and Solubles(DDGS).

Importance of Sorghum as Feedstock: May 2007

As early as May 2007, the grain sorghum production sector requestedthat the National Biofuels Task Team take note of the importance of grain sorghum as a promisingfeedstock for bio-ethanol production.

Grain sorghum serves as a supplement to maize as a feedstock for many bio-ethanol production plants in the U.S. The ethanol yield per ton of grain sorghum is equal to or even better than that of maize. Grain sorghum is an indigenous crop and well-known to grain producers in Africa. The crop is drought resistant and serves for these reasons as an excellent vehicle to further the development of emerging producers.Furthermore, undeveloped production areas suitable for the production of

grain sorghum may complement an increase in net grain production. The soil and climate requirements for grain sorghum differ to those of maize.
The current market for grain sorghum is shrinking and discourages any expansion in production. A significant expansion in grain sorghum production could be expected as a result of increased and stable sorghum demand for biofuels. Consequently, this may lead to a stimulus for economic growth of the rural economy through the creation of jobs and employment.

Expectations of the Grain and Biofuels Industries :September 2007

During September 2007 the South African Biofuels Association in anticipation of the expected announcement of the Biofuels Industrial Strategy stated that a multifeedstock approach is crucial for sustainable biofuel production in South Africa. A multifeedstock approach will enable producers to select crops best suited to the agro-climate of the regions where their plants are situated and to minimise logistic costs by sourcing crops grown closest to their plants.

The grain industry expected by October 2007 that government would enable a supportive environment with the needed incentives to develop the biofuels industry fully without any limitations on feedstock. The strategy may contribute to higher living standards for citizens in South Africa as it may support rural economic development and an increase in GDP. This is very much in line with South Africa's ASGISA and Africa's NEPAD goals.

Cabinet Decision to Exclude Maize: Dec 2007

By the end of 2007 Cabinet discussed the Draft Biofuels Industrial Strategy and indicated that Cabinet had certain reservations regarding the use of maize as feedstock for bio-ethanol production. The grain industry took note of Government's fears that the use of maize to produce ethanol could possibly compromise food security in South Africa.

Grain SA appealed to government that maize as a feedstock for bio-ethanol production not be rejected until its advantages for food security, rural development and the potential of a larger maize market to ease volatilities in the domestic maize price have been properly assessed.

Cabinet decided on 5 December 2007 to exclude maize from the National Biofuels Industrial Policy. The decision was based on concerns that the inclusion of maize will incur additional risk in terms of food security. The decision implied that bio-ethanol projects based on maize as feedstock will not qualify for the necessary government support.

The Minister of Agriculture stated in a follow up meeting that maize may only be considered as a feedstock, if maize producers can guarantee surplus production and that the production of maize for food purposes will enjoy priority over the production of maize as feedstock for bio-ethanol production purposes.

Minister of Agriculture meets with Grain SA: Dec 2007

During a meeting between the Minister of Agriculture and Grain SA in December 2007 the increase in food prices following the introduction of maize in the strategy was raised as a concern. It was stated that there would not be enough maize for biofuel production purposes and that Cabinet was concerned about the effect on food security as maize is a staple food, not only for South Africa but also the neighbouring countries.

The Director General of Agriculture at the time added that yellow maize may be considered by government for the purpose as bio-ethanol feedstock. He explicitly stated that;

- White maize would not be brought on the table as feedstock for bio-ethanol production; and
- that total maize production must exceed the consumption thereof and furthermore
- that Cabinet needs to be able to manage the price impact when maize is allowed to be utilised for biofuel production purposes.

The Director General of Agriculture added that Cabinet will not prioritise maize. Cabinet should be convinced that maize will be produced at the level of demand. The biofuels industry is not only a surplus clearing mechanism. A case needs to be made that 8 - 9 million tons of maize will be available to meet current demand.The Minister of Agriculture added that if there was a possibility to produce above 9 million tons in order to supply for biofuel purposes this amount of maize could be considered for biofuel production.

According to Cabinet an additional 3 million hectares of under-utilised agricultural land still exists in the former homeland areas. See the complete ARC Report in Appendix B.

The Director General of Agriculture explained that a 2 percent inclusion rate was proposed by the Department of Minerals and Energy because of fears with regards to the mandatory blending of biofuels; which wouldrequire a continuous supply of biofuel to the petroleum industry as required by the Regulator at DME. The DME didnot want to risk importing biofuels in case the local producers could notsupply enough bio-ethanol feedstock demanded because of mandatory blending.

According to National Agricultural Farmer's Union (NAFU) who also attended the meeting the biofuel development offers opportunities for black producers and therefore NAFU supports the developmentof the strategy. NAFU agreed that maize should not be excluded but utilised to create a market for emerging producers. How else should the link between the first and second economy be made?

The Deputy Minister of Agriculture mentioned that it would not be easy to cap production at 9 million tons in order to set the rest aside for biofuel development purposes in the free market. Previously, when prices peaked at R2000 a ton, food security became an issue because the poor could not afford available food.

Meeting: Raw Material Production for the Biofuels Industry: May 2008

During May 2008 members of the executive management and officials of the following institutions: Grain SA, the Presidency, the COSATU federation, the Food and Allied Workers Union, NAFCOC, Southern Africa Biofuels Association, the National Department of Agriculture, the Free State Provincial Government, Agricultural Research Council, Investec and SASOL OIL met to discuss raw material production for the biofuel industry.

Even though this meeting did not have any decision-making authority, ideas were shared on the application of oilseed as material for biofuel production. Grain SA was able to point out why the market for grains could be expanded without compromising the availability and affordability of food produced domestically. The grain industry did not aim to impair food security but would rather expand production capacity to levels that were previously possible. The labour sector indicated that the representatives were empowered with new information and a better understanding of the unintentional consequences of policy decisions.

Views of FAWU

The Food and Allied Workers Union (FAWU) proposed sorghum as raw material. It is important for the grain industry that free market principles promote the development of the industry and that grain sorghum's specific crop production needs should be re-evaluated as a raw material for bio-ethanol production. The expansion of the sorghum market should also lead to lower price fluctuations. The focus should be to create job opportunities and bring under developed agricultural land into production. According to FAWU the primary consideration why government excluded maize as raw material arose from the fear that maize be used for biofuel and that the application thereof will be to the disadvantage of food security in terms of availability and affordability. By considering sorghum as raw material the risks associated to this might be less.

The labour sector requires that the grain producer guarantees that the food market will be serviced first before consideration will be given to the production of alternative crops for biofuel. The fear exists that grains that are destined for the food industry will be channelled to the more profitable fuel industry. Even though Grain SA does not necessarily agree with this, the organisation understands government's point of view that the first 9 million ton maize that is produced should be retained for food consumption.

Views of Grain SA

The expansion of the local grain and oilseed market is, however, necessary to ensure sustainable production and bring about bigger trust in the grain and oilseed industry. The number of hectares that can be developed by the market for raw material for biofuel purposes includes about 2 million hectares for commercial production areas and about 3 million hectares for previously under-developed production areas.

Since the seventies, the profitability of maize production resulted in a decrease of 2 million hectares in the area that was planted. The continuous downward tendency in areas planted and consequent increase in food security risk must be prevented by expanding the market for maize and other grains, such as sorghum, and should not be limited by the wrong policy options.

South African producers have the resources to produce 12 million tons of maize as has been done in the past. For example, if a drought is experienced, the production may decrease from 9 million ton to 6 million ton by about 1/3. With a goal of 12 million ton under these circumstances, it could mean that about 8 million ton is produced. Consequently the food security is a lot better against 8 million ton compared to 6 million ton, particularly keeping in mind that the consumption of maize as food only amounts to 4 million ton.If a shortage should develop and 8 million ton is not produced, biofuel manufacturers should be able to import largevolumes of grain independently of local production.

See Grain SA's complete view on biofuels in Appendix A

ARC Research Objectives

The final goal for the grain industry should be to produce for a local demand of 12 million ton. Decision-making in this regard is important and should be supported by good research. **Table 2.1** gives an indication of proposed research initiatives in this regard.

Table 2.1: Proposed ARC research activities in the focus area for bio-ethanol research.

Project title	Objective	Duration
Biofuel crop breeding	Breed suitable crop species and cultivars for local conditions to give SA a competitive advantage in biofuel production	4 years
Conservation agriculture biofuel production systems	To develop and promote appropriate sustainable biofuel production systems based on conservation agriculture principles and technologies for both large scale commercial and small scale emerging farmer operations.	4 years
Rehabilitation of unproductive land for biofuel production	To map all the unproductive land and develop strategies to make the land productive for bio-fuel crops	2 years
Mapping of biofuel production areas	To further develop the assessment and mapping, at a more detailed scale, of areas suitable for sustainable biofuel production	2 years
Engineering technologies for biofuel value chain	To develop appropriate technologies for local conditions for the harvesting, processing, storage, transport and value adding of biofuel products.	5 years
Biofuel decision support analyses	To provide decision support for policy and strategy development surrounding the development and promotion of a biofuel industry for South Africa	3 years
Producer development and capacity building	To provide training and advisory services based on biofuel incubator experience for capacity building	4 years

It is important that a long-term view is taken in the planning of food security and that events and variables in the short-term do not jeopardise the issue. Even though food is available, it is important that trust in the production of grain and oilseed is renewed. It is also important that the opportunities for the expansion of the grain sorghum market are improved.

The Views of COSATU

COSATU did not oppose the application of grains such as maize unconditionally, but they supported the decision of the ministry. The Congress of South African Trade Unions are of the opinion that more has to be done to involve as many people as possible in developing sustainable alternative energy sources for our economy. Questions were being asked about the effectiveness of bio-fuel in reducing emissions and its potential threats to food security. COSATU knew that the bio-fuel production constitutes one of the key programme pillars of ASGISA aimed at creating new jobs and halving unemployment by 2014.

In the context of the high rate of unemployment, which was at 23% when using a narrow definition, COSATU welcomedinitiatives meant to create jobs and deal with high levels of poverty in the country. Although economic growth is important, it would ring hollow to the majority of the population if these initiatives do not address their socio-economic conditions. COSATU have seen impressive rates of economic growth in the past few years (5,3% in the 4th quarter of 2007) but this hadnot translated into significant decline in unemployment figures.

COSATU'S concerns in relation to the use of food crops in the production of ethanol centre around the possible negative consequences this would have on the struggle for the achievement of Decent Work, which includes labour standards and workers' rights, job creation and social protection, in South Africa.

When the concept of bio-fuel was first introduced in ASGISA, and maize was suggested as a feedstock for the production of bio-ethanol, COSATU raised the concern that the usage of maize would sharply increase the price of this staple food and the majority of workers and the poor would be negatively affected. Effectively, the usage of staple food for the production of bio-fuel would result in the majority of working people and the poor subsidising the better off in society. COSATU were accordingly delighted when cabinet took a decision not to okay the usage of maize as a feedstock in the production of ethanol.

According to COSATU there is evidence that in the US, the usage of corn in the production of ethanol has resulted in dramatic increases in the prices of corn and its animal feed substitute, soy. As a result of high prices of corn and soy in the US, there have been sharp increases in the prices of meat, milk and other dairy products. Given this situation, the US food companies, Dean Foods Co., H.J Heinz Co., Kellogg Co., Nestle USA, Pepsico Inc., and Coca-Cola Co. had to complain to the US Senators about the negative impact the use of corn in the production of ethanol had on their competitiveness

Furthermore, with the production of agricultural feedstock for ethanol, more land would be used for this purpose as opposed to food crops, with devastating consequences to food security. It is also reported that in Brazil workers face harsh working conditions in sugarcane fields. COSATU had reasons to be less excited about the production of bio-ethanol in SA given such experiences. COSATU asked what guaranteeswere there that farm workers would not be exploited more with the mass production of agricultural feedstock for ethanol in South Africa?

Experiences from other countries that have started with the production of bio-fuel are critical in this regard. Developing countries like South Africa may not stand to benefit in exporting bio-ethanol to her trading partners. For instance, Brazil, which is currently the global leader in the production and export of bio-ethanol, is not competitive in the US (Brazil's main trading partner in bio-ethanol) domestic market because its bio-ethanol faces high US import tariffs (US$0.14/litre) meant to protect US farmers. Furthermore, the US ensures that Brazilian bio-ethanol is not competitive in its market by providing tax incentives to its (US) bio-ethanol producers.

According to COSATU's sources,Brazil remains an important case study given its global role in the bio-ethanol business. The production of bio-ethanol in Brazil has resulted in displacement of rural populations, destruction of traditional livelihoods, increase in rural violence and forced evictions, losses in biodiversity, deforestation, water depletion and desertification of soils. Whilst the world is concerned about the effects of global warming on humanity, bio-fuel production seems to be exacerbating the global warming through deforestation.

Recent Developments in 2010 and the IPAP

It was evident by October 2010 that no private initiatives succeeded over the past five years inestablishing any South African bio-ethanol projects. The only projects in the pipeline are those initiated by government but even those are not yet operational.

The Industrial Policy Action Plan: 2010

In February 2010 the Industrial Policy Action Plan was launched with short term objectives aimed to accelerate, amongst other objectives, the introduction of bio-ethanol projects. The Action Plan for biofuels acknowledges that South Africa did not keep up with bio-ethanol developments worldwide. The reasons include regulatory shortcomings, the world economic crises and the fact that the debate for the past of couple of years focused on food security instead of fuel security. As acknowledged by the IPAP, the dynamics of agriculture to utilize this industry's potential in supplying feedstock to the biofuels industry therefore did not receive appropriate attention.

The advantages of a significant biofuels industry promise to include, according to the IPAP, import substitution of fuel and DDGS, increased fuel security and expansion of grain production.

The Recent Developments in 2011

Officials assigned to the Directorate Food Security at the Department of Agriculture, Forestry and Fisheries (DAFF) serves on the National Biofuels Task Team. DAFF is mandated to provide recommendations with regards to feedstock suitable for bio-ethanol production without compromising food security. Food Security concerns are therefore addressed by DAFF. Additionally to the exclusion of maize, DAFF is also of the opinion that the water requirements for bio-ethanol factories is from an environmental perspective, a limitation on the future development of the bio-ethanol industry. DAFF is also keen to support bio-fuel developments which plans to utilise feedstock production from commercial production areas with the prerequisite to increase food production in poverty stricken and food insecure areas such as the former homeland areas. DAFF requires a model in this regard to be proposed to the National Biofuels Task Team but concerns are flagged that this may lead to increased government intervention in the free market.

The Department of Energy investigatedthe extent of incentives for bio-ethanol production purposes from different feedstocks required for the successful implementation of a economically viable biofuels industry. The report will be submitted to Treasury who will determine if the future development of the bio-ethanol industry, given the proposed incentives, is for the common good of the population in South Africa. The decision to use grain and not sugar depends on the availability of the feedstock in areas where economic development is needed and where it is not possible to cultivate sugar cane.

A Shift to New Air Quality Objectives

In the past the debate on food security and the availability of maize as feedstock was emphasized in South Africa to the extent that maize was excluded from the biofuels industrial strategy. More recently the importance of air quality came to the forefront when European legislation incorporated the Auto Oil Programmes from the European Commission. According to the findings of this program

- measures needs to be taken against air pollution by emissions from motor vehicles and
- measures needs to be taken to regulate the quality of gasoline and diesel.

This approach ensured the gradual introduction of cleaner vehicles and cleaner fuels as of 2000. Fuel quality parameters in the EU are regulated by binding legislation because of theirimpact on the environment and human health.

The latest developments in the EU includes the blending of fuel ethers as oxygenate into gasoline to enhance engine performance and reduce toxic exhaust emissions. Bio-ethers also represent a quick and straightforward way for delivering bio-ethanol into gasoline (petroleum) due to their ability to improve its compatibility with fuel systems in cars and reduce problems in the fuel supply chain. In addition fuel ethers augment the greenhouse gas savings delivered by the bo-ethanol. EFOA (European Fuel Oxygenates Association) considers that ethers have an important role to play in creating a cleaner environment based on sustainable transport fuels (ACFA News; 2009).

According to the EFOA in the EU, fuel ethers are considered to be renewable fuel components. The new EU Renewable Energy Directive (2009/28/EC) lists ETBE, MRBE and TAME as renewable fuel components provided that they are produced using bio-methanol or bio-ethanol. At the current time only bio-ethanol is available in Europe and hence only ETBE is widely used by EC Member States to meet their renewable energy targets.

Given the above it is important to note that vehicle manufacturers who export to the EU are required to comply with the standards in the EU.

In South Africa the changed views of members of the petroleum industry to increasingly support the uptake of domestically produced bio-ethanol are attributed to the global movement to support the future increased consumption of cleaner fuels as demanded in the EU. The pressure to reduce vehicle emissions is mounting and local vehicle engine manufacturers and exporters demand cleaner fuels. All world regions are mandating increasingly restrictive emissions standards requiringcleaner fuels and lubricants. South African vehicle manufacturers and exporters are part of the world economy and needs to comply to international standards.

Therefore, a Cleaner Fuels Policy supports the abandonment of imported and expensive oxygenates such as MTBE, lead, managanese and other metal –based oxygenates in favour of environmentally safe substitutes such as bio-ethanol. This explains the recent urgency noted to prioritise the development of the bio-ethanol industry in South Africa.

The broad industry view is that the phasing in of suitable cleaner fuels (Clean Fuels II policy followed by Clean Fuels III policy) will bring South Africa in line with the global path.

It is important to take note that the specifications in the proposed Clean Fuels II and III policies are developed by SAPIA in conjunction with NAAMSA.

Draft regulations regarding the mandatory blending of biofuels with petrol and diesel

The Department of Energy gazetted the draft regulations regarding the mandatory blending of biofuels with petrol and diesel on 16 September 2011. According to these regulations the minimum concentration to be allowed for bio-ethanol blending is 2% v/v. A licensee must purchase all bio-ethanol sold by a biofuel manufacturer as contemplated in the Regulations provided that the volume of the bio-ethanol cannot be blended due to insufficient volumes of petrol to accommodate the volume of bio-ethanol. Comments on this draft must be submitted by 18 November 2011.

KEYCONCEPTS AND ASSUMPTIONS FOR THIS STUDY

The literature study ofltheinternational and South African food security debate reveals important key concepts and assumptions that needs to be considered in order to prevent public backlash in developing the biofuels Industry in South Africa.Concerns with regards to the impact of political risk on future bio-ethanol developments is justifiable and needs to be accounted for in the planning of bio-ethanol production initiatives.

Key Concepts and Assumptions at the Global Level

From the discussion on the theoretical framework, the following key concepts and assumptions for this study can be summarised as follows at the global level;

- Internationally, governments realised that the price hikes in food prices cannot be ascribed to bio-ethanol only. However it is true that the impact of bio-ethanol on food prices in developiong countries is higher due to the fact that the typical food basket in those areas contains more direct grain consumption. Biofuels also do not represent a large percentage of world wide grain and oilseed use.
- According to the World Bank the financialisation of commodities, index fund activity, volatile oil prices, adverse weather conditions, fiscal expansion and lax monetary policies, depreciation of the US-Dollar, geopolitical concerns – all contributed more to the increase in food prices than bio-ethanol only.

- The expansion in biofuels could cause significant land re-allocation and a reduction in food supply and it could impact significantly on food supply in Sub-Saharan Africa if implemented irresponsibly. Agricultural commodities such as corn (maize) and sugar could experience significant increases in their prices.
- However, reports by the World Bank states that all countries with biofuel targets would experience increasesin the total trade and export in agricultural commodities. The price of corn may increase by eight percent up to 2020 in developing countries.
- The World Bank is of the opinion that South Afica will not experience an impact on food supply with a national blending rate of two percent although the world food supply may decrease slightly. The US will not subsidise ethanol production after 2015 and in South Africa maize will not be allowed to be utilised for biofuel production. Production and land-use for corn (maize) may decrease in South Africa according to the World Bank.
- The recent growth of the bio-energy sector includes; concerns related to energy security and worries over greenhouse gas emissions from fossil fuels. Europe is likely to emerge as an export market for bio-energy products.
- The potential benefits of biofuels developments given that the initiatives are managed properly include; new markets, livelihood opportunities, revitalisation of rural economies, much needed investment in agriculture and the transport infrastructure in rural areas, job creation, higher household incomes, alleviation of poverty and household food security, increased food production in the developing world and exports of bio-ethanol products.
- The potential draw-backs of biofuels developments may include expansion of biofuel production at expense of food production, reduced food availability and higher food prices. Oxfam warns that without the right policies in place among companies, producer governments and importing governments the kinds of negative social impacts will only get worse as the scramble to supply intensifies.

Key Concepts and Assumptions at National Level

The key concepts and assumptions at global level are assumed to be true for those at national level. Therefore it is not repeated in the discussion at national level but should not be overlooked. The following key concepts and assumptions are distinctively important for South Africa.

- The use of grains as feedstock in the domestic bio-ethanol industry wil improve food security andstabilise food prices because the current (surplus) production capacity of grains will be utilised more efficiently when used in the promising bio-fuel industry.
- The development of the biofuel industry will significantly add to the objectives of NEPAD, ASGISA and the Industrial Policy Action Plan (IPAP) by creating jobs and by substituting soy oilcake imports because of the domestic production of DDGS. According to the IPAP South Africa need to scale up the mandatory upliftment of biofuels in the national fuel pool to 10% of fuel supply in the next ten years. Biofuels from agriculture has according to the IPAP the potential to create 125 000 jobs mostly in rural areas. South Africa’s dependence on oil imports will also decrease because of the contribution by agriculture. Also the New Growth Path identifies large opportunities in the green economy. South Africa has committed to reducing the carbon-intensity of the economy but at the same time to seize jobs and opportunities in biofuel energy creation.

- Cabinet decided in December 2005 to exclude maize on concerns that the inclusion of maize will incur additional risk in terms of food security. According to FAWU, grain sorghum can serve as a provensubstitute to maize as feedstock in bio-ethanol production reducingthe concerns about food security as the majority of the people consume white maize. Domestic food security can only be improved by a policy that supports economic growth. Food security depends on three pillars, namely economic acces to food, the availability of food and the right and opportunity to utilize food in a safe and healty environment. According to Cabinet an additional 3 million hectares of under-utilised agricultural land still exist in the former homeland areas.
- From May 2005 until April 2010 South Africa exported nearly 9 million tons of maize and proved that the production sector is able to produce in excess of domestic demand without increasing the risk for food security thereby meeting the demands of the Minister of Agriculture. The number of litres of bio-ethanol which could have been produced by maize as feedstock is a conservative 3,6 billion litres. In 2005 the domestic demand for petroleum reached 11,2 billion litres. It is noted that the grain production sector can contribute more than 1 million tons of maize to the bio-ethanol sector annually without compromising food security.
- The free market in South Africa will ensure that resources are utilised optimally so that communities need not face unnecessary surpluses or shortages. Thus, government policy should only regulate the free market in order to counter monopolies, collusion and other attempts by role-players to disrupt the decent functioning of the free market system.Governement may consider the inclusion of yellow maize given that white maize would not be considered as feedstock for bio-ethanol purposes, that total maize production exceed the national consumption thereof and that Cabinet needs to be able to manage the price impact when maize is allowed to be utilised for biofuel production purposes.
- The Department of Minerals and Energy proposed a two percent inclusion rate because the DME do not want to risk importing biofuels in case the local producers cannot supply enoughbio-ethanol feedstock demanded by mandatory blending. However, South Africa has become a net exporter of maize through productivity increases, while sorghum as potential feedstock, can substitute the utilisation of maize given a supportive biofuels strategy which ensures guaranteed offtake and incentives to develop the industry.
- According to the sorghum seeds industry, new conventional cultivars that have the potential to yield between 0,75 and 1 ton/ha more than the current average is almost ready to be released.
- DAFF is mandated to provide recommendations with regards to feedstock suitable for bio-ethanol production without compromising food security. DAFF is of the opinion that the water requirements for bio-ethanol plants is from an environmental perspective a limitation on the future development of the bio-ethanol industry.
- The Food and Allied Workers Union (FAWU) propose sorghum as a feedstock for bio-ethanol production. By considering sorghum as raw material the risks associated with food security might be less.The labour sector also requires that the grain producer quarantees that the food market will be serviced first before consideration will be given to the production of alternative crops for biofuel.The number of hectares that can be developed for biofuel puposes includes about 2 million hectares for commercial production areas and about 3

million hectares for previously under-developed production areas.Since the seventies the profitability of maize production resulted in a decrease of 2 million hectares in the area that was planted. The continuous downward tendency in areas planted and consequent increase in food security risk must be prevented by expanding the market for grains such as sorghum. South Africa has the resources to produce 12 million tons of grain as proven in the past.

- COSATU asked questions about the effectiveness of bio-fuel in reducing emissions and its potential threats to food security. COSATU is aware that bio-fuel production constitutes one of the key programmes of ASGISA aimed at creating new jobs and halving unemployment by 2014. The Federation welcomes initiatives to create jobs and deal with high levels of poverty. However COSATU is concerned about food security, the exploitation of workers and the number of actual jobs to be created.
- The IPAP document acknowledged that regulatory shortcomings, the world economic crises and the fact that the debate focused on food security instead of fuel security was the reasons why South Africa did not keep up with global biofuel developments. According to the IPAP the advantages of a significant biofuels industry promises to include import substitution of fuels by the domestic production of bio-ethanol and oilcake through substitution by DDGS, thereby increasing fuel security and expanding grain production.
- The latest developments in the EU includesthe blending of fuel ethers as oxygenates into gasoline to enhance engine performance and reduce toxic exhaust emmissions. In the EU bio-ethers are considered to be renewable fuel components. The most recent focus therefore moves from food security to emission control for better air quality. South Africa is knownworldwide one of the countries with the poorest air quality in certain regions. There are also known cases of spillages of MTBE in the groundwater supply. A Cleaner Fuels Policy supports the abandonement of imported and expensive oxygenates such as MTBE for environmentally safe substitutes such as bio-ethanol or bio-ethanol ethers.

CONCLUSION

It stems from the discussion and by delineating the key concepts and assumptions above on the food security debate that the following important conclusions can be reached, namely;

- That the grain production sector has proven capacity to produce sufficient feedstock without compromising food security and is already evident noting the increase in grain and oilseed exports.
- That sorghum is a suitable alternative to maize with promising yield increases according to plant breeders in order to substitute maize as envisaged bio-ethanol feedstock. Sorghum is also proposed by the FAWU as feedstock and therefore acceptable not only by the FAWU but also COSATU.
- The strong public and labour union support in favour of the Industrial Policy Action Plan,andunderscore of government policies in favour of biofuel production, job creation and rural economic development,especially in areas where sugar cane cannot be grown, support grain sorghum as proper feedstock.
- White maize is consumed by people and government maycontinue refrainingfrom allowing the inclusion of white maize as potential feedstock. Production of white and yellow maize in total in excess of 9 million tons may be considered as bio-ethanol feedstock in the future.

But because of the practical complexities of allocating maize as priority feedstock for industrial use versus human consumption and possible intervention of government in the free market system, the grain industry is not at ease to accept the conditional inclusion of maize as feedstock.

- The fact that Cabinet excluded maize in the current biofuels industrial strategy due to food security concerns but still allowed the use of sorghum as feedstock and by addressing the limiting factors of bio-ethanol production in the current IPAP combined with other supportive policies such as ASGISA provide proof of a wellmanaged, convervative biofuels policy. Given this fact, the successful development of the bio-ethanol industry, including the promising benefits for South Africa, may at last be underway.
- Lastly, it is very important for roleplayers such as government, labour unions and federations to note that the latest drive to establish a successful domestic biofuel industry stems from most importantly a Cleaner Fuel Policy and need for rural economic development given that food security will not be compromised by the poor management of government policies.

The publishing of the draft regulations for comment on the compulsory blending of biofuel in the petroleum pool on 19 September 2011 in the Governement Gazette is very promising.

The following chapter presents the current status of the grain and oilseeds industry in terms of supply and demand and indicates the potential impact of an increase in the demand of sorghum on food security.

CHAPTER 3: THE SUPPLY AND DEMAND OF GRAIN AND OILSEEDS IN SOUTH AFRICA

Note: This chapter was compiled by Grain SA

The chapter gives an overview of the supply and demand of grains and oilseeds for the most recent five marketing years. For information on long term trends see the presentation in Appendix C.

Sorghum

The area planted to sorghum over the last five years fluctuated significantly**(Table 3.1)**. In the 2007/08 marketing year, producers only seeded 69 000 ha of sorghum and harvested 176 000 tons with an average yield of 2.55 ton/ha. The next three years however, showed a substantial increase of nearly 18 000 ha to 87 000 ha planted with sorghum. During 2009/10 the largest sorghum crop since 2004/05 was produced (277 000 tons) with an average yield of 3.23 ton/ha. Given the minor growth in the sorghum meal industry and regular demand for malt/brew, the 2009/10 marketing year ended with a leading carry-out stock of 93 000 tons. South Africa also exported 52 000 tons during this year mainly to neighbouring Botswana. Although producers seeded the same arable land in 2010/11, average yields were down to 2.27 ton/ha due to unfavourable production conditions. The 2010/11 crop was realised at 197 000 tons, with exports down 54% from the previous year at 24 000 tons. During the current marketing year competitive maize prices lead to a lower cultivation of sorghum. Only 69 000 ha was planted with an average expected yield of 2.31ton/ha. With local demand and exports estimated at 211 000 tons and 25 000 tons respectively, ending stocks of 26 000 tons are projected.

Table 3.1: Supply and demand of sorghum

Marketing Year	2007/08	2008/09	2009/10	2010/11	2011/12
Area planted (x1 000 ha)	*69*	*87*	*86*	*87*	*69*
CEC crop estimate ('000ton)	*176*	*255*	*277*	*197*	*160*
Yield (ton/ha)	*2.55*	*2.94*	*3.23*	*2.27*	*2.31*
	SAGIS	**SAGIS**	**SAGIS**	**SAGIS**	**Grain SA**
	000 ton	000 ton	000 ton	000 ton	000 ton
Supply					
Opening stocks 1 April	76	43	63	93	58
Production	176	251	279	190	160
Imports	32	0	4	0	44
Total supply	**284**	**293**	**347**	**283**	**262**
Demand					
Food consumption					
Malt/brew	89	87	85	79	80
Meal	95	92	97	103	103
Total food	184	179	182	182	183
Feed consumption					
Petfood and poultry	7	6	6	6	6
Other feed	10	8	13	16	15
Total feed	17	15	19	22	21
Total domestic demand	201	194	201	204	204
On-farm unexplained consumption	12	-1	1	-4	7
Total RSA consumption	**213**	**193**	**202**	**200**	**211**
Exports	27	37	52	24	25
Total demand	**241**	**230**	**254**	**225**	**236**
Carry-out (31 March)	**43**	**63**	**93**	**58**	**26**
Pipeline requirements	25	22	23	23	23
Surplus above pipeline	18	**41**	**70**	**35**	**3**

White Maize

In the 2007/08 marketing year, producers planted 1.6 million hectares of white maize **(Table 3.2)**. A crop of 4.3 million tons was harvested with an average yield of 2.66 ton/ha. Domestic consumption totalled 4.9 million tons with the majority consumed in the food industry. Favourable production conditions and technological advances in cultivars led to an increase in the area planted and average yield over the following four years. Producers inevitably increased plantings by 7% to 1.7 million hectares in 2008/09. Sufficient white maize was produced to meet the growing local demand and to export 1.9 million tons. Lower international and domestic maize prices discouraged producers to plant maize in 2009/10. Predictably 14% less white maize was planted. Unfortunately exports to especially Zimbabwe subsided and larger than expected carry-out stocks were left for the 2010/11 year. Plantings increased again and a record crop of 7.8 million tons was harvested. Although feed consumption grew by 356% y/y and new export markets to Korea and Italy were supportive, large ending stocks of 1.6 million tons realised. In the current marketing year lower yields are expected but sufficient stock levels are available to meet the local demand and still be able to serve the export market.

Table 3.2: Supply and demand of white maize

Marketing Year	**2007/08**	**2008/09**	**2009/10**	**2010/11**	**2011/12**
Area planted (x1 000 ha)	*1 625*	*1 737*	*1 489*	*1 720*	*1 418*
CEC crop estimate ('000ton)	*4 315*	*7 480*	*6 775*	*7 830*	*6 200*
Yield (ton/ha)	*2. 66*	*4. 31*	*4. 55*	*4. 55*	*4. 37*
	SAGIS	**SAGIS**	**SAGIS**	**SAGIS**	**Grain SA**
	000 ton	000 ton	000 ton	000 ton	000 ton
Commercial supply					
Opening stocks 1 May	1 630	618	762	1 362	1 637
Commercial deliveries	4 309	7 190	6 737	7 524	6 200
Imports	46	0	0	0	0
Total commercial supply	**5 985**	**7 808**	**7 499**	**8 886**	**7 837**
Commercial demand					
Commercial consumption					
Food	3 728	4 242	4 275	4 433	4 400
Feed	1 142	772	362	1 651	1 280
Total	**4 870**	**5 014**	**4 637**	**6 084**	**5 680**
Other consumption					
On-farm consumption and withdrawals	6	290	38	306	60
Gristing	57	62	68	63	60
SAGIS unexplained	9	7	- 38	- 14	
Total	72	359	68	355	120
Total RSA consumption commercial	**4 942**	**5 373**	**4 705**	**6 439**	**5 800**
Exports					
Products	31	66	62	68	72
Whole maize	400	1897	1408	1048	1240
Total	431	1 963	1 470	1 116	1 312
Total commercial demand	**5 373**	**7 336**	**6 175**	**7 555**	**7 112**
Carry-out (30 April)	**618**	**762**	**1 362**	**1 637**	**725**
Pipeline requirements	609	627	580	761	710
Surplus above pipeline	**9**	**135**	**782**	**877**	**15**

Yellow maize

In the 2007/08 marketing year producers planted 927 000 hectares of yellow maize **(Table 3.3)**. A crop of 2.8 million tons was harvested with an average yield of 3.03 ton/ha. Although sufficient yellow maize was available for domestic- and export demand a lack of export markets led to higher carry-out stock levels. Producers increased plantings by 15% to 1.0 million hectares in 2008/09. Sufficient yellow maize was produced to meet the growing local food and feed demand. Exports jumped by 197% to 303 000 tons. Lower international and domestic maize prices discouraged producers to plant maize in 2009/10 and only 939 000 hectares was seeded. Favourable growing conditions however were supportive and a record yield of 5.62 ton/ha was harvested. The demand for feed increased by 600 000 tons while exports remained steady. Plantings increased again in 2010/11 and a crop of 4.98 million tons was harvested. Although feed consumption decreased due to cheaper white maize availability, a new export market to countries such as Korea, Kuwait and Japan was established. In the current marketing year lower yields are expected but sufficient stock levels is available to meet the local demand and still be able to serve the export market. The carry-out however is the lowest projected in 13 years.

Table 3.3: Supply and demand of yellow maize

Marketing Year	**2007/08**	**2008/09**	**2009/10**	**2010/11**	**2011/12**
Area planted (x1 000 ha)	*927*	*1 062*	*939*	*1 023*	*954*
CEC crop estimate ('000ton)	*2 810*	*5 220*	*5 275*	*4 985*	*4 480*
Yield (ton/ha)	*3. 03*	*4. 92*	*5. 62*	*4. 87*	*4. 7*
	SAGIS	**SAGIS**	**SAGIS**	**SAGIS**	**Grain SA**
	000 ton	000 ton	000 ton	000 ton	000 ton
Commercial supply					
Opening stocks 1 May	440	431	819	769	748
Commercial deliveries	2 575	4 701	4 892	4 506	4 480
Imports	1074	27	27	0	0
Total commercial supply	**4 089**	**5 159**	**5 738**	**5 275**	**5 228**
Commercial demand					
Commercial consumption					
Food	257	501	346	352	330
Feed	3 287	3 512	4 265	3 096	3 350
Total	3 544	**4 013**	**4 611**	**3 448**	**3 680**
Other consumption					
On-farm consumption and withdrawals	235	519	383	479	280
Gristing	6	7	18	17	18
SAGIS unexplained	6	17	21	- 6	10
Total	247	543	422	490	308
Total RSA consumption commercial	**3 791**	**4 556**	**5 033**	**3 938**	**3 988**
Exports					
Products	30	38	57	51	50
Whole maize	72	265	262	1017	760
Total	102	303	319	1 068	810
Total commercial demand	**3 893**	**4 859**	**5 352**	**5 006**	**4 798**
Carry-out (30 April)	**431**	**819**	**769**	**748**	**430**
Pipeline requirements	443	502	576	431	460
Surplus above pipeline	**- 12**	**317**	**193**	**317**	**- 30**

White and Yellow Maize

In the 2007/08 marketing year, a crop of 7.12 million tons of white and yellow maize was harvested with an average yield of 2.79 ton/ha **(Table 3.4)**. After the domestic- and export demand was met, ending stocks of 1.0 million tons was carried over.

Producers increased total maize plantings by 10% in 2008/09. Yields soared from 2.79 to 4.54 tons/ha and a crop of 12.7 million tons was harvested. Although the local and export market grew significantly, higher yields partly offset the higher ending stocks of 1.58 million tons. Plantings diminished in 2009/10 and only 2.42 million hectares was seeded. Favourable production conditions were supportive and a record average yield of 4.96 ton/ha was harvested. Ending stocks soared by 35% y/y to 2.13 million tons. Plantings increased again in 2010/11 and a record maize crop of 12.81 million tons was harvested. New export market to countries such as Korea, Kuwait, Italy and Japan was established. In the current marketing year lower yields are expected due to prolonged wet weather conditions but sufficient stock levels are available to meet the local demand and still be able to export over 2.1 million tons.

Table 3.4: Supply and demand of total maize

Marketing Year	**2007/08**	**2008/09**	**2009/10**	**2010/11**	**2011/12**
Area planted (x1 000 ha)	*2 552*	*2 799*	*2 428*	*2 742*	*2 372*
CEC crop estimate ('000ton)	*7 125*	*12 700*	*12 050*	*12 815*	*10 679*
Yield (ton/ha)	*2. 79*	*4. 54*	*4. 96*	*4. 67*	*4. 5*
	SAGIS	**SAGIS**	**SAGIS**	**SAGIS**	**Grain SA**
	000 ton	000 ton	000 ton	000 ton	000 ton
Commercial supply					
Opening stocks 1 May	2 070	1 049	1 581	2 131	2 385
Commercial deliveries	6 884	11 891	11 629	12 030	10 679
Imports	1 120	27	27		
Total commercial supply	**10 074**	**12 967**	**13 237**	**14 161**	**13 064**
Commercial demand					
Commercial consumption					
Food	3 985	4 743	4 621	4 785	4 730
Feed	4 429	4 284	4 627	4 747	4 630
Total	**8 414**	**9 027**	**9 248**	**9 532**	**9 360**
Other consumption					
On-farm consumption and withdrawals	241	809	421	785	340
Gristing	63	69	86	80	78
SAGIS unexplained	15	24	- 17	- 20	10
Total	319	902	490	845	428
Total RSA consumption commercial	**8 733**	**9 929**	**9 738**	**10 377**	**9 788**
Exports					
Products	61	104	119	119	122
Whole maize	472	2 162	1 670	2 065	2 000
Total	533	2 266	1 789	2 184	2 122
Total commercial demand	**9 266**	**12 195**	**11 527**	**12 561**	**11 910**
Carry-out (30 April)	**1 049**	**1 581**	**2 131**	**2 385**	**1 155**
Pipeline requirements	1 052	1 128	1 156	1 192	1 170
Surplus above pipeline	**- 3**	**453**	**975**	**1 194**	**- 15**

Sunflower

The area planted to sunflower over the last five years varied substantially**(Table 3.5)**. In the 2007 marketing year only 316 000 ha of sunflower was planted and 300 000 tons was harvested with an average yield of 0.95 ton/ha. Over the next two years plantings increased due to the profitability of sunflower compared to other commodities.

During 2008 producers seeded 564 000 ha and harvested the third largest sunflower crop of 872 000 tons. South Africa consumed 653 000 tons of sunflower in 2008 and 79 000 tons was exported leaving a carry-out of 236 000 tons. The following year, another big harvest of 801 000 tons led to relatively high ending stocks of 266 000 tons. Domestic consumption in 2009 increased by 26% to 821 000 tons amid an expansion in local crushing capacity and lower soybean production. In 2010 producers cut back on their plantings of sunflower (398 000 ha) and a relatively small crop (490 000 tons) with an average yield of 1.23 ton/ha was harvested. Although production declined it was offset by large carry-over stocks from the previous year, but 62 000 tons was imported to meet the local demand. Producers planted 245 000 ha more in 2011 due to the lower plantings of especially maize. An average yield of 1.34 tons/ha is expected with ending stock estimated at 127 000 tons.

Table 3.5: Supply and demand of sunflower

Marketing year	2007	2008	2009	2010	2011
Area planted (x1 000 ha)	*316*	*564*	*636*	*398*	*643*
CEC crop estimate ('000ton)	*300*	*872*	*801*	*490*	*862*
Yield (ton/ha)	*0.95*	*1.55*	*1.26*	*1.23*	*1.34*
	SAGIS	**SAGIS**	**SAGIS**	**SAGIS**	**Grain SA**
	000 ton	000 ton	000 ton	000 ton	000 ton
Supply					
Opening stocks 1 anuary	161	95	236	266	48
Commercial deliveries	300	869	795	490	862
Imports	9	2	69	62	1
Total supply	**471**	**966**	**1 100**	**818**	**910**
Demand					
Commercial consumption sunflower	369	653	821	775	780
On-farm unexplained consumption	6	-2	13	-4	3
Total domestic demand	375	651	834	771	783
Exports	0	79	0	0	0
Total demand	**375**	**730**	**834**	**771**	**783**
Carry-out (31 December)	**95**	**236**	**266**	**48**	**127**
Pipeline requirements	92	163	205	194	195
Surplus above pipeline	3	73	61	-146	-68

Soyabean

As is the case of sunflower, the area planted to soybeans over the last five years varied substantially depending on the profitability margin of other summer crops **(Table 3.6)**. In 2007, 183 000 ha of soybeans was planted and 205 000 tons was harvested with an average yield of 1.12 ton/ha. The majority of the soybeans (53%) was used in the feed and full-fat sector. Unfortunately, local availability was not sufficient and 120 000 tons was imported. Although fewer soybeans were seeded in 2008, higher yields offset the lower area planted and a crop of 282 000 tons was harvested. Domestic demand shifted from feed to oil and oilcake. The following year, plantings swelled by 44% and 516 000 tons with an average yield of 2.17 ton/ha was harvested, after which the demand changed to feed and full-fat again. This harvest led to exports of 156 000 tons but relatively high ending stocks of 113 000 tons was realised. In 2010 producers again increased their plantings of soybeans by 31% and a crop (566 000 tons) with an average yield of 1.82 ton/ha was harvested. Carry-out was lower amid a 31% growth in domestic demand and exports of 121 000 tons. Producers planted a record 418 000 ha in 2011 with production projected at 709 000 tons. An average yield of 1.70 tons/ha is likely, with relatively high exports and ending stocks estimated at 180 000 and 158 000 tons respectively.

Table 3.6: Supply and demand of soybeans

Marketing year	**2007**	**2008**	**2009**	**2010**	**2011**
Area planted (x1 000 ha)	*183*	*165*	*238*	*311*	*418*
CEC crop estimate ('000ton)	*205*	*282*	*516*	*566*	*709*
Yield (ton/ha)	*1.12*	*1.70*	*2.17*	*1.82*	*1.70*
	SAGIS	**SAGIS**	**SAGIS**	**SAGIS**	**Grain SA**
	000 ton	000 ton	000 ton	000 ton	000 ton
Supply					
Opening stocks 1 anuary	132	97	90	113	105
Commercial deliveries	205	264	504	535	709
Imports	120	16	1	2	3
Total supply	**457**	**377**	**595**	**650**	**816**
Demand					
Commercial consumption					
Feed Full-fat soya	192	114	172	203	180
Human consumption	21	28	31	34	31
Crushed for oil and oilcake	134	137	115	185	260
Seed for production purposes		3	5	5	4
Total commercial consumption	**347**	**283**	**323**	**427**	**475**
On-farm unexplained consumption	13	-1	3	-3	3
Total domestic demand	**360**	**282**	**326**	**424**	**478**
Exports	1	5	156	121	180
Total demand	**361**	**287**	**482**	**545**	**658**
Carry-out (31 December)	**97**	**90**	**113**	**105**	**158**
Pipeline requirements	87	71	81	107	119
Surplus above pipeline	**10**	**19**	**32**	**-2**	**40**

Groundnuts

In the 2007/08 marketing year, 41 000 ha of groundnuts was planted and 58 000 tons was harvested with an average yield of 1.42 ton/ha **(Table 3.7)**. Most of the groundnuts produced locally are either consumed in the peanut butter or direct edible market, or are exported. Producers increased the area planted by 13 000 ha the following year after which an average yield of 1.64 ton/ha was harvested. Relatively low domestic prices led to a growing demand in the peanut butter and edible market. South Africa imported 11 000 tons to be exported to neighbouring BLNS countries in 2008/09. In 2009/10 producers planted 55 000 ha and the fourth largest crop of 100 000 tons with an average yield of 1.82 ton/ha was harvested. Although exports decreased it was offset by lower imports necessary to meet the demand of BLNS countries. Ending stocks were 63% higher y/y. Producers planted 2000 ha more in 2010/11 with production projected lower at 88 000 tons on lower yields due to unfavourable production conditions which led to aflatoxin contamination. An average yield of 1.26 tons/ha is likely in the current marketing year with relatively low ending stock estimated at 19 000 tons.

Table 3.7: Supply and demand of groundnuts

Marketing year	**2007/08**	**2008/09**	**2009/10**	**2010/11**	**2011/12**
Area planted (x1 000 ha)	*41*	*54*	*55*	*57*	*55*
CEC crop estimate ('000ton)	*58*	*89*	*100*	*88*	*69*
Yield (ton/ha)	*1.42*	*1.64*	*1.82*	*1.53*	*1.26*
	SAGIS	**SAGIS**	**SAGIS**	**SAGIS**	**Grain SA**
	000 ton	000 ton	000 ton	000 ton	000 ton
Supply					
Opening stocks 1 March	16	19	27	44	28
Commercial deliveries	58	90	89	84	69
Imports	23	11	6	1	11
Total supply	**97**	**119**	**121**	**129**	**109**
Demand					
Commercial consumption					
Oil and oilcake	1	1	2	6	5
Peanut butter	22	25	23	25	24
Direct edible market	35	39	35	39	37
Sold for seed	4	3	2	2	3
Total commercial consumption	**61**	**68**	**62**	**71**	**69**
On-farm/unexplained consumption	6	2	0	0	3
Total domestic demand	**68**	**70**	**62**	**71**	**72**
Exports	10	23	16	29	18
Total demand	**78**	**93**	**78**	**100**	**90**
Carry-out (28 February)	**19**	**27**	**44**	**28**	**19**
Pipeline requirements	17	18	15	18	18
Surplus above pipeline	**2**	**9**	**28**	**10**	**1**

Canola

The area planted to canola over the last four years remained almost constant and was sufficient to meet the local demand **(Table 3.8)**. All of the canola produced domestically is consumed for oil and oilcake purposes. In the 2007/08 marketing year 33 000 ha of canola was planted and 40 000 tons was harvested with an average yield of 1.20 ton/ha. During 2008/09 producers seeded 34 000 ha and harvested a crop of only 31 000 tons after yields were lowered due to unfavourable growing conditions in the production regions of the Cape. Despite an increase in production the following year of 9 000 tons, higher anticipated endings stocks were offset by an increase in domestic consumption of 11 000 tons. Carry-out realised at only 10 000 tons. In 2010/11 producers planted 35 000 ha of canola again but yields were projected lower at only 1.06 tons/ha. Producers planted 9 000 ha more in 2011/12 but an average yield of 1.32 tons/ha is expected which would lead to a record canola crop of 57 000 ton. Despite the growth in domestic consumption ending stocks are estimated at an all time high of 20 000 tons.

Table 3.8: Supply and demand of canola

Marketing year	**2007/08**	**2008/09**	**2009/10**	**2010/11**	**2011/12**
Area planted (x1 000 ha)	33	34	35	35	44
CEC crop estimate ('000ton)	40	31	40	37	57
Yield (ton/ha)	1.20	0.91	1.15	1.06	1.32
	SAGIS	**SAGIS**	**SAGIS**	**Grain SA**	**Grain SA**
	000 ton	000 ton	000 ton	000 ton	000 ton
Supply					
Opening stocks 1 October	11	11	11	10	9
Commecial deliveries	38	31	40	37	57
Imports	0	0	0	0	0
Total supply	**49**	**42**	**51**	**46**	**67**
Demand					
Commercial consumption					
Animal feed	0	1	1	2	2
Crushed for oil and oilcake	39	31	42	35	45
On farm/unexplained consumption	-2	-1	-1	0	0
Total RSA consumption	38	31	41	37	47
Exports	0	0	0	0	0
Total demand	**38**	**31**	**41**	**37**	**47**
Carry-out (31 September)	**11**	**11**	**10**	**9**	**20**
Pipeline requirements	9	8	10	9	12
Surplus above pipeline	**2**	**3**	**-1**	**0**	**8**

Wheat

Over the past five years domestic production of wheat was insufficient to meet the local demand and between 1.19 and 1.68 million tons had to be imported each year **(Table 3.9)**. In the 2007/08 marketing year producers planted 632 000 hectares of wheat. A crop of 1.90 million tons was harvested with an average yield of 3.01 tons/ha. Domestic consumption totalled 2.91 million tons with the majority consumed in the food industry for the baking of bread. Only 509 000 ton was carried over to the next year. Favourable prices led to an increase of 18% in the area planted in 2008/09. Yields however failed expectations and a smaller than anticipated crop of 2.13 million tons was harvested. During the following three years local producers further decreased their plantings of wheat amid low profitability margins on the back of sufficient global stocks and low wheat prices. In 2010/11 South Africa had to import 1.68 million ton or 57% of the domestic demand required. Favourable growing conditions in the production regions of the Cape and Free State supported crops during the 2011/12 marketing year and an average yield of 3.07 tons/ha are anticipated.

Table 3.9: Supply and demand of wheat

Marketing Year	**2007/08**	**2008/09**	**2009/10**	**2010/11**	**2011/12**
Area planted (x1 000 ha)	632	748	643	558	607
CEC crop estimate ('000ton)	1 905	2 130	1 958	1 430	1 862
Yield (ton/ha)	*3.01*	*2.85*	*3.05*	2.56	3.07
	SAGIS	**SAGIS**	**SAGIS**	**Grain SA**	**Grain SA**
	000 ton	000 ton	000 ton	000 ton	000 ton
Supply					
Opening stocks 1 October	376	509	694	579	554
Commercial deliveries	1876	2130	1910	1430	1862
Imports	1396	1192	1285	1680	1400
Total supply	**3 648**	**3 831**	**3 889**	**3 689**	**3 816**
Demand					
Commercial consumption					
Food consumption	2 844	2 862	2 994	2 880	2 880
Feed	1	20	40	8	20
Seed	22	26	17	20	26
Total	**2 867**	**2 908**	**3 051**	**2 908**	**2 926**
On-farm/unexplained consumption	49	- 2	19	22	22
Total RSA consumption	**2 916**	**2 906**	**3 070**	**2 930**	**2 948**
Exports					
Products	9	21	35	35	35
Whole wheat	214	210	205	170	215
Total	223	231	240	205	250
Total demand	**3 139**	**3 137**	**3 310**	**3 135**	**3 198**
Carry-out (30 September)	**509**	**694**	**579**	**554**	**618**
Pipeline requirements	623	627	656	631	631
Surplus above pipeline	**- 114**	**67**	**- 77**	**- 77**	**- 13**

Barley

Over the past five years the domestic production of barley was inadequate to meet the local demand **(Table 3.10)**. In the 2007/08 marketing year, producers planted 73 000 hectares of barley and a crop of 223 000 tons was harvested with an average yield of 3.03 tons/ha. Domestic consumption totalled 286 000 tons with the majority consumed for human demand. In this year 97 000 ton had to be imported to ensure sufficient supply. A carry-out of 106 000 tons realised at the end of the marketing year.

Producers decreased their plantings of barley by 5 000 ha in 2008/09. Yields were lower than anticipated and a crop of 192 000 tons was harvested. During the following three years local producers started to increase their plantings of barley. In 2009/10 a crop of 216 000 tons was harvested and only 54 000 tons were imported to meet our local demand. In 2010/11 producers seeded 11% more than the previous year but yields dwindled to the lowest in 6 years to only 2.35 tons/ha. A carry-out of 88 000 tons are expected at the end of September 2011. Favourable growing conditions in the production regions of the Cape supported crops during the 2011/12 marketing year and a crop of 248 000 tons with an average yield of 3.07 tons/ha is anticipated.

Table 3.10: Supply and demand of barley

Marketing Year	2007/08	2008/09	2009/10	2010/11	2011/12
Area planted (x1 000 ha)	73	68	75	83	81
CEC crop estimate ('000ton)	223	192	216	194	248
Yield (ton/ha)	3.03	2.81	2.89	2.35	3.07
	SAGIS	**SAGIS**	**SAGIS**	**Grain SA**	**Grain SA**
	000 ton	000 ton	000 ton	000 ton	000 ton
Supply					
Opening stocks 1 October	82	106	100	109	88
Commercial deliveries	217	190	214	194	248
Imports	97	99	54	70	50
Total supply	**395**	**394**	**368**	**373**	**386**
Demand					
Commercial consumption					
Human consumption	261	268	236	255	265
Feed	10	19	17	16	16
Seed	6	5	5	5	5
Total commercial consumption	277	292	258	276	286
On farm/unexplained consumption	9	0	-1	7	7
Total RSA consumption	**286**	**292**	**257**	**283**	**293**
Exports	4	2	3	2	4
Total demand	**290**	**294**	**259**	**285**	**297**
Carry-out (30 September)	**106**	**100**	**109**	**88**	**89**
Pipeline requirements	34	36	32	34	35
Surplus above pipeline	**72**	**64**	**77**	**54**	**54**

The supply and demand of grains and oilseeds needs to be understood in order to make validated assumptions and conclusions on the current status of crop production with reference to food security in future.

In the following chapter the impact of the mandatory blending of bio-ethanol into petroleum is discussed with specific reference to the role of sorghum production.

CHAPTER 4: THE IMPACT OF MANDATORY BLENDING ON SORGHUM PRODUCTION AND FOOD SECURITY

Note: This chapter was compiled by Grain SA

The mandatory blending of bio-ethanol into petroleum requires the production of feedstock such as grain sorghum for bio-ethanol production. The three different levels of mandatory blending at 2% (E2), 5% (E5) or 10% (E10)and the required supply of grain sorghum is evaluated. In this chapter, the historical production of grain sorghum is compared to the other grain and oilseed crops. The re-introduction of sorghum production, substitution of surplus maize production, increase in sorghum yields and the contribution of DDGSproduction, and their role in easing the impact of mandatory blending on food security is discussed.

SCENARIO'S

In the discussion, the amount of feedstock required to meet the bio-ethanol demand for the following scenarios are discussed. The realistic, practical impact of additional sorghum requirements at different bio-ethanol/petroleum blend levels on food security is evaluated.

Scenario 1: E2 (Short term: 2012 – 2015), E5 (Medium term: 2016 – 2020), E10 (Long term: 2021 – onward)

In the first scenario the mandatory blending of bio-ethanol is taken as 2% in the short term (2012 – 2015), 5% in the medium term (2016 -2020) and 10% from 2021 onwards. The amount of grain sorghum needed to produce sufficient quantities of bio-ethanol to meet the mandatory blending level in 2012 is 600 000 tons, 1,6 million tons from 2016 and 3,5 million tons from 2021. The demand for petroleum is assumed to increase at a rate of 2 percent per annum. The equivalent hectares needed increase from 243 900 ha (E2-level), 673 220 ha (E5-level) and 1 457 430 ha (E10-level). The amount of DDGS produced is respectively 180 000 tons in 2012. The DDGS quantity increases to 487 094 tons in 2016 and 1 075 583 tons in 2021 (Table 4.1).

Table 4.1: Scenario 1: E2 (Short term: 2012 – 2015), E5 (Medium Term: 2016 – 2020), E10 (Long Term: 2021 – onward)

	Unit	2012	2016	2021
Petroleum demand	Liter	12 000 000 000	12 989 185 920	14 341 110 823
Mandatory blending	%	2%	5%	10%
Bio-ethanol equivalent	Liter	240 000 000	649 459 296	1 434 111 082
Bio-ethanol yield	liter/ton	400	400	400
Sorghum production	Ton	600 000	1 623 648	3 585 278
Sorghum yield	ton/ha	2,46	2,46	2,46
Equivalent hectares	Ha	243 902	673 220	1 457 430
DDGS produced	Ton	180 000	487 094	1 075 583

Scenario 2: E2 only (Long term: 2012 – onwards)

In the second scenario the amount of sorghum needed in 2012 aims at 600 000 tons with 243 902 equivalent hectares and 180 000 tons of DDGS produced. Due to the annual 2 % increase in the demand of petroleum in scenario 1 and 2 the amount of sorghum needed in 2021 for a mandatory blending level of 2% increases respectively to 731 397 tons in terms of sorghum production, 297 316 hectares (Equivalent hectares) and 219 419 tons of DDGS.

Table 4.2: Scenario 2: E2 only (Long Term: 2012 – onwards)

	Unit	2012	2016	2021
Petroleum demand	liter	12 000 000 000	12 989 185 920	14 627 933 040
Mandatory blending	%	2%	2%	2%
Bio-ethanol equivalent	liter	240 000 000	259 783 718	292 558 661
Bio-ethanol yield	liter/ton	400	400	400
Sorghum production	ton	600 000	649 459	731 397
Sorghum yield	ton/ha	2,46	2,46	2,46
Equivalent hectares	ha	243 902	264 008	297 316
DDGS produced	ton	180 000	194 838	219 419

Potential hectares not planted

The total plantings of grain and oilseeds in South Africa declined since 1995/96 from 5,7 million hectares to 3,3 million hectares (-42%) in 2005/06 and increased to 4,2 million hectares in 2010/11 (Figure 1).

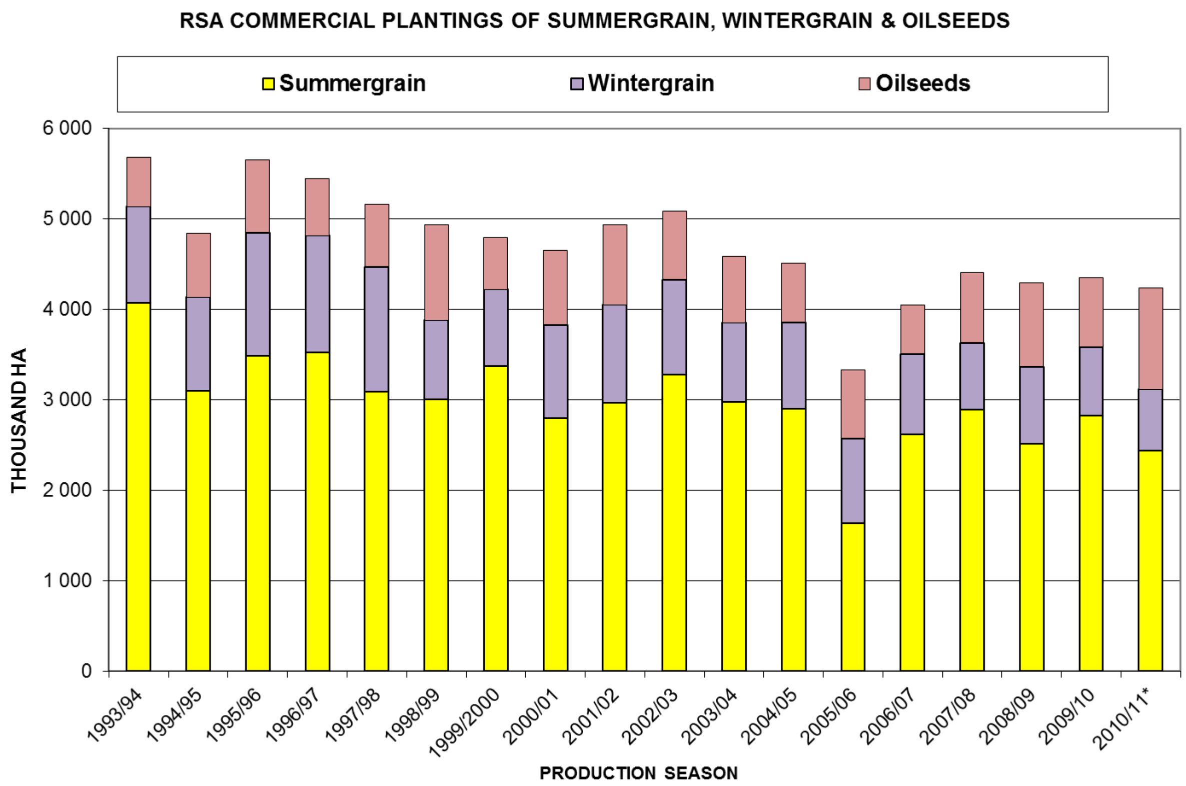

Figure 4.1: RSA Commercial Plantings of Summergrain, Wintergrain and Oilseeds

The decline in the total number of hectares for all grain and oilseed crops since 1995/96 until 2010/11 are 1,4 million hectares (-25%). Given this, the hectares available for the potential re-introduction of commercial crop production should be about 1 422 000 hectares

During the 2010/11 production season, producers planted 3,8 million hectares to maize, sorghum, sunflower, soyabean and groundnuts. Nearly 2,4 million hectares or 67% of the total number of hectares planted were to maize. The sunflowerseed plantings reached 643 000 hectares (18%), soyabean 418 000 hectares (12%), Sorghum 69 000 hectares (2%) and groundnuts only 55 000 hectares (1%).

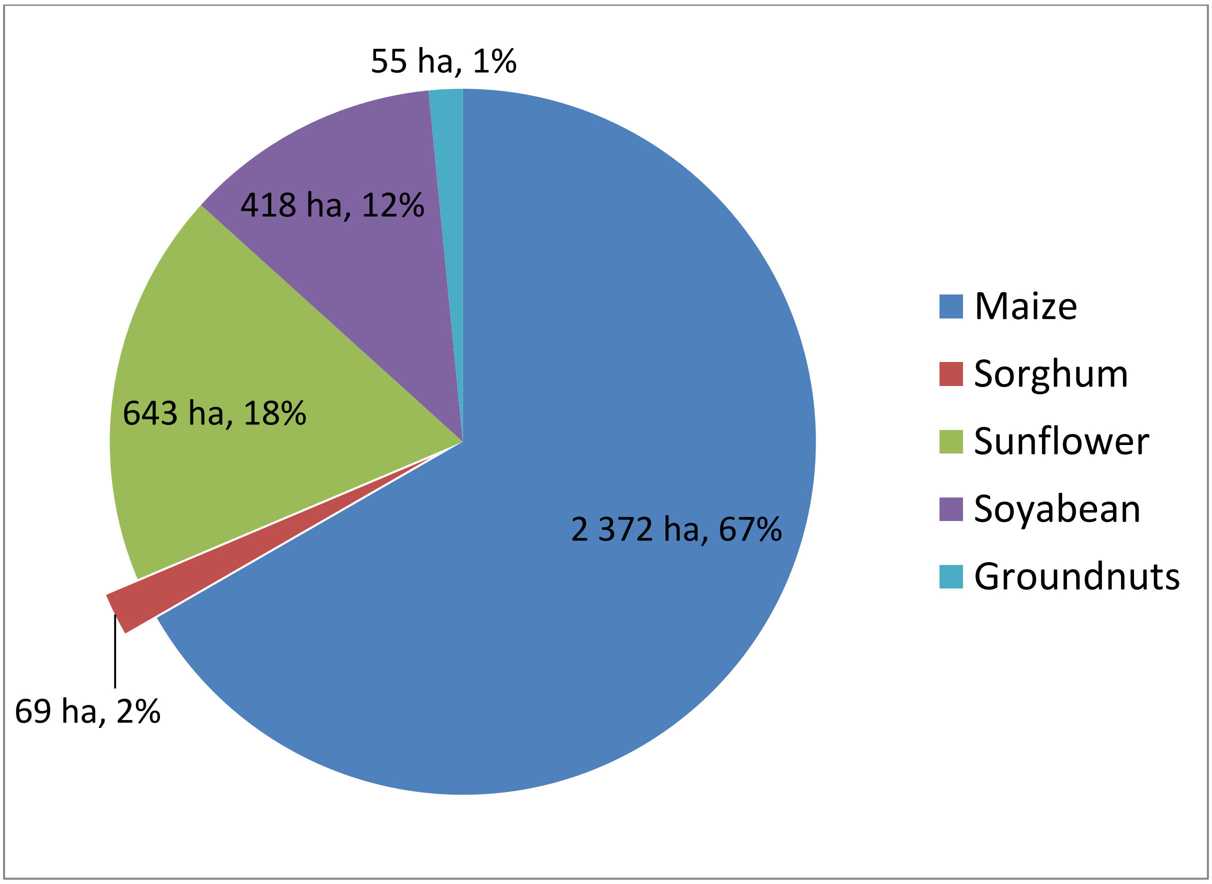

Figure 4.2: Distribution of Hectares in the 2010/11 Production Season (x 000 ha)

The plantings of sorghum may conservatively increase to244 000 hectares if the 2% inclusion rate of bio-ethanol became mandatory. Based on the 2010/11 productions season as an example, it implies that the percentage share of sorghum to total selected crops planted will increase from 2% (69 000 ha) to 8% (313 000 ha).

The total hectares planted to maize, sorghum, sunflower, soyabean and groundnuts will increase from 3 557 350 hectares to 3 801 252 hectares (+6,9%). Compared to the 1993/94 production season when 4 617 038 hectares were planted it is clear that an increase of 244 000 hectares for bio-ethanol production purposes will not impact on food security. Thus, based on the historical plantings of the mentioned crops it should be possible to increase the production of sorghum without impacting on the current production levels of the other crops. Please note also that as recently as 2002/03 South Africa planted 4 036 927 hectares in total to Maize, Sorghum, Sunflower, Soyabean and Groundnuts

Even a scenario with a mandatory blending percentage of 5 percent in 2016 requires additional sorghum crop land of just 660 000 hectares. The total hectares planted to sorghum will increase from 69 000 ha to 729 000 hectares which will increase the total hectares planted to 4 217 350.

These level of planted hectares are equivalent to the 1995/96 production season when 4 292 121 hectares were planted to maize, sorghum, sunflower, soyabean and groundnuts. It is clear that given the above, food security will not be compromised if producers are allowed to increase sorghum plantings to levels which were planted during the past 18 years to the aforementioned crops.

At a blending % of 10 percent in 2021 an additional amount of 1 457 430 hectares is needed assuming that crop yields do not improve with time.

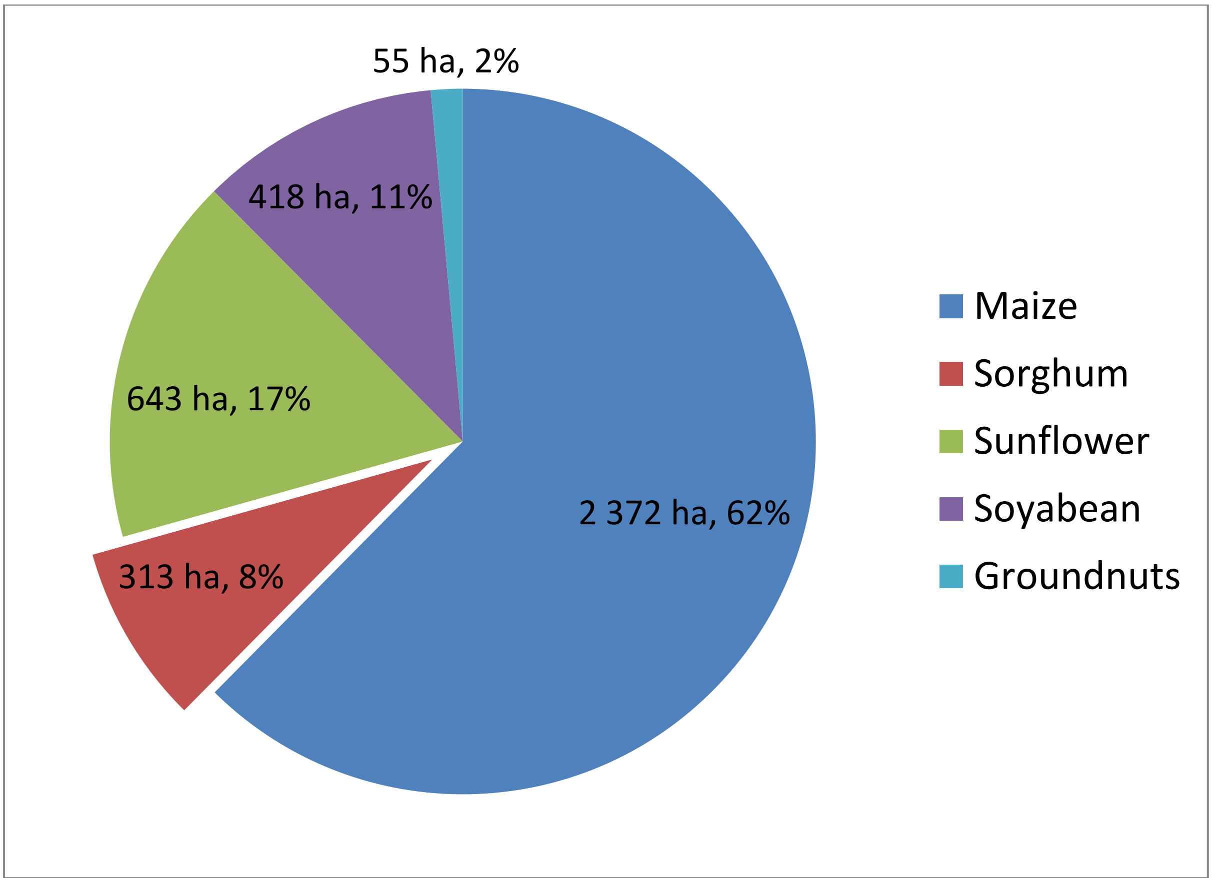

Figure 4.3 Distribution of Hectares in the 2010/11 Production Season Including an Additional 243 000 Hectares for Bio-ethanol Production Purposes (x 000 ha)

Surplus production of maize

Since 2007/08 the average annual production of maize in particular reached 10,6 million tons compared to the annual average domestic consumption of 9,7 million tons. At an average yield of 4,3 ton/ha the resulting average carry out (Including exports but excluding imports of maize) reaches just more than 900 000 tons. The area (hectare equivalent) of this 900 000 tons of maize is almost

210 000 hectares. This number of 210 000 hectares indicates that the production of sorghum can substitute 210 000 hectares of maize without compromising food security and the domestic demand of maize. A two percent inclusion rate requires an increase in sorghum hectares by 243 000 ha. This implies that 86% of the land requirements for increased sorghum production (for E2) could be satisfied by substituting land currently used for 'export' maize. Focusing on the past four marketing years (2008/09-2011/12), the annual average domestic production for maize reached 11 557 000 tons and the domestic demand 9 958 000 tons.This provided an average of 1,6 million tons of exported maize, the equivalent land of which would be available to bio-ethanol production without compromising food security. A number of 1,6 million tons of maize equals at the average maize yield of 4,67 ton/ha an area of 342 162 ha available for additional sorghum production relative to the 243 000 ha requirement.

Increase in the yield of sorghum

The average yields of sorghum did not keep up with the yields realised by the new bio-technology advanced maize cultivars (Figure 3.4). However, according to the domestic seed industry the release of a cultivar with an increased yield of about 40% above the available sorghum cultivars is possible. In other words the release of a cultivar with a potential yield increase of between 0,75 ton/ha and 1,0 ton/ha is expected given that the sorghum milling industry supports this initiative of the plant breeding companies. The seed companies received the sorghum milling industry's support during an inclusive industry meeting during June 2011.

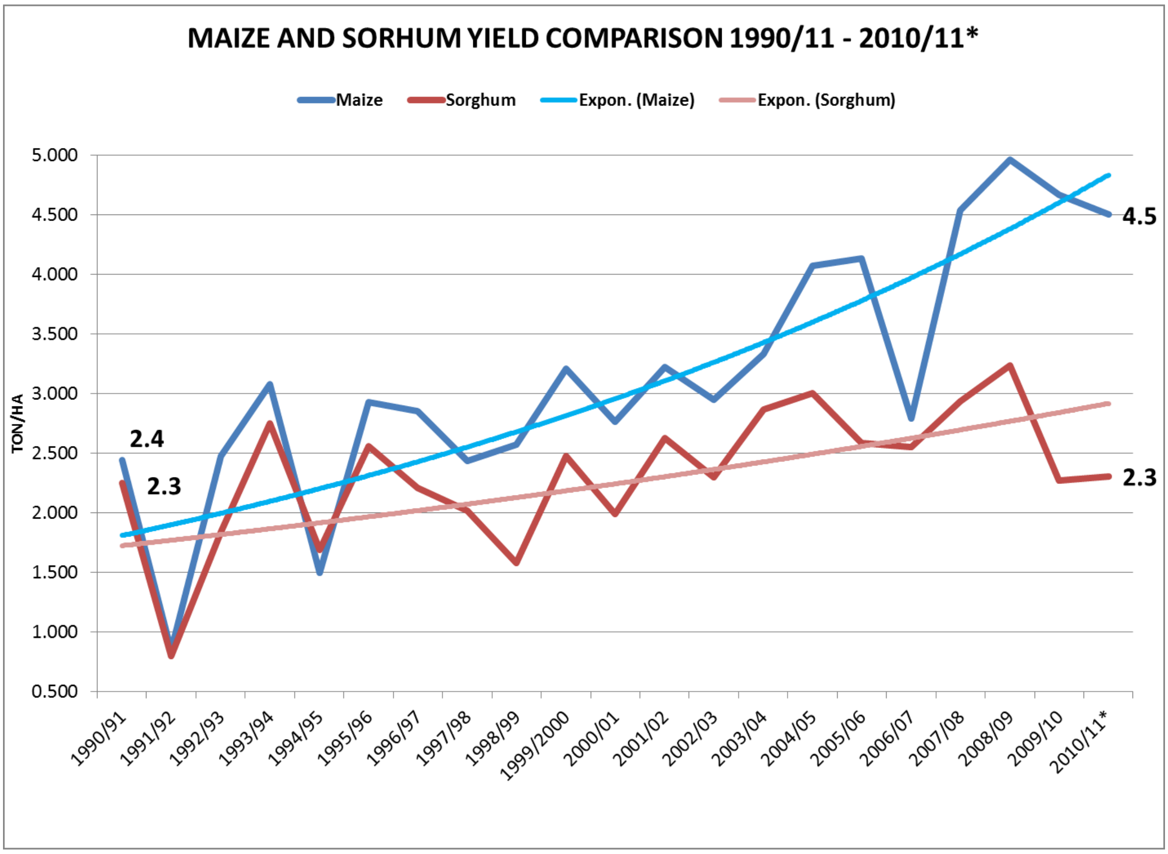

Figure 4.4: Maize and Sorghum Yield Comparison 1990/11 – 2010/11

The long term average yield of sorghum is 2,46 ton/ha which is quite conservative and at the lower range of yields realised during the past ten years of sorghum production. With an increase of 1 ton/ha in the foreseeable future, we may expect the national average yield to reach 3,46 ton/ha. At an average yield of 2,46 ton/ha an additional production area of 243 000 hectares is required to produce 600 000 tons which is sufficient for the bio-ethanol demand at a 2% compulsory blending rate. At an average yield of 3,46 ton/ha, production increase by 40%.

Therefore, for the same required production level of 600 000 tons of sorghum production, the additional required hectares for bio-ethanol production purposes reduces to173 410 ha (600 000 tons / 3.46 ton/ha = 173 410 ha).

Compared to the total hectares planted to summer crops, this constitutes only a 4.9% increase in hectares which is comparatively very low given also that South Africa planted only 70 000 hectares to sorghum in the past production season. It should be noted that in 1995/96 a maximum number of hectares totalling 174 000 hectares was planted to sorghum. There is no reason to expect that it cannot happen again without compromising food security.

Replacement by DDGS

The amount ofDDGS to be produced at a compulsory blending rate of 2 % equals 180 000 tons (600 000 ton x 30%). Based on the assumptions by Dunn (2005) approximately 180 000 tons of DDGS replaces the following products in the feed market namely:

- Maize, 77040 ton (43%)
- Wheaten bran, 32395 ton (18%)
- Fullfat soya, 8557 ton (5%)
- Oilcake (Soyabean meal, Sunflower meal, Cottonseed meal), 41 088 (37%)
- Fish meal, 2445 ton (1%)

Equally, according to Dunn (2005) and given the price relationship at the time, 297 170 tons of DDGS replaces 322 492 tons of maize.

Therefore 180 000 tons of DDGS may replace 195 338 tons of maize in the feed market. At an average yield of 4,67 ton/ha the equivalent area of maize land that can be replaced is 41 828 hectares. Given the assumption that the ethanol yield and DDGS production from sorghum is similar to maize it can be assumed that the DDGS from sorghum may replace a similar amount of hectares as maize.

SUMMARY AND CONCLUSION

The impact of bio-ethanol production on food security in terms of the availability of food derived from grain and oilseed commodities at the 2% and 5% compulsory blending rates for bio-ethanol will not be significant. The following facts as discussed above prove that the production of bio-ethanol will have almost no effect on the availability of food.

- During the 1995/96 production season 5,7 million hectares were planted to summer grains. The difference between the total plantings in the 2010/11 production season (4,2 million hectares) compared to the plantings during the 1995/96 production season equals enough hectares to allow a mandatory blending rate of 5%.

- Focusing on the past four marketing years, South Africa produces on average 1,6 million tons of excess maize per year which is available for bio-ethanol production without compromising food security in South Africa. This amount of available maize equals 342 000 hectares relative to the 243 000 hectares required for sorghum production at a compulsory blending rate of 2%. In fact, enough hectares should be available to substitute from maize to sorghum in order to support a mandatory blending rate of 2,8%.
- At an average yield of 2,46 ton/ha (which is the lower level of production during the past ten years) and an additional required production area of 243 000 hectares, 600 000 tons can be produced which is sufficient for the bio-ethanol demand at a 2% compulsory blending rate.
- At the expected increase of 1 ton/ha due to the release of new suitable cultivars,production of sorghum will increase by 40%. At an average yield of 3,46 ton/ha on 243 000 hectares, sufficient quantities of sorghum can be produced to meet a mandatory blend of 2,8% (3,46 ton/ha X 243 000 ha X 400 liter /ton / 12 000 000 000 liter)

In summary and given the facts above, a mandatory blending percentage of as much as 10percent bio-ethanol should be viable without compromising food security.

Potential increase in hectares based on history (1,5 million ha)	5%
Existing surplus production capacity to switch from maize land to sorghum	2,8%
Expected increase of 1 ton/ha in sorghum yield	2,8%
Potential total bio-ethanol production increase	**10,6%**

According to the analysis in this chapter it is possible that the potential increase in hectares (+5%), switch from surplus maize to sorghum (+2,8%), and the expected increase of 1 ton/ha in sorghum yield (2,8%) will more than just cover a mandatory blend of 10 percent without compromising food security. Please note that the potential production of sorghum in the former homeland areas is not considered in the above estimates and still needs to be included. According to the ARC an additional area of approximately 3 million hectares in the former homeland areas have potential for crop production.

The increased demand for bio-ethanol feedstock, and in this case sorghum, may in the short term increase to import parity. As soon as the immediate demand is met by sufficient sorghum supply sorghum prices will return to a normal equilibrium between supply and demand. In the short term sorghum products may increase in price relative to those of maize, making sorghum products less affordable to the consumer.

CHAPTER 5: PROJECTING THE IMPACT OF SORGHUM-BASED ETHANOL PRODUCTION ON FOOD SECURITY

Note: This chapter was compiled by the Bureau for Food and Agricultural Policy (BFAP)

The previous chapter provided an overview of grain markets and a description of possible shifts in production and consumption of sorghum and maize, due to the introduction of sorghum-based ethanol production. This chapter presents an outlook of the possible shifts in key market fundamentals due to ethanol production from sorghum. The two scenarios, as summarized in table 4.1 and 4.2, are simulate in the BFAP Sector model and compared to a Baseline (Benchmark).

BFAP has developed a system of econometric models using historical information from agricultural commodity markets as well as information obtained from producer and farmer groups as well as other industry specialists. At the heart of the system of models lies the BFAP sector model, which covers 44 commodities in the South African agricultural sector. For each commodity, the most important determinants of supply and demand have been identified. For a typical crop, these include the area under production, yield per hectare, total production, direct human consumption, industrial use, exports, imports, and ending stocks.

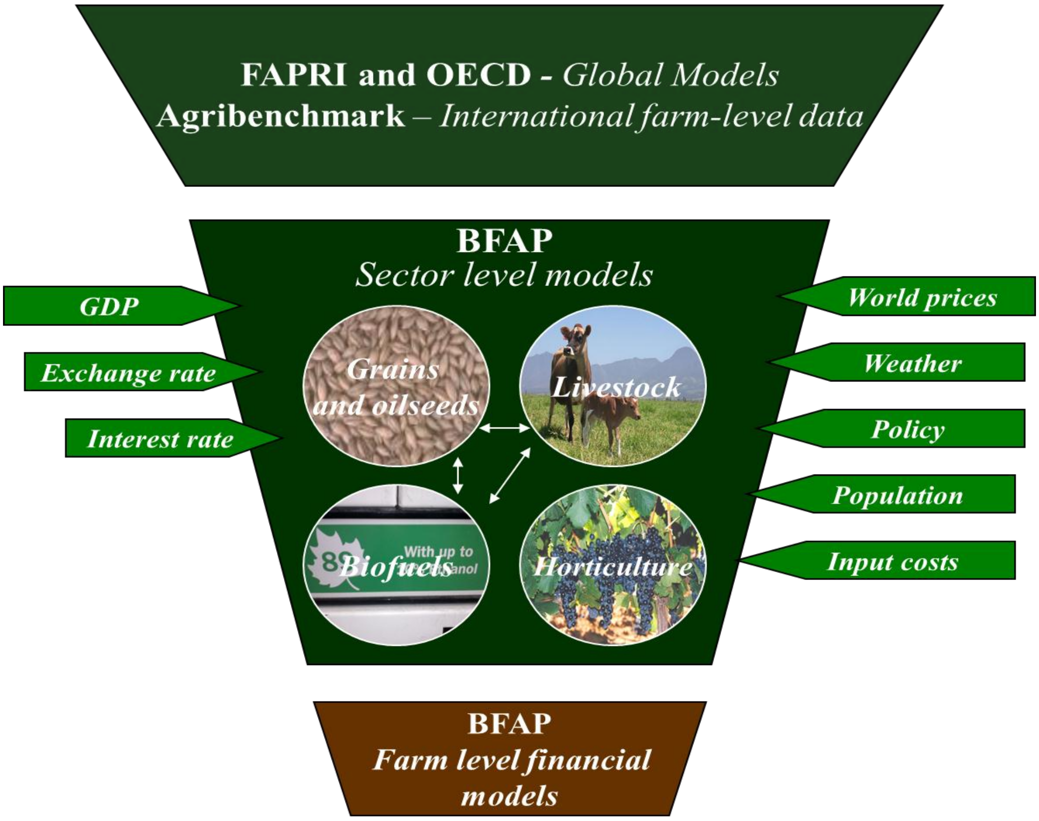

Figure 5.1: BFAP system of equations

Figure 5.1 illustrates the basic structure of the system of models. The BFAP sector model is a partial equilibrium model, which has the ability to model the cross-commodity linkages between field crops, biofuels and livestock sectors. This makes the model ideal to analyse scenarios as required for this report, where not only the dynamic substitution between commodities like maize and sorghum is taken into consideration, but also the interaction between livestock industries and feed grains, where the production of DDGS has an influence.

The first basic projections generated by the sector level model are called *"Deterministic Baseline projections".* These baseline projections are grounded in a series of assumptions about the general economy, agricultural policies, the weather, and technological change. These variables are referred to as exogenous or pre-determined variables and are indicated by the green arrows in figure 4.1. Rather than project the absolute levels of a range of variables in future, the pupose of the Baseline in this report is to set a 10-year outlook or benchmark to which the alternative scenarios can be compared. The macro economic assumptions that are used to generate the baseline are presented in table 5.1.

Table 5.1: Baseline macro-economic assumptions

	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Crude Oil Persian Gulf: (USD/barrel)	103	105	107	109	111	113	115	117	120
SA Population (Millions) [Millions]	51.1	51.3	51.5	51.7	51.9	52.1	52.3	52.5	52.7
Exchange Rate (R/USD) [SA c/US$]	7.13	7.36	7.60	7.85	8.08	8.31	8.54	8.78	9.03
SA GDP [%]	3.6	3.1	3.2	3.4	2.9	2.6	2.3	2.1	2.1

Given the the set of macro-economic assumptions and keeping the rainfall as "normal" (30-year average rainfall) over the outlook period (2010- 2020), the BFAP sector model generates the long-run equilibrium in each of the commodity markets. Although only the maize and sorghum industry results are presented in table 4.2, the results for the other industries are available upon request.

The baseline results show an intial increase in the area planted to maize in 2012. However, over the long run, the area under white maize is projected to decline whereas the area under yellow maize is projected to increase. This relative switch in area is driven by long-run consumption patterns, where human consumption of maize is projected to decline as per capita income is projected to increase and feed consumption of maize is projected to grow rapidly as the demand for meat (especially chicken meat) grows by approximately 40 percent over the next decade. Total domestic maize production is expected to come in at 11.7 million tons and comfortably meet the projected total demand of 11 million tons by 2020. SA is projected to remain a net exporter of maize over the next decade. Hence, SA will have a surplus of maize and maize prices are expected to trade at export parity levels, which implies that under the baseline assumptions SA will be food secure on average in terms of maize.

Compared to the maize industry, the Baseline suggests that the sorghum industry will remain relatively stagnant with marginal growth in the total demand for sorghum. The area under sorghum production is also not expected to expand with yields staying relatively constant due to lack of investment in this sector. SA is expected to meet its local needs and export small quantities mainly across the borders to neighboring countries. Sorghum prices are also expected to trade at export parity levels over the baseline.

Table 5.2: BFAP Sector model baseline projections

		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
White Maize											
Area harvested	1000ha	1418	1587	1550	1445	1400	1365	1230	1240	1192	1145
Yield	t/ha	4.37	4.36	4.39	4.42	4.44	4.47	4.49	4.52	4.54	4.57
Production	1000 tons	6199	6922	6805	6382	6222	6101	5526	5604	5413	5227
Domestic use	1000 tons	5563	5381	5262	5150	5154	5243	4885	4716	4757	4783
Stocks	1000 tons	839	1356	1583	1406	1263	1149	956	912	846	754
Imports	1000 tons	0	0	0	0	0	0	0	0	0	0
Exports	1000 tons	1411	1024	1316	1409	1211	972	834	932	721	536
SAFEX price	R/ton	1916	2264	2001	2117	2232	2280	2404	2569	2546	2634
Yellow maize											
Area harvested	1000ha	954	1146	1192	1177	1199	1227	1351	1270	1321	1286
Yield	t/ha	4.69	4.80	4.84	4.88	4.92	4.96	4.99	5.03	5.07	5.10
Production	1000 tons	4479	5501	5771	5742	5900	6083	6750	6387	6694	6562
Feed consumption	1000 tons	3552	3936	4226	4446	4647	4689	5071	5371	5759	5815
Human consumption	1000 tons	316	304	317	314	310	293	306	291	296	292
Domestic use	1000 tons	4052	4424	4727	4944	5141	5166	5561	5847	6239	6291
Stocks	1000 tons	368	622	743	593	473	404	549	520	593	612
Exports	1000 tons	826	833	922	948	879	986	1043	570	367	280
Imports	1000 tons	0	0	0	0	0	0	0	0	15	28
SAFEX price	R/ton	1939	2181	1976	2051	2137	2463	2248	2532	2469	2556
Sorghum											
Area harvested	1000ha	69	84	81	82	82	83	82	81	81	81
Yield	t/ha	2.31	2.90	2.91	2.93	2.94	2.95	2.97	2.98	2.99	3.00
Production	1000 tons	160	243	237	239	242	246	244	242	243	244
Feed consumption	1000 tons	6	25	27	29	32	37	34	37	36	38
Human consumption	1000 tons	180	186	187	187	186	185	184	184	183	183
Domestic use	1000 tons	188	213	217	219	220	225	221	224	222	224
Stocks	1000 tons	27	46	48	49	50	51	51	50	51	51
Net exports	1000 tons	0	11	18	20	21	21	23	19	20	20
SAFEX price	R/ton	2493	2297	1981	2048	2102	2191	2220	2402	2435	2494

In order to simulate the impact of sorghum-based ethanol production on prices and availability of maize, the assumptions ofthe two scenarios (table 4.1 and 4.2) were introduced in the BFAP sector model respectively. The second scenario was simulated first to illustrate the impact of a constant E2 blending rate. For the ease of interpretation of the results, the absolute and percentage deviations from the baseline for the total maize and sorghum industry are presented in tables 4.3 and 4.4. It is important to note that the model still solves for an equilibrium once the shock is introduced. This implies that the net effect of all impacts on supply and demand have to equal zero, since total demand has to equal total supply. In other words, if for example an additional amount of 600 000 tons of sorghum is suddenly required, the model will find equilibrium in the short run where the additional amount is imported and local prices will increase to import parity levels.

Table 5.3: Absolute and percentage deviatons from the baseline – Scenario 2 (E2 only)

		2012	2013	2014	2015	2016	2017	2018	2019	2020
Area harvested		Thousand ha								
	Baseline	2733	2742	2621	2599	2592	2581	2510	2513	2431
	Scenario	2714	2715	2592	2567	2556	2538	2460	2454	2358
	Absolute Change	-19	-27	-29	-32	-37	-43	-50	-59	-73
	% Change	-1%	-1%	-1%	-1%	-1%	-2%	-2%	-2%	-3%
Production		Thousand tons								
	Baseline	12423	12576	12124	12121	12184	12276	11992	12107	11788
	Scenario	12342	12453	11992	11977	12012	12065	11756	11829	11445
	Absolute Change	-81	-123	-132	-145	-172	-211	-236	-278	-343
	% Change	-1%	-1%	-1%	-1%	-1%	-2%	-2%	-2%	-3%
Stocks		Thousand tons								
	Baseline	1978	2327	1999	1735	1553	1506	1432	1439	1366
	Scenario	1951	2275	1933	1656	1468	1421	1328	1306	1192
	Absolute Change	-27	-52	-66	-79	-84	-85	-103	-133	-173
	% Change	-1%	-2%	-3%	-5%	-5%	-6%	-7%	-9%	-13%
Domestic use		Thousand tons								
	Baseline	9805	9989	10094	10295	10409	10447	10563	10997	11073
	Scenario	9740	9927	10027	10227	10334	10368	10477	10907	10957
	Absolute Change	-65	-62	-66	-68	-74	-79	-86	-90	-116
	% Change	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%
Exports		Thousand tons								
	Baseline	1857	2239	2357	2090	1958	1877	1503	1088	817
	Scenario	1868	2202	2306	2027	1865	1745	1371	930	627
	Absolute Change	11	-36	-51	-63	-93	-132	-131	-158	-190
	% Change	1%	-2%	-2%	-3%	-5%	-7%	-9%	-15%	-23%
White Maize SAFEX		R/ton								
	Baseline	2264	2001	2117	2232	2280	2404	2569	2546	2634
	Scenario	2277	2020	2140	2261	2307	2427	2607	2601	2712
	Absolute Change	13	19	23	29	27	23	38	55	77
	% Change	1%	1%	1%	1%	1%	1%	1%	2%	3%
Yellow Maize SAFEX		R/ton								
	Baseline	2181	1976	2051	2137	2463	2248	2532	2469	2556
	Scenario	2173	1971	2046	2131	2464	2259	2537	2472	2555
	Absolute Change	-8	-5	-5	-5	1	11	5	2	-1
	% Change	0%	0%	0%	0%	0%	1%	0%	0%	0%

Higher prices will improve the profitability of sorghum production and the area under production will expand. However, higher prices will also have a negative impact on human and feed consumption of sorghum in the short term. The model repeats this process (iterations) until a new long-run equilibrium is established.

Table 5.4: Absolute and percentage deviatons from the baseline – Scenario 2 (E2 only)

		2012	2013	2014	2015	2016	2017	2018	2019	2020
Area harvested		Thousand ha								
	Baseline	84	81	82	82	83	82	81	81	81
	Scenario	105	125	141	154	171	186	201	218	234
	Absolute Change	21	44	60	72	88	104	119	137	153
	% Change	25%	53%	73%	87%	105%	126%	147%	168%	189%
Production		Thousand tons								
	Baseline	243	237	239	242	246	244	242	243	244
	Scenario	322	412	469	547	627	704	784	855	949
	Absolute Change	79	175	229	304	381	460	542	612	705
	% Change	33%	74%	96%	126%	155%	189%	223%	252%	289%
Stocks		Thousand tons								
	Baseline	46	48	49	50	51	51	50	51	51
	Scenario	57	78	90	106	122	138	156	171	194
	Absolute Change	12	30	41	56	72	88	106	120	143
	% Change	26%	62%	84%	113%	142%	173%	211%	236%	279%
Domestic use		Thousand tons								
	Baseline	213	217	219	220	225	221	224	222	224
	Scenario	787	787	811	823	835	847	860	873	888
	Absolute Change	574	571	593	603	610	626	636	651	665
	% Change	270%	263%	271%	274%	272%	283%	284%	293%	297%
Sorghum Net Exports		Thousand tons								
	Baseline	11	18	20	21	21	23	19	20	20
	Scenario	-495	-396	-355	-292	-224	-159	-93	-33	37
	Absolute Change	-506	-414	-374	-314	-245	-182	-112	-53	17
	% Change	-4591%	-2255%	-1909%	-1483%	-1181%	-807%	-593%	-263%	87%
Sorghum SAFEX		R/ton								
	Baseline	2297	1981	2048	2102	2191	2220	2402	2435	2494
	Scenario	2930	2854	3005	3159	3288	3431	3444	3572	2702
	Absolute Change	633	873	958	1057	1097	1211	1042	1138	208
	% Change	28%	44%	47%	50%	50%	55%	43%	47%	8%

The shock is introduced in the model by increasing the domestic demand for sorghum by the amount required as feedstock to meet the E2 blending rate. The additional amount of sorghum required in 2012 is 600 000 tons and grows over the baseline as the demand for fuel increases. Yet, the model simulates a slightly reduced net increase in local consumption of 574 000 tons (table 5.4) due to the sharp increase in local sorghum prices when the local market moves from export to import parity. In orther words, human and feed consumption will decline due to higher market prices. Over time, the area under sorghum is projected to increase and by 2020 the total net increase will amount to 153 000 ha, which will bring the total area under sorghum to 234 000 ha and production to 948 900 tons. The negative sign in front of Net Exports implies that sorghum is actually being imported for a number of years. Over time imports will drop as the local production of sorghum increases. Figure 4.2 clearly indicates how local prices will increase to import parity levels as soon as ethanol production commences. Yet, in the outlying years (2018-2020) the local price is projected to break away from importy parity as local production meets local demand and prices are expected to be only R200/ton higher than under the baseline.

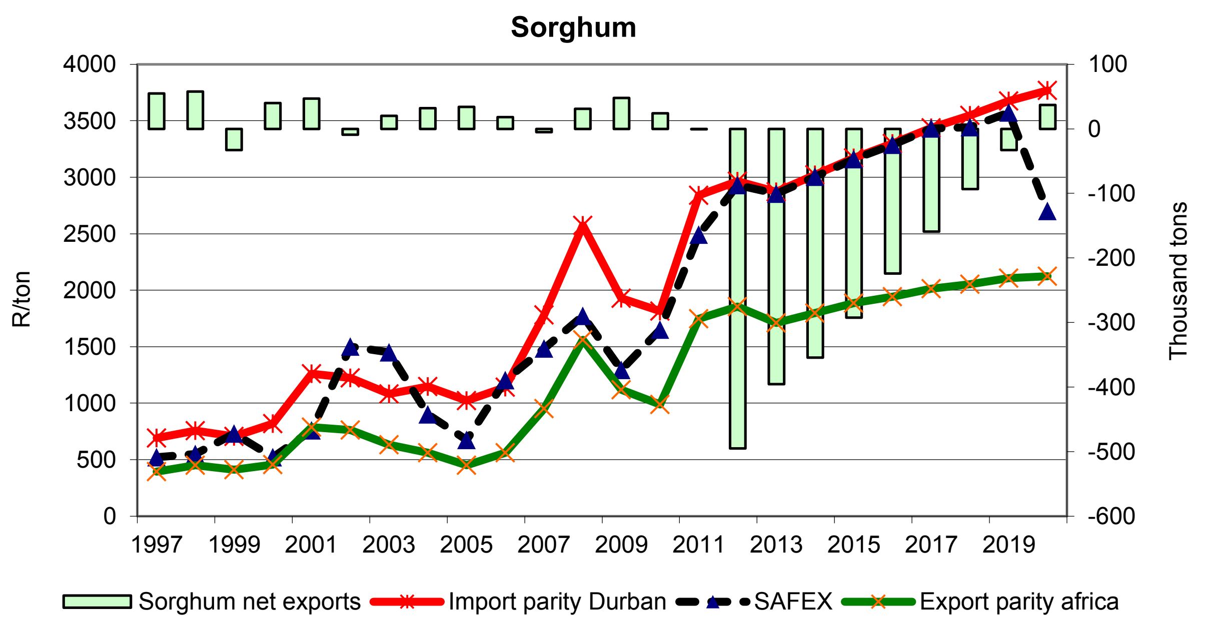

Figure 5.2: Sorghum price and trade space, Scenario 2 (E2 only)

The total decline in the area under maize amounts to 73 000ha by 2020 and the price impact on both white and yellow maize seems negligible. The impacts on supply and demand fundamentals are relatively small and yellow and white maize prices remain at export parity levels. The drop in production due to less plantings will mainly be absorbed by less feed demand and lower levels of exports. Feed demand for maize is projected to decline due to the introduction of DDGS from the production of ethanol. The average rate of replacement of maize by DDGS is approximately 40% in the model. Apart from maize, DDGS will also replace soybean and sunflower cake.

The increase in the area under production of sorghum will not only be driven by significantly higher prices, but also by the introduction of higher yields. Whereas sorghum yields are projected to reach only 3t/ha by 2020 under the Baseline, yields are boosted to more than 4t/ha by 2020 under the Scenario. Higher yields are essential to support the switch from maize to sorghum production. In the previous sections the possibility of improved varieties of sorghum was already mentioned. Figure 5.3 compares the expected market returns (price * yield) per hectare for yellow maize and sorghum. It is evident that more than just a growth in yields is required to make sorghum market returns competitive to yellow maize market returns. The green line in the figure illustrates the increase in sorghum market returns without the introduction of ethanol (in other words no price effect). Once ethanol is introduced on top of improved yields, the market returns for sorghum are higher than for maize and a shift to sorghum production is more likely to occur.

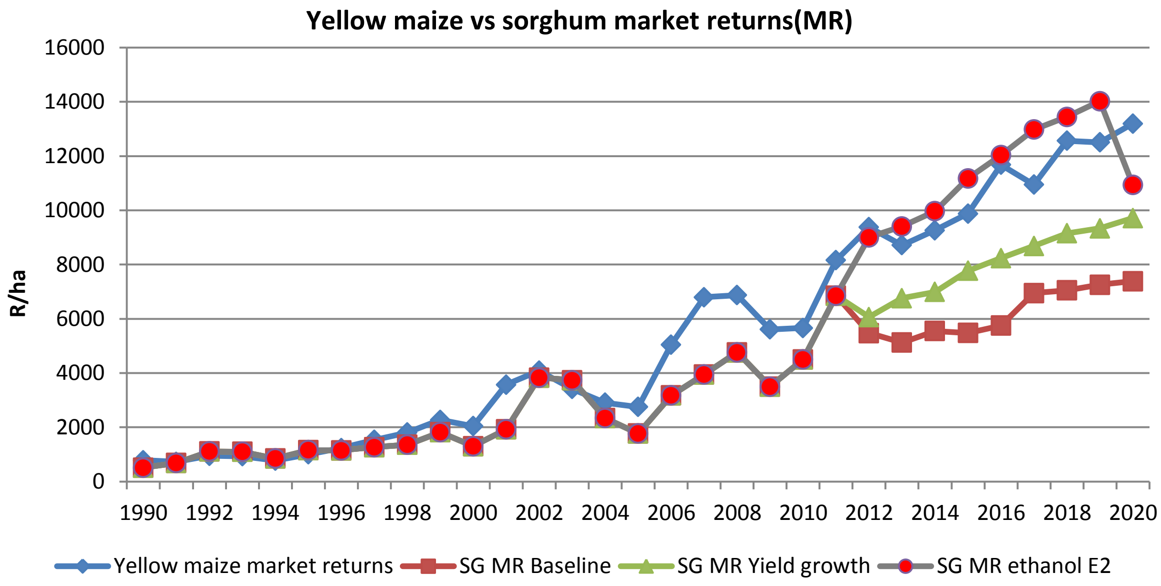

Figure 5.3: Yellow maize vs sorghum market returns

Lastly, it is interesting to note that the impact on the total area under production of summer grains is positive. Although the total area under sorghum production increases by 153 000ha, only 73 000ha less maize is planted. **Hence, there is a net increase in the total area under summer grains of approximately 80 000 ha due to a boost in profitability of sorghum production**.

The scenario that is presented in table 4.1 was also introduced in the model, where the ethanol blending rate increases from 2% to 5% in 2016 and 10% beyond 2020. The BFAP sector model is currently set up to simulate results only up to 2020. Hence the impact of a 10% blending rate could not be analysed, but from the analysis of a 5% blending it was already clear that maize prices do not remain unaffected. Table 5.5 (page 49) summarizes the key impacts on the total maize industry once an E2 and E5 blending levels are introduced in the model. By 2020 white and yellow maize prices are projected to increase by 16% and 18% respectively. This implies that one cannot assume that food security, in terms of affordability of maize meal, will not be affected by the introduction of a E5 blending rate. However this assessment is subject to change and should be reassessed at a later stage depending on the success and outcomes of phase one of the biofuels implementation strategy i.e. E2

Table 5.5: Absolute and percentage deviations from the baseline – Scenario 1 (E2 and E5)

		2012	2013	2014	2015	2016	2017	2018	2019	2020
Area harvested		Thousand ha								
	Baseline	2733	2742	2621	2599	2592	2581	2510	2513	2431
	Scenario	2714	2715	2580	2544	2508	2465	2389	2413	2262
	Absolute Change	-19	-27	-41	-55	-84	-116	-121	-99	-169
	% Change	-1%	-1%	-2%	-2%	-3%	-5%	-5%	-4%	-7%
Production		Thousand tons								
	Baseline	12423	12576	12124	12121	12184	12276	11992	12107	11788
	Scenario	12342	12453	11929	11854	11776	11703	11396	11637	10965
	Absolute Change	-81	-123	-195	-267	-409	-573	-596	-470	-823
	% Change	-1%	-1%	-2%	-2%	-3%	-5%	-5%	-4%	-7%
Stocks		Thousand tons								
	Baseline	1978	2327	1999	1735	1553	1506	1432	1439	1366
	Scenario	1951	2275	1931	1655	1446	1362	1183	1206	941
	Absolute Change	-27	-52	-68	-80	-107	-144	-248	-233	-424
	% Change	-1%	-2%	-3%	-5%	-7%	-10%	-17%	-16%	-31%
Domestic use		Thousand tons								
	Baseline	9805	9989	10094	10295	10409	10447	10563	10997	11073
	Scenario	9740	9925	10023	10217	10183	10205	10150	10735	10567
	Absolute Change	-65	-64	-71	-78	-226	-241	-413	-261	-506
	% Change	-1%	-1%	-1%	-1%	-2%	-2%	-4%	-2%	-5%
White Maize SAFEX		R/ton								
	Baseline	2264	2001	2117	2232	2280	2404	2569	2546	2634
	Scenario	2277	2020	2134	2246	2301	2428	2830	2625	3050
	Absolute Change	13	19	17	15	21	24	262	79	416
	% Change	1%	1%	1%	1%	1%	1%	10%	3%	16%
Yellow Maize SAFEX		R/ton								
	Baseline	2181	1976	2051	2137	2463	2248	2532	2469	2556
	Scenario	2173	1971	2058	2157	2478	2287	2805	2472	3018
	Absolute Change	-8	-5	7	20	15	40	273	3	461
	% Change	0%	0%	0%	1%	1%	2%	11%	0%	18%

CHAPTER 6: SUMMARY AND CONCLUSION

Since the inception of the biofuels industry, the world is taking note of the associated benefits for job creation, poverty alleviation and food security. Generalisations about the impact of the biofuels industry on food security is not acceptable because circumstances between countries differ. For some countries, and if managed well through good management practices and policy, a lucrative biofuels industry can be a significant asset to a country and its economy.

With regards to the food security debate in South Africa, the grain production sector has proven capacity to produce sufficient feedstock without compromising food security and this is already evident noting the increase in grain and oilseed exports.

Sorghum is a suitable alternative to maize with promising yield increases according to plant breeders. Sorghum is also proposed by the FAWU as feedstock and is acceptable to COSATU.The strong public and labour union support in favour of the Industrial Policy Action Plan, underscore government policies in favour of biofuel production, job creation and rural economic development. Especially in areas where sugar cane cannot be grown. The fact that Cabinet allowed the use of sorghum as feedstock and by addressing the limiting factors of bio-ethanol production in the current IPAP combined with other supportive policies such as ASGISA provide proof of a well managed, conservative biofuels policy. The successful development of the bio-ethanol industry, including the promising benefits for South Africa, may at last be underway. The current drive to establish a successful domestic biofuel industry stems primarily from a Cleaner Fuel Policy and need for rural economic development. Thus, thepublishing of the draft regulations for comment on the compulsory blending of biofuel in the petroleum pool on 19 September 2011 in the Governement Gazette is very promising.

The realistic, practical impact of additional sorghum requirements at different ethanol/petroleum blend levels for two likely scenarios on food security is analysed:

- E2 in the short term (2012 – 2015), E5 in the medium term (2016 – 2020) and E10 in the long term (2021 onward)
- E2 only

The impact of bio-ethanol production on food security in terms of the availability of food derived from grain and oilseed commodities at the 2% and 5% compulsory blending rates for bio-ethanol will not be significantin terms of food availability. It is possible that the potential increase in hectares (+5%), switch from surplus maize to sorghum (+2,8%), and the expected increase of 1 ton/ha in sorghum yield (2,8%) will comfortably cover a mandatory blend of 10 percent without compromising food security. The potential production of sorghum in the former homeland areas is not considered in the above estimates and still needs to be included – the above assessment is very conservative by implication.

Without the implementation of a mandatory blend for bio-ethanol the sorghum industry will remain relatively stagnant with marginal growth in the total demand for sorghum. The area under sorghum production is also not expected to expand with yields staying relatively constant. SA is expected to meet its local needs and export small quantities mainly across the borders to neighboring countries. Sorghum prices are also expected to trade at export parity levels.

By increasing the domestic demand for sorghum by the amount required as feedstock to meet the E2 blending rate, the additional amount of sorghum required in 2012 is 600 000 tons and grows as the demand for fuel increases. Yet, a slightly reduced net increase in local consumption of 574 000 tons due to the sharp increase in local sorghum prices is expected when the local market moves from export to import parity. In orther words, human and feed consumption will decline due to higher market prices. Over time, the area under sorghum is projected to increase and by 2020 the total net increase will amount to 153 000 ha. This will bring the total area under sorghum to 234 000 ha and production to 948 900 tons.

It is expected that sorghum will be imported for a number of years. Over time imports will drop as the local production of sorghum increases. Local sorghum prices will increase to import parity levels as soon as ethanol production commences. Yet, in the outlying years (2018-2020) the local price is projected to break away from importy parity as local production meets local demand and prices are expected to be only R200/ton higher than under the current conditions without mandatory blending.

The total decline in the area under maize amounts to 73 000ha by 2020 and the price impact on both white and yellow maize seems negligible. The impacts on supply and demand fundamentals are relatively small and yellow and white maize prices remain at export parity levels. The drop in production due to less plantings will mainly be absorbed by less feed demand and lower levels of exports. Feed demand for maize is projected to decline due to the introduction of DDGS from the production of ethanol. The average rate of replacement of maize by DDGS is approximately 40%. Apart from maize, DDGS will also replace soybean - and sunflower cake.

The increase in the area under production of sorghum will not only be driven by significantly higher prices, but also by the introduction of higher yields. Whereas sorghum yields are projected to reach only 3t/ha by 2020 under current conditions, yields are boosted to more than 4t/ha by 2020 under the Scenario. Higher yields are essential to support the switch from maize to sorghum production.

It is evident that more than just a growth in yields is required to make sorghum market returns competitive to yellow maize market returns. Once ethanol is introduced on top of improved yields, the market returns for sorghum are higher than for maize and a shift to sorghum production is more likely to occur. Sorghum is inherently more drought tolerant than maize and therefore it can lower the production risk for producers if sorghum becomes economically more attractive to plant.

The impact on the total area under production of summer grains is positive. Although the total area under sorghum production increases by 153 000ha, only 73 000ha less maize is planted. **Hence, there is a net increase in the total area under summer grains of approximately 80 000 ha due to a boost in profitability of sorghum production.**

Where the ethanol blending rate increases from 2% to 5% in 2016 and 10% beyond 2020 it is already clear that maize prices does not remain unaffected. By 2020 white and yellow maize prices are projected to increase by 16% and 18% respectively. This implies that one cannot assume that food security, in terms of affordability of maize meal, will not be affected by the introduction of a E5 blending rate. However this assessment is subject to change and should be reassessed at a later stage depending on the success and outcomes of phase one of the biofuels implementation strategy i.e. E2

As food security is based on three pillars namely food availability, food affordability and access to clean and safe food it can be concluded that the introduction of a two percent mandatory blending level will not impact on food affordability with the exemption of sorghum products. With reference to the five percent mandatory blending level it can be concluded that food security may be compromised in terms of the affordability of both sorghum and maize consumer products. However, at both mandatory blending levels, the availability of food will not be compromised.

An analysis on a 10 percent mandatory blending level was not possible.

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APPENDIX A: Grain SA's view on biofuels

Views of Grain SA

The expansion of the local grain and oilseed market is, however, necessary to ensure sustainable production and bring about bigger trust in the grain and oilseed industry. The number of hectares that can be developed by the market for raw material for biofuel purposes includes about 2 million hectares for commercial production areas and about 3 million hectares for previously under-developed production areas.

Since the seventies, the profitability of maize production resulted in a decrease of 2 million hectares in the area that was planted. The continuous downward tendency in areas planted and consequent increase in food security risk must be prevented by expanding the market for maize and other grains, such as sorghum, and should not be limited by the wrong policy options.

South African producers have the resources to produce 12 million tons of maize as has been done in the past. For example, if a drought is experienced, the production may decrease from 9 million ton to 6 million ton by about 1/3. With a goal of 12 million ton under these circumstances, it could mean that about 8 million ton is produced. Consequently the food security is a lot better against 8 million ton compared to 6 million ton, particularly keeping in mind that the consumption of maize as food only amounts to 4 million ton.If a shortage should develop and 8 million ton is not produced, biofuel manufacturers should be able to import large volumes of grain independently of local production.

Exports of maize

Since Grain SA investigated the economic feasibility of the bio-ethanol industry in 2005 South Africa exported between May 2005 and April 2010 nearly 9 million tons of maize (Table 1). The number of litres bio-ethanol which could have been produced by maize as feedstock is a conservative 3,6 billion litre.

In 2005 the domestic demand for petroleum only was 11,2 billion litre compared to a possible annual average production of 720 million litre of bio-ethanol from available maize for the past five years. This number equals to about 6,4% bio-ethanol in the national petroleum pool. The importance of maize of feedstock can therefore not be under estimated.

Supply and demand including additional feedstock demand of 1 million tons for bio-ethanol production

Table 2 represent a possible scenario for the time period since 2005/06 given that the bio-ethanol industry demanded 1 million tons of maize annually to produce 400 million litres of bio-ethanol.

From this scenario it is clear that South African maize producers were in a position to support the bio-ethanol industry with available dedicated feedstock of 1 million tons annually with ease. During the 2006/07 and the 2007/08 marketing year it would have been necessary to import 1,6 million and 2,7 million tons of maize respectively to meet domestic demand. These imports were the result of exports of 2,1 million tons in 2006/07 and production that declined from an average of 4,14 tons per ha to 2,79 tons/ha in 2007/08. The scenario also makes provision of a necessary pipeline requirements (90 days of available stocks) to ensure that there is additionally 1 million tons of maize per year available for food security purposes also.

Table 1: The supply and demand of maize (x1000 ton)

	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11
Commercial Supply						
Opening stocks (1 May)	3 148	3 169	2 070	1049	1 581	2 131
Commercial Production	10 055	6 707	6 884	11891	11 629	13 043
Imports	360	930	1 120	27	27	0
Total Commercial Supply	13 563	10 806	10 074	12967	13 237	15 174
Commercial Demand						
Food	3 997	4 008	3 985	4743	4 621	4 680
Feed	4 011	4 047	4 429	4284	4 627	4 730
Gristing	100	81	63	69	86	78
Other	40	3	15	24	-17	520
Exports						
Products	103	49	61	104	119	105
Whole maize	2 143	548	472	2162	1 670	1 390
Total Commercial Demand	10 394	8 736	9 025	11386	11 106	11 503
Carry out 30 April	3 169	2 070	1 049	1581	2 131	3 671

It can be concluded that maize as feedstock,or any other grain as substitute such as grain sorghum, should be considered to be included in the biofuels strategy as a feedstock to the bio-ethanol industry. It is evident from the actual supply and demand figure (Table 1) and the scenario in retrospect (Table 2) that maize as feedstock could have been used as feedstock without impacting on food security.

The grain industry's position on biofuels

The current Biofuels Strategy accepted in December 2007 needs reconsideration as the start of a total revision. The conditions that led to the promulgation of the current Biofuels Strategy have changed significantly enough to justify interrogation of the facts and processes.

It can be argued that had the current Biofuels Strategy allowed it

- The surplus maize could be used for ethanol production leading to less dependence on foreign crude oil, imported petroleum an oxygenates
- A significant percentage of petroleum could have been replaced since 2005
- The rural economy could have been stimulated

- Food security could have improved as new biofuel developments introduce new entrants to opportunities offered by new agricultural development and skills in production

Table 2: Supply and demand scenario: 2005/06 – 2010/11 with the provision of 1 million tons of annual feedstock demand for a 400 million litre size bio-ethanol plant

	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11
Commercial Supply						
Opening Stock	3 148	1 809	1 000	1 000	2 667	3 860
Commercial production	10 055	6 707	6 884	11 891	11 629	13 043
Imports		1 672	2 669			
Total commercial supply	**13 203**	**10 188**	**10 553**	**12 891**	**14 296**	**16 903**
Commercial demand						
Food	3 997	4 008	3 985	4 743	4 621	4 680
Feed	4 011	4 047	4 429	4 284	4 627	4 730
Gristing	100	81	63	69	86	78
Other	40	3	15	24	-17	520
Exports						
Products	103	49	61	104	119	105
Whole maize	2 143					
Bio-ethanol	1 000	1 000	1 000	1 000	1 000	1 000
Total commercial demand	**11 394**	**9 188**	**9 553**	**10 224**	**10 436**	**11 113**
Carry-out (30 April)	**1 809**	**1 000**	**1 000**	**2 667**	**3 860**	**5 790**
Pipeline requirements	**1 000**	**1 000**	**1 000**	**1 000**	**1 000**	**1 000**
Surplus above pipeline	**809**			**1 667**	**2 860**	**4 790**

- Additional jobs could have been created by the labour absorbing farming sector
- Foreign exchange savings could have been realised
- The government tax basis could have been extended
- A more carbon friendly nature and contribution to emission control could have been achieved

Government (DAFF) is still of opinion that government have to be mindful of food security concerns and the impact on food prices and furthermore that large tracts of existing agricultural land were to be turned to the production of bio-fuel feedstock. Government acknowledges that it is potentially possible to reconcile food security with biofuel production if we are able to expand the net agricultural output, through more land under cultivation or productivity increases or both.

Given the following food security and biofuel production in South Africa is totally reconcilable.

- South Africa developed through productivity increases to become a net exporter of maize. We produce above current export estimates of 1,85 million tons an additional carry-out (surplus) of about 2,8 million tons of maize. The same principal accounts for soybeans in the case of biodiesel production with expected exports in 2011 to reach 220 000 tons.
- Sorghum as potential feedstock which yields the same amount of bio-ethanol than maize can substitute the utilisation of maize given a supportive biofuels strategy which ensure guaranteed take off and incentives to develop the bio-ethanol industry.
- We acknowledge the fact that each unit of grain as feedstock used for bio-ethanol production adds one –third of DDGS (Dried Distillers Grains and Solubles). The DDGS produced is a high protein animal feed which may substitute the imports of soya oilcake.
- Agricultural output is expanding on existing land through the availability of biotechnology (GMO-traits) which increase the yield and consequent total production of crops such as maize and soybean. According to the sorghum seeds industry new conventional cultivars that have the potential to yield between 0,75 to 1,0 ton/ha more is almost ready to be released.
- We acknowledge the contribution that a potential market for biofuels in South Africa can add to create opportunities for farmers to expand production and to acquire skills in the production of feedstock and consequently food.
- Instead of banning maize altogether measures should be imposed, as in the USA that will ensure food security in case of crop failure.

South Africa therefore do not have to fear food insecurity given the limited introduction of biofuel production from grain and oilseeds in our economy. Additionally, the following and recent public statements by government implicate the need to revisit the current biofuels strategy.

- The New Growth Path identifies large opportunities in the green economy. South Africa has committed to reducing the carbon-intensity of the economy but at the same time to seize the jobs and growth opportunities in amongst others bio-fuel energy generation. For agriculture biofuels are particularly important.
- According to the Industrial Policy Action Plan biofuels has substantial opportunity to generate employment and value added across primary (farming) manufacturing (refining) and tertiary (distribution) sectors and to contribute to rural development.

The grain industry supports the agricultural dimensions of the Industrial Policy Action Plan which identify the following key opportunities.

- South Africa need to fast track regulatory processes to further the “quick win” opportunities around employment and rural development.
- Secondly we need to scale up the inclusion of biofuels in the national fuel pool to 10% of fuel supply.
- According to the IPAP biofuels from agriculture has the potential to create 125 000 jobs over the next ten years, mostly in rural areas.

- Our dependence on oil imports will also decrease because of the contribution by agriculture. The following action is however needed and includes the mandatory uplift of 2% of bio-ethanol into the national fuel supply, at a minimum support price level, rising to 10% over the next ten years.

Since 2005 South Africans lacked the opportunity to share in the benefits which could have been brought forward by the development of a lucrative biofuels industry supported by a sufficient strategy. Food security concerns curbed these developments unnecessary.

APPENDIX B: ARC report and presentation

REPORT

to

DEPARTMENT OF AGRICULTURE

OVERVIEW OF LAND SUITABILITY FOR BIOFUEL CROPS

Report Number GW/A/2006/17

by

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March 2006

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EXECUTIVE SUMMARY

Introduction

The ARC-Institute for Soil, Climate and Water was approached by officials of the DoA Directorate Land Use and Soil Management to assist with the preparation of a set of maps and tables providing information on land suitability for potential biofuel crops in South Africa. This initial study was not required to weigh alternatives and identify best land-use options applicable to various parts of the country.

Results

Overview maps were produced, depicting land suitability for six biofuel crops (two potential oil seed crops: sunflower and soya bean, and four potential ethanol crops: maize, grain sorghum, sugarcane and sugar beet). The maps were produced by matching best available crop requirements (in terms of climate and soil) to land attribute data from the National Asset natural resource information systems. This approach is in accordance with land evaluation methodologies propagated by FAO. The crop requirement and land attribute criteria used, as well as class value thresholds are shown in an annexure.

Two of the crops, sugarcane and sugar beet was also evaluated in terms of whether or not their temperature requirements are met in currently irrigated areas. Hectares of currently irrigated land that meet these requirements are given.

Tables are given for each crop, showing the yield norms used, the areas and the potential total yield per suitability class if all suitable land were to be used for a particular crop.

The following should be considered when using the maps and tables:

- Although transformed areas (urban etc.) have been subtracted and are not reflected in the areas reported, the remaining areas reported as being suitable for crop production still contain a certain percentage of non-usable land such as land covered by roads, farm buildings, land peripheries etc.
- Some areas may be potentially suitable for a particular crop in the long-term, but a lack of adapted cultivars or technologies currently precludes it. Examples are misty, high rainfall areas that might be suitable to produce sunflower if incentives are sufficiently strong for adapted cultivars to be developed. Such areas were either rated as unsuitable or rated down one or more classes.
- Best land-use options, taking economic, biophysical, political and cultural criteria as well as competition for land into account, are beyond the scope of this initial study. The maps are based solely on biophysical parameters.
- Potential bird damage to sunflower and sorghum crops have not been taken into account. According to certain sources, this factor has the potential to have severe effects.
- Crops are to be grown in rotation. Thus, ideally, land suitability has to be assessed in terms of major potential *crop rotations*. For simplicity's sake, this approach was not followed in the present analysis. Current results would constitute a useful basis for a subsequent crop rotation approach, however.

Key findings

The picture that emerged in terms of suitable areas is summarized in the table below. The figures were rounded to the closest 1 million in order to retain only the essential. The table shows the following:

- The total arable land (including marginal land) for a drought tolerant crop (in this instance grain sorghum) amounts to approximately 25 million ha. Moderately to highly suitable land in this context amounts to 17 million ha.
- For a crop with average requirements such as maize, the corresponding figures are 21 and 12 million ha respectively.
- The total area suited to a particular crop becomes increasingly more limited the higher a crop's requirements are. Extremely limited areas, for example, are suitable for rainfed sugarcane due to its high requirements with respect to the temperature regime and water availability. The table shows energy crops in decreasing order of requirements. It is clear that the suitable area decreases down the list from grain sorghum to sugarcane.

The total suitable hectares, as shown, constitute a basis for further analysis. They stand in need of being broken down per district (or natural resource zone) into scenarios of land allocation to different crops, each according to its competitive edge in the area.

Areas of land suitable for the main potential rainfed biofuel field crops in relation to non-arable and non-agricultural land (million ha)

Crop	Agricultural system	High (a)	Suitable (b)	Moderate (c)	**Subtotal (a-c)**	Marginal (d)	**Total (a-d)**
Grain sorghum	Commercial	5	2	5	**12**	5	**18**
	Communal	2	1	2	**5**	3	**7**
	Total	7	3	7	**17**	8	**25**
Sunflower	Commercial	4	2	4	**11**	6	**17**
	Communal	1	0	2	**4**	2	**6**
	Total	6	3	6	**15**	8	**23**
Maize	Commercial	1	3	5	**9**	9	**18**
	Communal	0	0	2	**3**	0	**3**
	Total	2	3	7	**12**	9	**21**
Soybeans	Commercial	0	2	2	**4**	6	**10**
	Communal	0	1	1	**2**	3	**4**
	Total	1	2	3	**6**	9	**15**
Sugarcane	Commercial		0		**0**	0	**0**
	Communal		0		**0**	0	**0**
	Total		0		**0**	1	**1**
Maximum arable							25
Non-arable							85
National parks and transformed							8
Other (e.g. provincial and private parks)							4
Total RSA							122

The picture with respect to potential yields is summarized in the table below. Even more than the previous table, it shows the necessity of working with scenarios. The figures (though probably fairly correct) do not provide material to work with unless the arable land is fractionated or zoned between various crops and land-uses. The present study can serve as basis for subsequent studies.

The relatively small contribution of marginal land to yield figures is clearly shown. With respect to maize, for example, marginal land constitutes 43% of the total suitable land, but contributes only 26% of the potential yield.

Yield figures for each of the main potential rainfed biofuel field crops that would apply if all suitable land were used for a single crop only (million t a^{-1})							
Crop	Agricultural system	High (a)	Suitable (b)	Moderate (c)	**Subtotal (a-c)**	Marginal (d)	**Total (a-d)**
Grain sorghum	Commercial	33	10	15	**58**	8	**66**
	Communal	4	1	3	**8**	2	**9**
	Total	37	11	18	**66**	10	**75**
Sunflower	Commercial	9	3	5	**17**	5	**21**
	Communal	1	0	1	**2**	1	**3**
	Total	10	3	6	**19**	5	**24**
Maize	Commercial	8	12	15	**35**	13	**49**
	Communal	1	1	3	**5**	1	**5**
	Total	9	13	18	**40**	14	**54**
Soybeans	Commercial	1	2	2	**5**	4	**10**
	Communal	0	0	0	**1**	1	**2**
	Total	1	3	2	**6**	5	**11**
Sugarcane	Commercial		0		**0**	12	**12**
	Communal		0		**0**	9	**9**
	Total		0		**0**	21	**21**

Concerning irrigated agriculture, the areas of land currently irrigated, and that are suitable for the main potential biofuel crops that are being considered for production under irrigation, are shown in the table below (million ha):

Crop	Agricultural system	Suitable	Marginal	**Total**
Sugarcane	Commercial	0.1	0.7	0.7
	Communal	0.0	0.1	0.1
	Total	0.1	0.7	0.8
Sugar beet	Commercial	0.5	0.3	0.8
	Communal	0.0	0.0	0.0
	Total	0.5	0.3	0.8
Total area currently under irrigation				1.9

Potential yields, if all currently irrigated areas that are climatically suitable were to be used for sugarcane and sugar beet, respectively, are shown in the table below (million t a^{-1}):

Crop	Agricultural system	Moderate	Marginal	**Total**
Sugarcane	Commercial	5.3	26.1	31.5
	Communal	0.3	1.1	1.5
	Total	5.6	27.3	32.9
Sugar beet	Commercial	25.5	9.8	35.3
	Communal	0.2	0.0	0.3
	Total	25.7	9.9	35.6

INTRODUCTION

The ARC-Institute for Soil, Climate and Water was approached by officials of the DoA Directorate Land Use and Soil Management to assist with the preparation of a set of maps and tables providing information on land suitability for potential biofuel crops in South Africa.

TERMS OF REFERENCE

Overview maps were to be produced, depicting land suitability with respect to six biofuel crops (two potential oil seed crops: sunflower and soya bean, and four potential ethanol crops: maize, grain sorghum, sugarcane and sugar beet). Results were to be shown in terms of commercial and communal agriculture, as well as irrigation and rainfed agriculture. The maps were to be accompanied by tables showing the total hectares per suitability class per crop per province.

Due to time constraints, the study was to stop short of dealing with the issue of competition for land, the competitive edge various crops might have in particular districts, recommendations on best land-use options, and which crops ought to be promoted in various districts. To go some way in that direction, one or more maps were to be produced that would identify "hot spots" of suitability by identifying land rated suitable or highly suitable to all six crops, five out of six, four out of six and three out of six. The concession was made that should this task prove to be unattainable within the time frame, it could follow after the delivery date of 27 March.

METHODOLOGY

The maps were produced by matching best available crop requirements (in terms of climate and soil) to land attribute data from the National Asset natural resource information systems. This approach is in accordance with land evaluation methodologies propagated by FAO (FAO, 1976, 1984).

The following natural resource data were used in the analysis:

- 1:250 000 scale land type information on soil type (soil forms grouped into simplified classes), average soil depth, average soil clay content and derived internal drainage class.
- Mean annual rainfall data for the summer season (defined as October to March) obtained from measured and interpolated rainfall surfaces on a 1 km x 1 km grid (ARC AgroMet).
- Various temperature parameters obtained from measured and modeled temperature surfaces on a 1 km x 1 km grid (ARC AgroMet).

Slope class was not selected as a criterion due to the fact that relatively deep, rock-free soils are an uncommon occurrence on steep slopes in the low rainfall areas. Where they do occur on steeper slopes in the high rainfall areas, the situation is commonly that such land, if not used for plantation forestry, can be arable if appropriate conservation measures are applied (e.g. strip cropping).

Environmental and yield norms were derived from publications and the Internet, as well as personal communications with specialists in the fields of agronomy and plant breeding.

Crop requirements and yield norms are set out in Annexure A.

Excluded from the analysis were national parks (data obtained from DEAT) and urban areas, mined areas, forest plantations and water bodies (from National Land Cover data, CSIR).

The boundaries of communal agriculture were assumed to coincide broadly with the previous homelands and self governing territories. These were previously digitized from maps by the Surveyor General.

While crop requirements are similar for commercial and communal agriculture, the average communal crop *yield ranges* were differentiated in accordance with the views and experience of researchers working in the LandCare Programme. The average management level of future small scale producers were assumed to be representative of a situation "a number of years into a relatively successful government and private sector agricultural support programme".

Irrigated areas were identified by selecting all irrigated categories from the National land Cover data and by adding certain areas planted to sugarcane. This was necessitated by the fact that, in the land Cover dataset, sugarcane (due to problems of distinguishing) is not differentiated between irrigated and rainfed. To overcome this problem, sugarcane occurring in the following high rainfall districts, where rainfed production was judged or known to dominate, were deselected and not added to irrigated areas: Durban, Hlabisa, Kranskop, Lower Tugela, Mapumulu, Pietermaritzburg, Port Shepstone, Umvoti and Umzinto.

The following should be considered when using the maps and tables:

- Although transformed areas (urban etc.) have been subtracted and are not reflected in the areas reported, the remaining areas reported as being suitable for crop production still contain a certain percentage of non-usable land such as land covered by roads, farm buildings, land peripheries etc. The percentage still to be subtracted in order to obtain a net usable area probably ranges between five and 15.
- Some areas may be potentially suitable for a particular crop in the long-term, but a lack of adapted cultivars or technologies currently precludes it. Examples are misty, high rainfall areas that might be suitable to produce sunflower if incentives are sufficiently strong for adapted cultivars to be developed. Such areas were either rated as unsuitable or rated down one or more classes.
- Best land-use options, taking economic, biophysical, political and cultural criteria as well as competition for land into account, are beyond the scope of the study. The maps are based solely on biophysical parameters.
- Potential bird damage to sunflower and sorghum crops have not been taken into account. According to certain sources, this factor has the potential to have severe effects.
- Crops are to be grown in rotation. Thus, ideally, land suitability has to be assessed in terms of major potential *crop rotations*. For simplicity's sake, this approach was not followed in the present analysis. It ought to be an element in any follow-up work, however.

Expressing numbers (hectares and tonnes of crop) per province did not prove to be feasible within the time frame due to the immense size of the datasets and the computer time required. Thus, numeric results are presented for the time being for the country as a whole. Subsequent work will entail subdividing the datasets per province.

RESULTS

POTENTIAL OIL SEED CROPS

Rainfed sunflower

Suitable areas for sunflower production are shown in Figure 1.

Table 1 shows the approximate yield range, per suitability class, that can be attained under commercial and communal agriculture, respectively. Table 2 shows the area occupied by each suitability class (million ha) and the potential yield if all suitable land were to be planted to sunflower (million t).

Table 1. Sunflower: Yield norms (t ha^{-1})

Suitability class		High	Suitable	Moderate	Marginal
Commercial agriculture	Range	1.5-2.5	1.2-1.5	1.0-1.2	0.5-1.0
	Average	2.0	1.4	1.1	0.8
Communal agriculture	Range	0.6-1.0	0.5-0.6	0.4-0.5	0.2-0.4
	Average	0.80	0.55	0.45	0.30

Table 2. Sunflower: Area and potential total yield per suitability class if all suitable land were to be used for sunflower only

	High		Suitable		Moderate		Marginal		Total	
	Area (million ha)	Potential yield (million t)	Area (million ha)	Potential yield (million t)	Area (million ha)	Potential yield (million t)	Area (million ha)	Potential yield (million t)	Area (million ha)	Potential yield (million t)
Commercial Agriculture	4.433	8.865	2.147	3.006	4.344	4.778	5.777	4.621	16.700	21.271
Communal Agriculture	1.069	0.855	0.462	o.254	2.050	0.922	2.345	0.704	5.925	2.735
Total	5.502	9.720	2.609	3.260	6.394	5.700	8.122	5.325	22.625	24.006

It is important to note that the above depicts the maximum *potential* for sunflower production, were all suitable land to be used for that purpose. The issue of competition for land between various crops and animal production land-uses is not addressed due to lack of information and time constraints.

Rainfed soya beans

Suitable areas for soya bean production are shown in Figure 2.

Table 3 shows the approximate yield range, per suitability class, that can be attained with soya beans under commercial and communal agriculture, respectively. Table 4 shows the area occupied by each suitability class (million ha) and the potential yield if all suitable land were to be planted to soya beans (million t).

Table 3. Soya beans: Yield norms (t ha^{-1})

Suitability class		High	Suitable	Moderate	Marginal
Commercial agriculture	Range	2.0-3.0	1.0-2.0	0.8-1.0	0.5-0.8
	Average	2.5	1.5	0.9	0.7
Communal agriculture	Range	0.8-1.2	0.4-0.8	0.3-0.4	0.2-0.3
	Average	1.00	0.60	0.35	0.25

Table 4. Soya beans: Area and potential total yield per suitability class if all suitable land were to be used for soya beans only

	High		Suitable		Moderate		Marginal		Total	
	Area (million ha)	Potential yield (million t)	Area (million ha)	Potential yield (million t)	Area (million ha)	Potential yield (million t)	Area (million ha)	Potential yield (million t)	Area (million ha)	Potential yield (million t)
Commercial Agriculture	0.407	1.018	1.603	2.404	2.203	1.982	6.042	4.230	10.255	9.634
Communal Agriculture	0.280	0.280	0.691	0.415	0.544	0.190	2.910	0.727	4.425	1.613
Total	0.687	1.298	2.294	2.819	2.747	2.172	8.952	4.957	14.680	11.247

As with sunflower, it is important to note that the above depicts the maximum *potential* for soya bean production, were all suitable land to be used for that purpose.

POTENTIAL ETHANOL CROPS

Rainfed maize

Suitable areas for maize production are shown in Figure 3.

Table 5 shows the approximate yield range, per suitability class, that can be attained with maize under commercial and communal agriculture, respectively. Table 6 shows the area occupied by each suitability class (million ha) and the potential yield if all suitable land were to be planted to maize (million t).

Table 5. Maize: Yield norms (t ha^{-1})

Suitability class		High	Suitable	Moderate	Marginal
Commercial agriculture	Range	5.0-10.0	4.0-5.0	2.0-4.0	1.0-2.0
	Average	7.50	4.50	3.0	1.5
Communal agriculture	Range	2.0-4.0	1.6-2.0	0.8-2.0	0.4-0.8
	Average	3.00	1.80	1.40	0.60

Table 6. Maize: Area and potential total yield per suitability class if all suitable land were to be used for maize only

	High		Suitable		Moderate		Marginal		Total	
	Area (million ha)	Potential yield (million t)	Area (million ha)	Potential yield (million t)	Area (million ha)	Potential yield (million t)	Area (million ha)	Potential yield (million t)	Area (million ha)	Potential yield (million t)
Commercial Agriculture	1.056	7.920	2.762	12.428	5.022	15.066	8.851	13.277	17.691	48.691
Communal Agriculture	0.494	1.482	0.358	0.644	1.927	2.698	0.358	0.644	3.137	5.468
Total	1.550	9.402	3.120	13.073	6.949	17.764	9.209	13.921	20.828	54.159

As with the previous crops, it is important to note that the above depicts the maximum *potential* for maize production, were all suitable land to be used for that purpose.

Rainfed grain sorghum

Suitable areas for grain sorghum production are shown in Figure 4.

Table 7 shows the approximate yield range, per suitability class, that can be attained with grain sorghum under commercial and communal agriculture, respectively. Table 8 shows the area occupied by each suitability class (million ha) and the potential yield if all suitable land were to be planted to grain sorghum (million t).

Table 7. Grain sorghum: Yield norms (t ha^{-1})

Suitability class		High	Suitable	Moderate	Marginal
Commercial agriculture	Range	4.5-8.0	3.5-4.5	2.0-4.5	1.0-2.0
	Average	6.25	4.0	3.25	1.5
Communal agriculture	Range	1.8-3.2	1.4-1.8	0.8-1.4	0.4-0.8
	Average	2.5	1.6	1.1	0.6

Table 8. Grain sorghum: Area and potential total yield per suitability class if all suitable land were to be used for grain sorghum only

	High		Suitable		Moderate		Marginal		Total	
	Area (million ha)	Potential yield (million t)	Area (million ha)	Potential yield (million t)	Area (million ha)	Potential yield (million t)	Area (million ha)	Potential yield (million t)	Area (million ha)	Potential yield (million t)
Commercial Agriculture	5.257	32.857	2.413	9.651	4.748	15.430	5.495	8.243	17.913	66.181
Communal Agriculture	1.628	4.071	0.548	0.876	2.497	2.747	2.617	1.570	7.290	9.264
Total	6.885	36.928	2.961	10.527	7.245	18.177	8.112	9.813	25.203	75.445

As with the previous crops, it is important to note that the above depicts the maximum *potential* for grain sorghum production, were all suitable land to be used for that purpose.

Rainfed sugarcane

Suitable areas for production of sugarcane under rainfed conditions are shown in Figure 5.

Table 9 shows the approximate yield range, per suitability class, that can be attained with rainfed sugarcane under commercial and communal agriculture, respectively. Table 10 shows the area occupied by each suitability class (million ha) and the potential yield if all suitable land were to be planted to sugarcane (million t).

Table 9. Rainfed sugarcane: Yield norms (t ha^{-1})

Suitability class		Suitable	Marginally suitable
Commercial agriculture	Range	50-120	30-50
	Average	85	40
Communal agriculture	Range	25-60	15-25
	Average	43	20

Table 10. Rainfed sugarcane: Area and potential total yield per suitability class if all suitable land were to be used for grain sugarcane only

	Suitable		Marginal		Total	
	Area (million ha)	Potential yield (million t)	Area (million ha)	Potential yield (million t)	Area (million ha)	Potential yield (million t)
Commercial Agriculture	0	0	0.304	12.169	0.304	12.169
Communal Agriculture	0	0	0.434	8.671	0.434	8.671
Total	0	0	0.738	20.840	0.738	20.840

As with the previous crops, it is important to note that the above depicts the maximum *potential* for sugar cane production, were all suitable land to be used for that purpose.

Irrigated sugarcane

Currently irrigated areas that are suitable for the production of sugarcane are shown in Figure 6.

Table 11 shows the approximate yield range, per suitability class, that can be attained with irrigated sugarcane under commercial and communal agriculture, respectively. Table 12 shows the area occupied by each suitability class (million ha) and the potential yield if all currently irrigated and suitable land were to be planted to sugarcane (million t).

Table 11. Irrigated sugarcane: Yield norms (t ha^{-1})

Suitability class		Suitable	Marginally suitable
Commercial agriculture	Range	100-160	60-100
	Average	130	80
Communal agriculture	Range	50-80	30-50
	Average	65	40

Table 12. Irrigated sugarcane: Area and potential yield if all currently irrigated and suitable land were to be planted to sugarcane

	Suitable		Marginal		Total	
	Area (million ha)	Potential yield (million t)	Area (million ha)	Potential yield (million t)	Area (million ha)	Potential yield (million t)
Commercial Agriculture	0.063	5.318	0.653	26.138	0.716	31.456
Communal Agriculture	0.008	0.323	0.057	1.141	0.065	1.464
Total	0.071	5.641	0.710	27.279	0.781	32.921

As with the previous crops, it is important to note that the above depicts the maximum *potential* for sugar cane production, were all currently irrigated and suitable land to be used for that purpose.

Irrigated sugar beet

Currently irrigated areas that are suitable for the production of sugar beet are shown in Figure 7.

Table 13 shows the approximate yield range, per suitability class, that can be attained with irrigated sugar beet under commercial and communal agriculture, respectively. Table 14 shows the area occupied by each suitability class (million ha) and the potential yield if all currently irrigated and suitable land were to be planted to sugar beet (million t).

Table 13. Irrigated sugar beet: Yield norms (t ha^{-1})

Suitability class		Suitable	Marginally suitable
Commercial agriculture	Range	40-60	20-40
	Average	50	30
Communal agriculture	Range	20-30	10-20
	Average	25	15

Table 14. Irrigated sugar beet: Area and potential yield if all currently irrigated and suitable land were to be planted to sugar beet

	Suitable		Marginal		Total	
	Area (million ha)	Potential yield (million t)	Area (million ha)	Potential yield (million t)	Area (million ha)	Potential yield (million t)
Commercial Agriculture	0.509	25.464	0.328	9.843	0.837	35.306
Communal Agriculture	0.009	0.234	0.002	0.031	0.012	0.265
Total	0.519	25.698	0.330	9.874	0.849	35.571

As with the previous crops, it is important to note that the above depicts the maximum *potential* for sugar cane production, were all currently irrigated and suitable land to be used for that purpose.

DISCUSSION

RAINFED AGRICULTURE

Areas

The picture that emerged in terms of hectares is summarized in Table 15. The figures were rounded to the closest 1 million to in order to retain only the essential. The table shows the following:

- The total arable land (including marginal land) for a drought tolerant crop (in this instance grain sorghum) amounts to approximately 25 million ha. Moderately to highly suitable land in this context amounts to 17 million ha.
- For a crop with average requirements such as maize, the corresponding figures are 21 and 12 million ha respectively.
- The area suited to a particular crop becomes increasingly more limited the higher the crop's requirements are. Extremely limited areas, for example, are suitable for rainfed sugarcane due to its high requirements with respect to the temperature regime and water availability. The table shows energy crops in decreasing order of requirements. It is clear that the suitable area decreases down the list from grain sorghum to sugarcane.

The total suitable hectares, as shown, constitute a basis for further analysis. They stand in need of being broken down per district (or natural resource zone) into scenarios of land allocation to different crops, each according to its competitive edge in the area.

Table15. Areas of land suitable for the main potential rainfed biofuel field crops in relation to non-arable and non-agricultural land (million ha)

Crop	Agricultural system	High (a)	Suitable (b)	Moderate (c)	**Subtotal (a-c)**	Marginal (d)	**Total (a-d)**
Grain sorghum	Commercial	5	2	5	**12**	5	**18**
	Communal	2	1	2	**5**	3	**7**
	Total	7	3	7	**17**	8	**25**
Sunflower	Commercial	4	2	4	**11**	6	**17**
	Communal	1	0	2	**4**	2	**6**
	Total	6	3	6	**15**	8	**23**
Maize	Commercial	1	3	5	**9**	9	**18**
	Communal	0	0	2	**3**	0	**3**
	Total	2	3	7	**12**	9	**21**
Soybeans	Commercial	0	2	2	**4**	6	**10**
	Communal	0	1	1	**2**	3	**4**
	Total	1	2	3	**6**	9	**15**
Sugarcane	Commercial	0			**0**	0	**0**
	Communal	0			**0**	0	**0**
	Total	0			**0**	1	**1**
Max. arable							25
Non-arable							85
National parks and transformed							8
Other (e.g. provincial and private parks)							4
Total RSA							122

Yields

The picture with respect to potential yields is summarized in Table 16. Even more than the previous table, Table 16 shows the necessity of working with scenarios. The figures (though probably fairly correct) do not provide material to work with unless the arable land is fractionated or zoned between various crops and land-uses. The present study can serve as basis for subsequent studies.
The relative small contribution of marginal land to yield figures is clearly shown. With respect to maize, for example, marginal land constitutes 43% of the total suitable land, but contributes only 26% of the potential yield.

Table 16. Yield figures for each of the main potential rainfed biofuel field crops that would apply if all suitable land were used for a single crop only (million t a^{-1})

Crop	Agricultural system	High (a)	Suitable (b)	Moderate (c)	**Subtotal (a-c)**	Marginal (d)	**Total (a-d)**
Grain sorghum	Commercial	33	10	15	**58**	8	**66**
	Communal	4	1	3	**8**	2	**9**
	Total	37	11	18	**66**	10	**75**
Sunflower	Commercial	9	3	5	**17**	5	**21**
	Communal	1	0	1	**2**	1	**3**
	Total	10	3	6	**19**	5	**24**
Maize	Commercial	8	12	15	**35**	13	**49**
	Communal	1	1	3	**5**	1	**5**
	Total	9	13	18	**40**	14	**54**
Soybeans	Commercial	1	2	2	**5**	4	**10**
	Communal	0	0	0	**1**	1	**2**
	Total	1	3	2	**6**	5	**11**
Sugarcane	Commercial	0			**0**	12	**12**
	Communal	0			**0**	9	**9**
	Total	0			**0**	21	**21**

IRRIGATED AGRICULTURE

Areas

Assessing the extent of land under irrigation at any point of time is known for its difficulties (e.g. difficulties in defining and identifying in the field whether land is permanently, temporarily, fully or partly irrigated). Some Karoo fields are irrigated once in five or ten years when flood events occur. In places the Land Cover data was found to over estimate. Nevertheless, the 1.87 million ha under irrigation, as depicted in Figure 8, is of the correct order of magnitude.

While the assumption can be made that cane fields will generally remain cane fields and that only the marketing of the product might undergo change, sugar beet is a new crop that will have to compete for water with established fodder crops such as lucerne and to an extent with high value export fruit crops.

Table 17. Areas of land currently irrigated and suitable for the main potential biofuel crops under irrigation (million ha)

Crop	Agricultural system	Suitable	Marginal	**Total**
Sugarcane	Commercial	0.1	0.7	0.7
	Communal	0.0	0.1	0.1
	Total	0.1	0.7	0.8
Sugar beet	Commercial	0.5	0.3	0.8
	Communal	0.0	0.0	0.0
	Total	0.5	0.3	0.8
Total area currently under irrigation				1.9

Yields

Potential total yields, if all currently irrigated areas that are climatically suitable are used for sugarcane and sugar beet respectively, are shown in Table 18.

Table 18. Yield figures for the main potentially irrigated biofuel crops, should all currently irrigated and climatically suitable land be used for these crops (million t a^{-1})

Crop	Agricultural system	Moderate	Marginal	**Total**
Sugarcane	Commercial	5.3	26.1	31.5
	Communal	0.3	1.1	1.5
	Total	5.6	27.3	32.9
Sugar beet	Commercial	25.5	9.8	35.3
	Communal	0.2	0.0	0.3
	Total	25.7	9.9	35.6

REFERENCES

FAO, 1976. A framework for land evaluation. Soils Bulletin 32, Food and Agriculture Organization of the United Nations, Rome.

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ANNEXURE A: CROP REQUIREMENTS AND YIELD NORMS

Rainfed sugarcane

Class	Suited	Marginally suited	Unsuited
Approx. yield range: Commercial (t cane ha^{-1} a^{-1})	50-120	30-50	<30
Approx. yield range: Communal (t cane ha^{-1} a^{-1})	25-60	15-25	<15
Mean Annual rainfall (mm)	≥1200[1]	≥1000	Other
T_{min} July (℃)	≥8	≥5	Other
T_{ave} May-Aug (℃)	13-17	11-19	Other
Soil Category [2]	1, 2, 3, 4, 6, 12, 13	5, 7, 8, 10, 11, 14	Other
Soil depth (mm)	≥750	≥450	Other
Soil Clay (%)	15-50	All	-

Notes:

(1) Class limits are sequentially applied, starting with class 1 and ending with class 5; criteria 1 to 5 must all be met within each class.

(2) See list of soil categories below.

Irrigated sugarcane

Class	Suited	Marginally suited	Unsuited
Approx. yield range: Commercial (t cane ha^{-1} a^{-1})	100-160	60-100	<60
Approx. yield range: Communal (t cane ha^{-1} a^{-1})	50-80	30-50	<30
Irrigation	Land currently irrigated	Land currently irrigated	Other
T_{min} July (℃)	≥8	≥5	Other
T_{ave} May-Aug (℃)	13-17	11-19	Other

Irrigated sugar beet [1]

Suitability class	Suited	Marginally suited	Unsuited
Approx. yield range: Commercial (t roots ha^{-1})	40-60	20-40	<20
Approx. yield range: Communal (t roots ha^{-1})	20-30	10-20	<10
Irrigation	Land currently irrigated	Land currently irrigated	Other
Latitude (Deg S)	>30	>29	Other
T_{ave} Feb-Apr (℃)	18-28	15-31	Other

[1] Sugar beet is considered under irrigation only, as day length requirements confine it to the higher latitudes where, the western Cape excepted, rainfall is generally insufficient.

Rainfed grain sorghum

Suitability Class	1				2		3		4		5
Class description	Highly suitable; little or no limitations				Suitable; slight limitations		Moderately suitable; moderate limitations		Marginally suitable; severe limitations		Not suitable; very severe limitations
Approx. yield range: Commercial (t ha^{-1})	4.5-8.0				3.5-4.5		2.0-3.5		1.0-2.0		<1.0
Approx. yield range: Communal (kg ha^{-1})	1.8-3.2				1.4-1.8		0.8-1.4		0.4-0.8		<0.4
1. Soil Category	≤2		≤3		≤5		All		All		All
2. Rainfall (Oct.- Mar)	≥550*	≥500*	≥550*	≥500*	≥500	≥450	≥450	≥400	≥400	≥350	All
3. Soil depth (mm)	>750	>1000	>550	>750	≥550	≥750	≥450	≥750	≥350	≥750	All
4. Topsoil Clay %	≥15	>6	≥15	>6	≥15	>6	≥15	>6	10-15	>6	All
5. Internal drainage class	W2, W3				W2, W3		W2, W3, W4		W2, W3, W4		All

*If Class 1, and rainfall is ≥850 mm, then rate one class lower

Rainfed maize

Suitability Class	1		2				3				4	5
Class description	Highly suitable; little or no limitations		Suitable; slight limitations				Moderately suitable; moderate limitations				Marginally suitable; severe limitations	Not suitable; very severe limitations
Approx. yield range: Commercial (t ha^{-1})	>5.0		4.0-5.0				2.0-4.0				1.0-2.0	<1.0
Approx. yield range: Communal (kg ha^{-1})	>2.0		1.6-2.0				0.8-2.0				0.4-0.8	<0.4
1. Rainfall (Oct.-Mar)	≥600		≥550		≥500		≥450		≥400		≥350	All
2. Soil Category	≤2	≤3	≤2	≤3	≤2	≤3	≤2	≤4, 8	≤2	≤2, 8	All	All
3. Soil depth (mm)	≥900	≥750	≥800	≥650	≥900	≥750	≥650	≥500	≥750	≥600	≥450	All
4. Topsoil Clay %	15-30		10-30				10-35				All	All

Note:
Where the annual A-Pan evaporation exceeds 2200 mm, the rating is lowered by one class

Rainfed sunflower

Suitability Class	1				2		3		4		5
Class description	Highly suitable; little or no limitations				Suitable; slight limitations		Moderately suitable; moderate limitations		Marginally suitable; severe limitations		Not suitable; very severe limitations
Approx. yield range: Commercial ($t\ ha^{-1}$)	1.5-2.5				1.2-1.5		1.0-1.2		0.5-1.0		<0.5
Approx. yield range: Communal ($kg\ ha^{-1}$)	0.6-1.0				0.5-0.6		0.4-0.5		0.2-0.4		<0.2
1. Soil Category	≤2		≤3		≤5		All		All		All
2. Rainfall (Oct.- Mar)	≥550*	≥500*	≥550*	≥500*	≥500	≥450	≥450	≥400	≥400	≥350	All
3. Soil depth (mm)	≥750	≥1000	≥550	≥750	≥550	≥750	≥450	≥750	≥350	≥750	All
4. Topsoil Clay %	≥15	≥10	≥15	≥10	≥15	≥10	≥15	≥10	All		All
5. T_{max} Nov-Dec	All	≤30°	All	≤30°	All	≤30°	All	≤30°	All	≤30°	All
6. Internal drainage class	W2 W3				W2, W3		W2, W3, W4		W2, W3, W4		All

* The extent of the Acocks vegetation types 44 and 45 (Highland and Dohne Sourveld and Natal Mistbelt, respectively), were used to demarcate and de-select high rainfall, misty areas that are stated to be unsuited to sunflower production by means of current cultivars.

Rainfed soya

Suitability Class[1]	1				2				3			4		5
Class description	Highly suitable; little or no limitations				Suitable; slight limitations				Moderately suitable; moderate limitations			Marginally suitable; severe limitations		Not suitable; very severe limitations
Approx. yield range: Commercial ($t\ ha^{-1}$)	2.0-3.0				1.0-2.0				0.8-1.0			0.5-0.8		<0.5
Approx. yield range: Communal ($kg\ ha^{-1}$)	0.8-1.2				0.4-0.8				0.3-0.4			0.2-0.3		<0.2
1. Rainfall (Oct.-Mar)	≥750		≥700		≥700		≥600		≥600	≥550		≥550	≥500	<500
2. Soil Category	2	3	2	3	2	3	2	3	2	3	2, 4, 8	All	All	All
3. Soil depth (mm)	>700	>600	>900	>700	≥500	≥400	≥700	≥500	≥500	≥400	≥600	≥400	≥500	<400
4. Topsoil Clay %	15-30				10-15; 30-35				10-15; 30-35			<10; >35		All
5. Internal drainage class	W2, W3				W2, W3				W2, W3, W4			All		-

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T E Simalenga

Research and technology Manager

ARC- Institute for Agricultural Engineering






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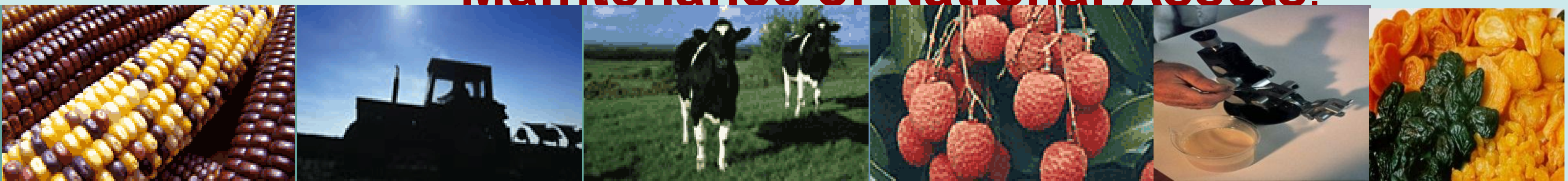
It is founded by national statute.
The Agriculture Research Act
(Act 86 0f 1990)

Mandate: Conduct Research, Technology Development and Technology Transfer.
Maintenance of National Assets.



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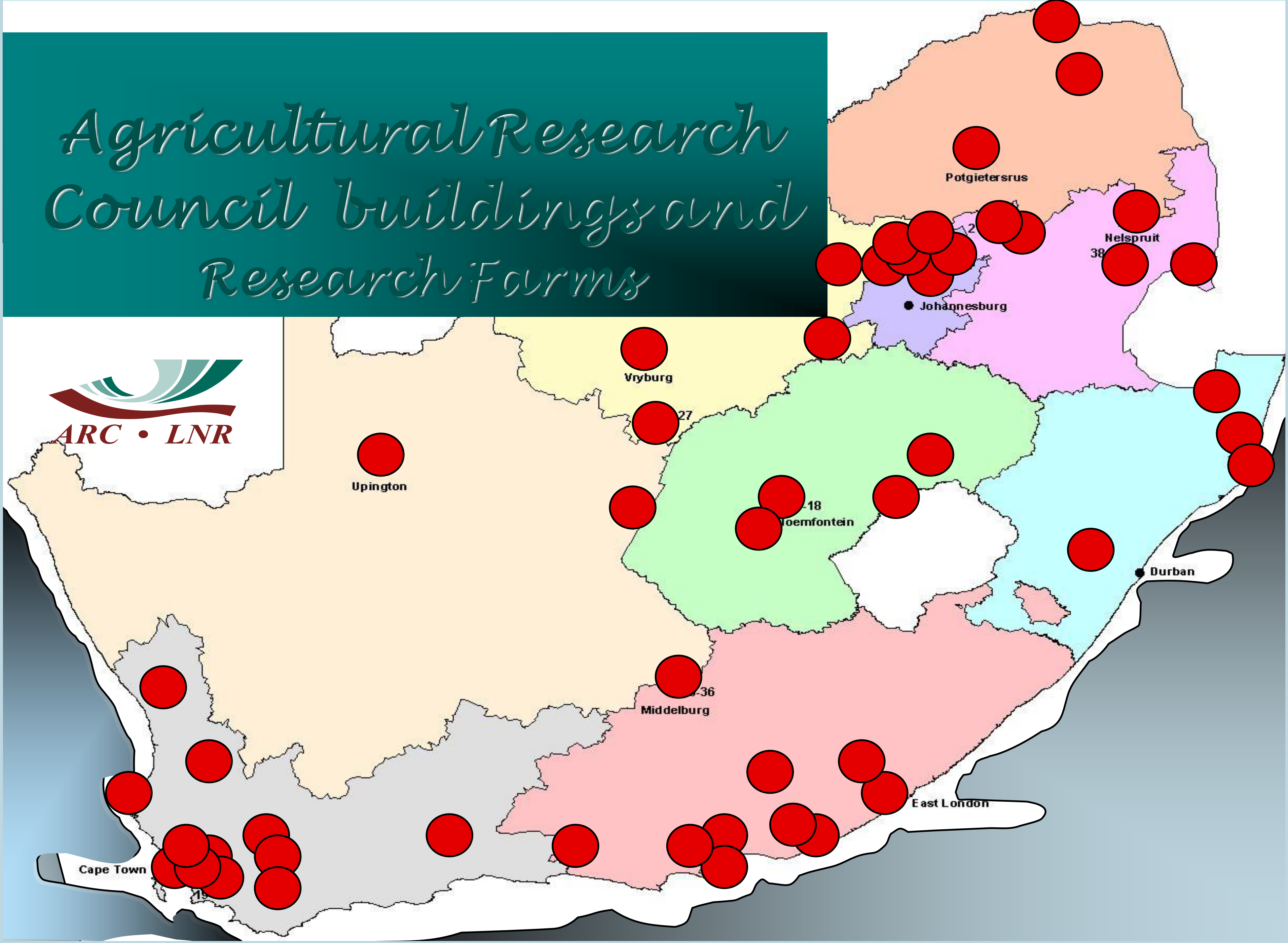

Introduction

- Bioenergy is the subject with increasing attention around the world mainly due:
  - Increasing fossil oil prices
  - Limitation of resources
  - The environmental concerns and
  - The climate change
- Bioenegy can provide new opportunities for rural communities

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Introduction

- Biofuels refers to renewable energy derived from either biomass, plant starch, sugar or plant oil

- Two categories of biofuels:
  - Biodiesel – from plant oils
  - Ethanol – mainly from biomass plant sugars and starch

Biofuels Crops

CROP	YIELD (HA^{-1})	SUGAR / OIL CONTENT (%)	PROD LEVELS (tons per yr)
Maize	**3t dryland** **6t irrigated**	75 starch	8-10 million
Sugar cane	**67t**	80 starch	2-3 million
Sorghum	**2.5t dryland** **4t irrigation**	72 starch	300 00- 500 000
Wheat	**2.5t dryland** **5t irrigated**	60 starch	2-3 million

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Biofuels Crops

CROP	YIELD (HA^{-1})	SUGAR / OIL CONTENT (%)	PROD LEVELS (tons per yr)
Soybean	1.5-2t dryland	18-22 oil	200 000-300 000
Sunflower	1.5-2t dryland	39-50 oil	500 000-700 000
Groundnuts	1-2t dryland	42-52 oil	60 000-70 000
Canola	1-1.5 dryland	42-45 oil	30 000-45 000






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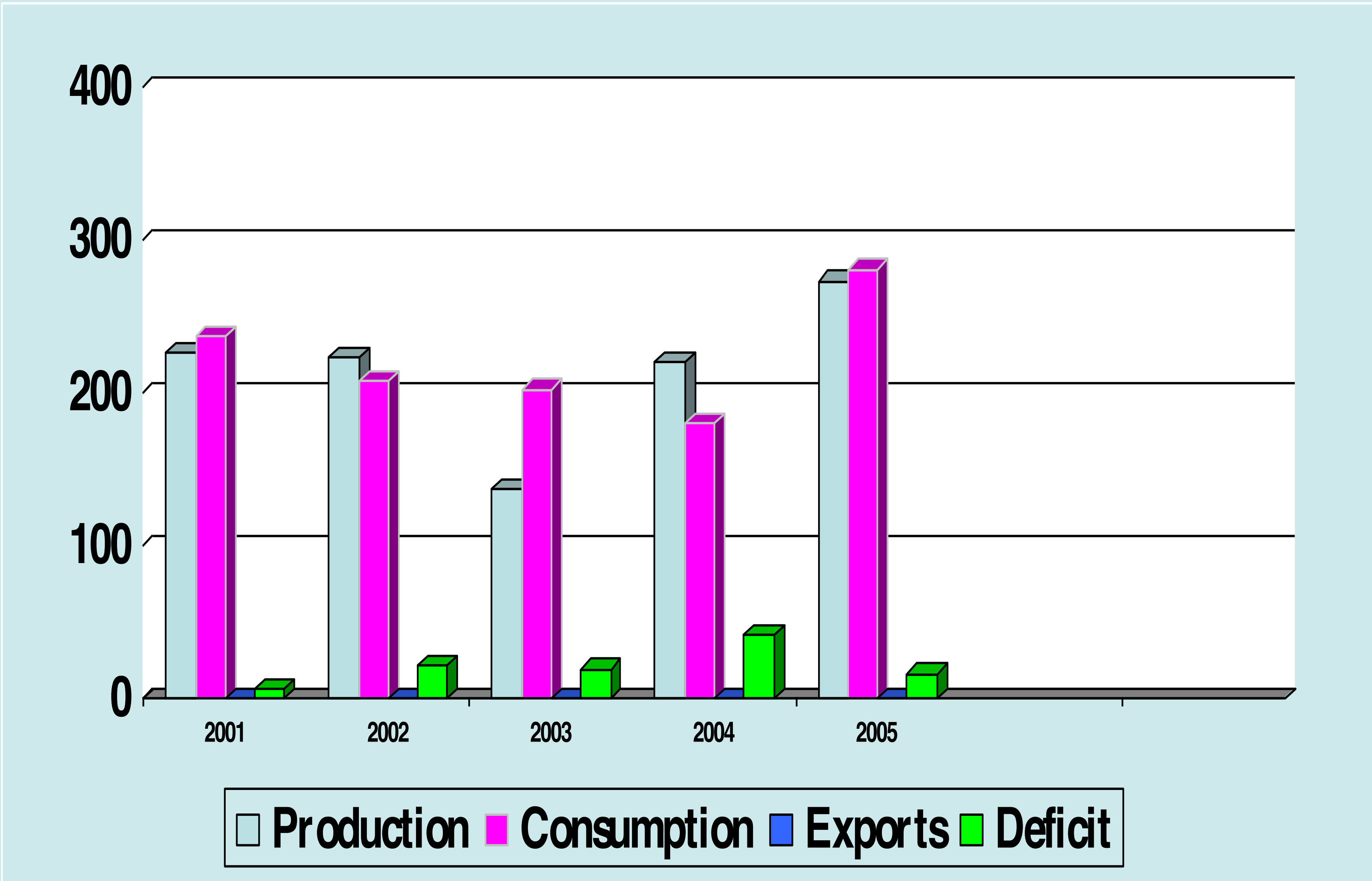
SOYABEAN

- **Annual summer crop**
- **Temperature: minimum of $25^{o}C$**
- **Annual rainfall above 600mm**
- **Average yield: 1.5 to 2 t/ha under dryland conditions**
- **Oil content: 18 – 22%**
- **Total annual production: 200 000 to 300 000 tons**

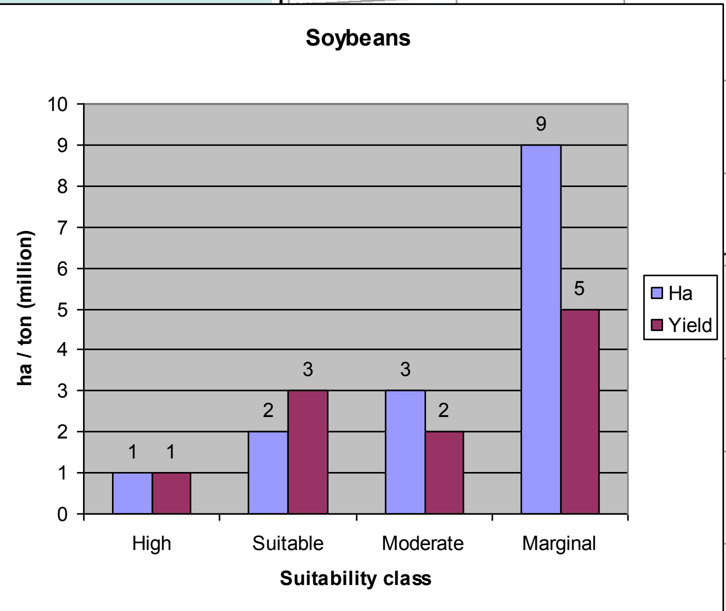
SOYABEAN PRODUCTION,

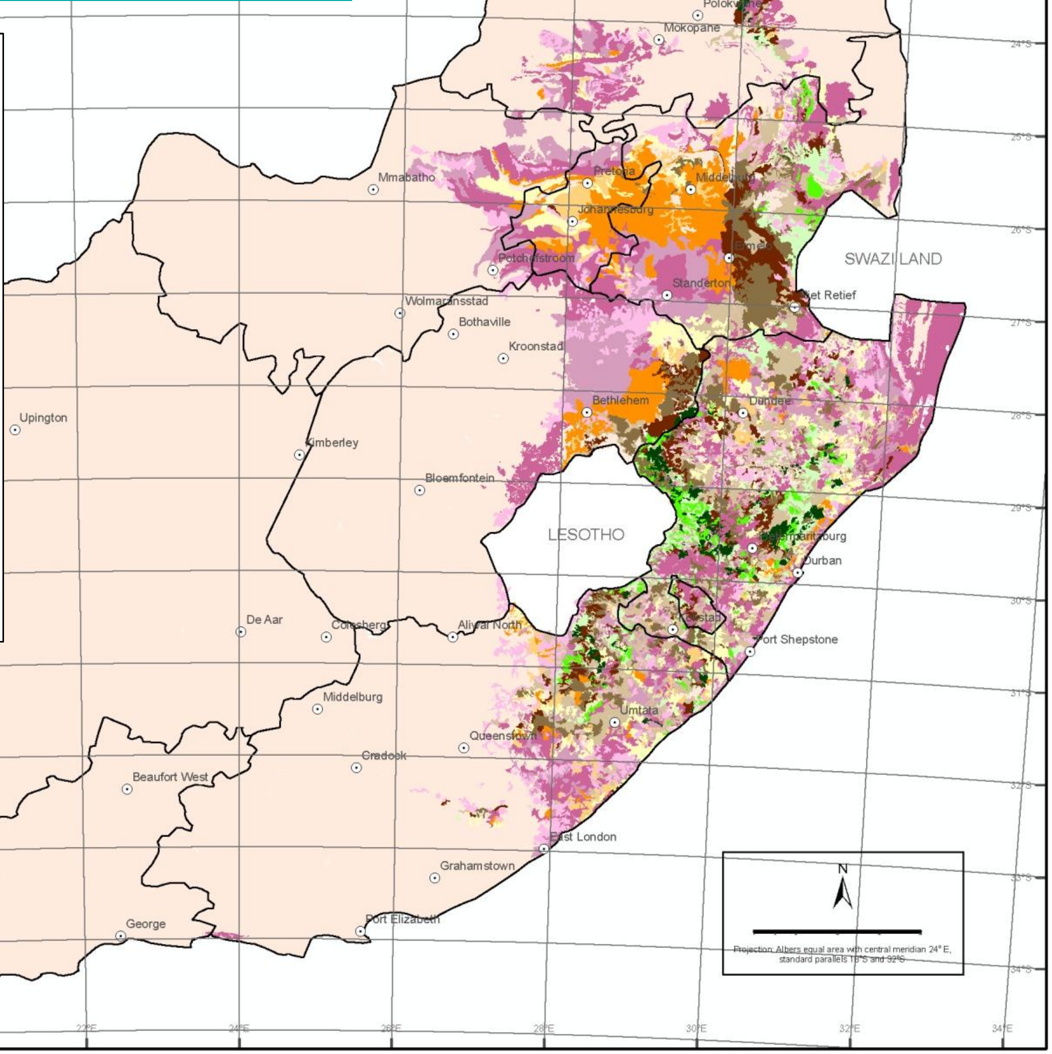
CONSUMPTION, EXPORTS AND SURPLUS IN SOUTH AFRICA

2001 TO 2005

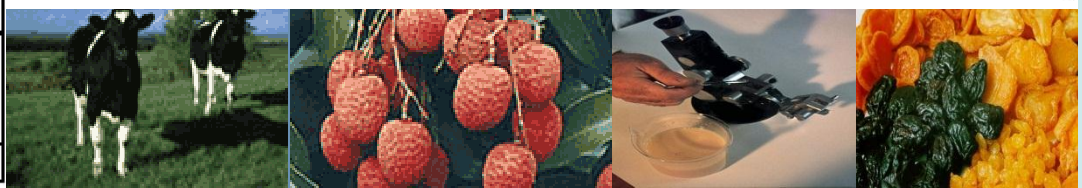


Land suitable for soya bean production





	%*	Class	Potential yield (t/ha)**
	≥ 50	High	2.0 - 3.0
	30 - 50		
	10 - 30		
	≥ 50	Suitable	1.0 - 2.0
	30 - 50		
	10 - 30		
	≥ 50	Moderate	0.8 - 1.0
	30 - 50		
	10 - 30		
	≥ 50	Marginal	0.5 - 0.8
	30 - 50		
	10 - 30		
		Not suitable***	< 0.5



ARC • LNR

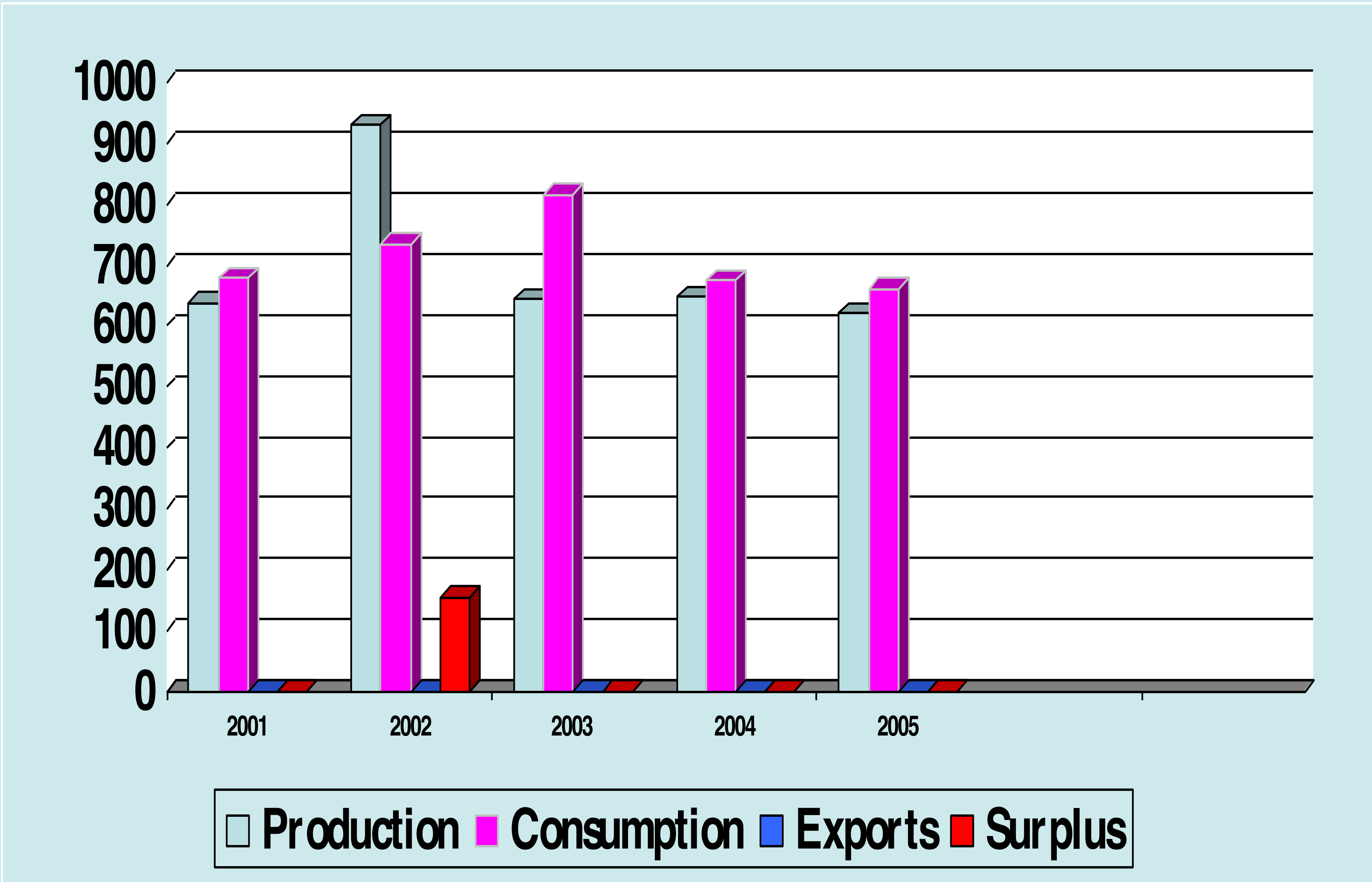
SUNFLOWER

- Annual summer crop
- Temperature: 26 to 34^{o}C
- Rainfall: 500mm
- Soils: variety of good drained soils
- Average yield: 1.2 to 1.8 t/ha under dryland
- Production: 500 000 to 700 000 tons per annum
- Oil content: 39 to 50%

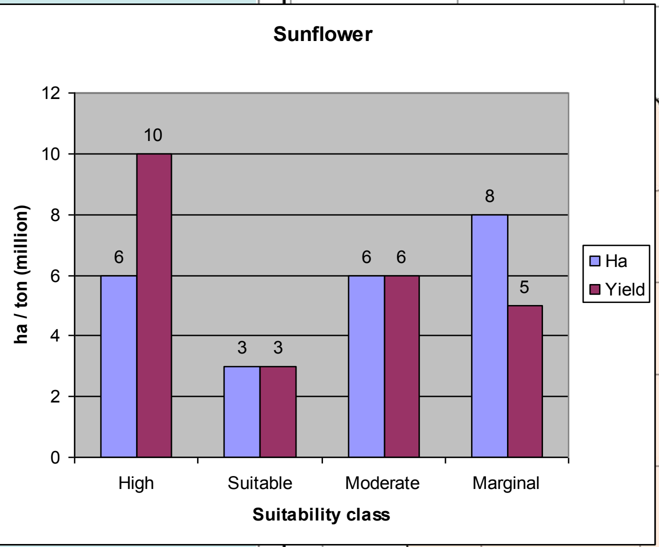
SUNFLOWER PRODUCTION

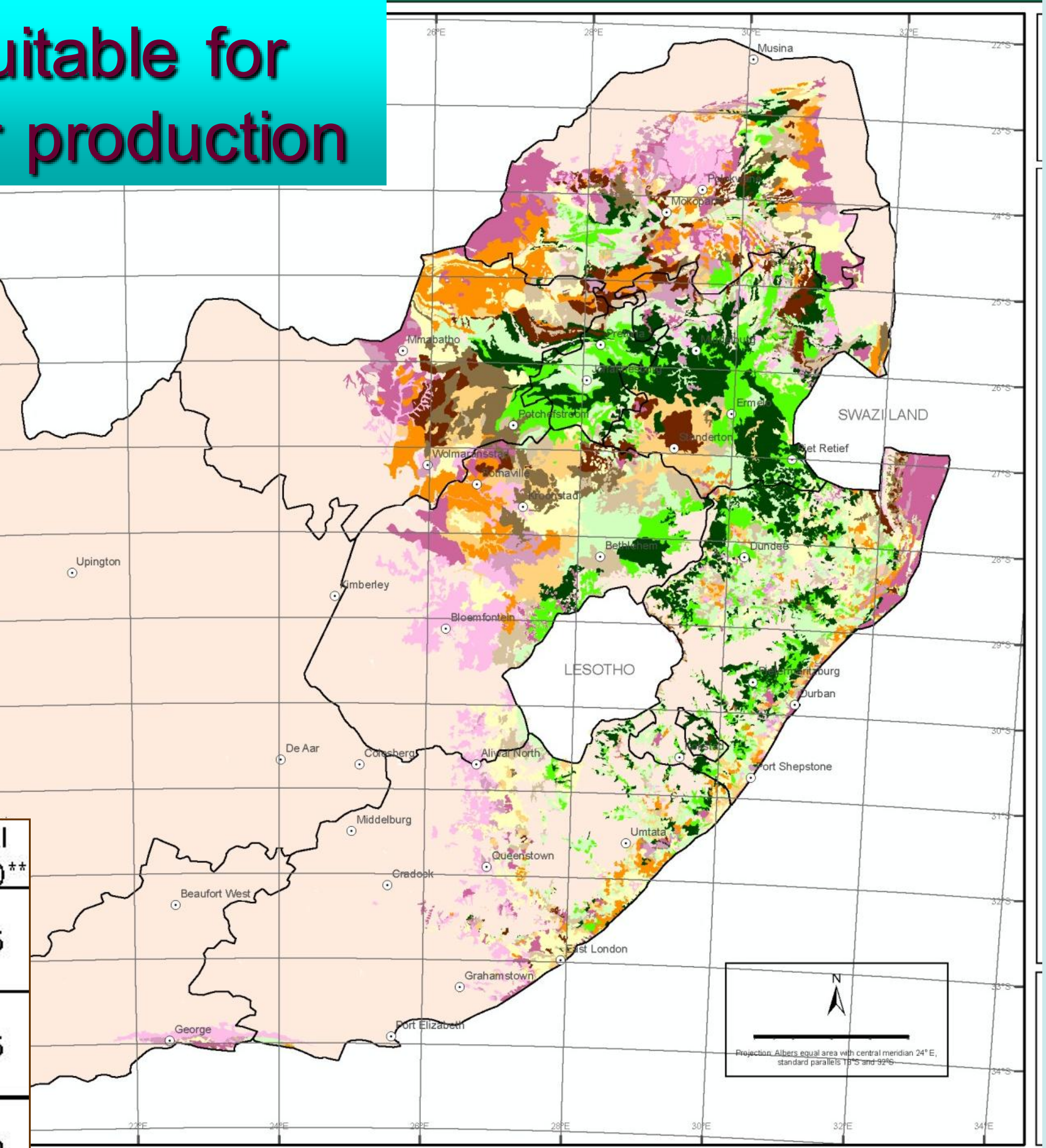
CONSUMPTION, EXPORTS AND SURPLUS IN SOUTH AFRICA 2001 TO

2005

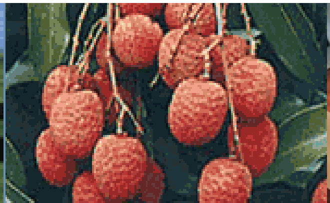


Land suitable for sunflower production





	%*	Class	Potential yield (t/ha)**
	≥ 50	High	1.5 - 2.5
	30 - 50		
	10 - 30		
	≥ 50	Suitable	1.2 - 1.5
	30 - 50		
	10 - 30		
	≥ 50	Moderate	1.0 - 1.2
	30 - 50		
	10 - 30		
	≥ 50	Marginal	0.5 - 1.0
	30 - 50		
	10 - 30		
		Not suitable***	< 0.5



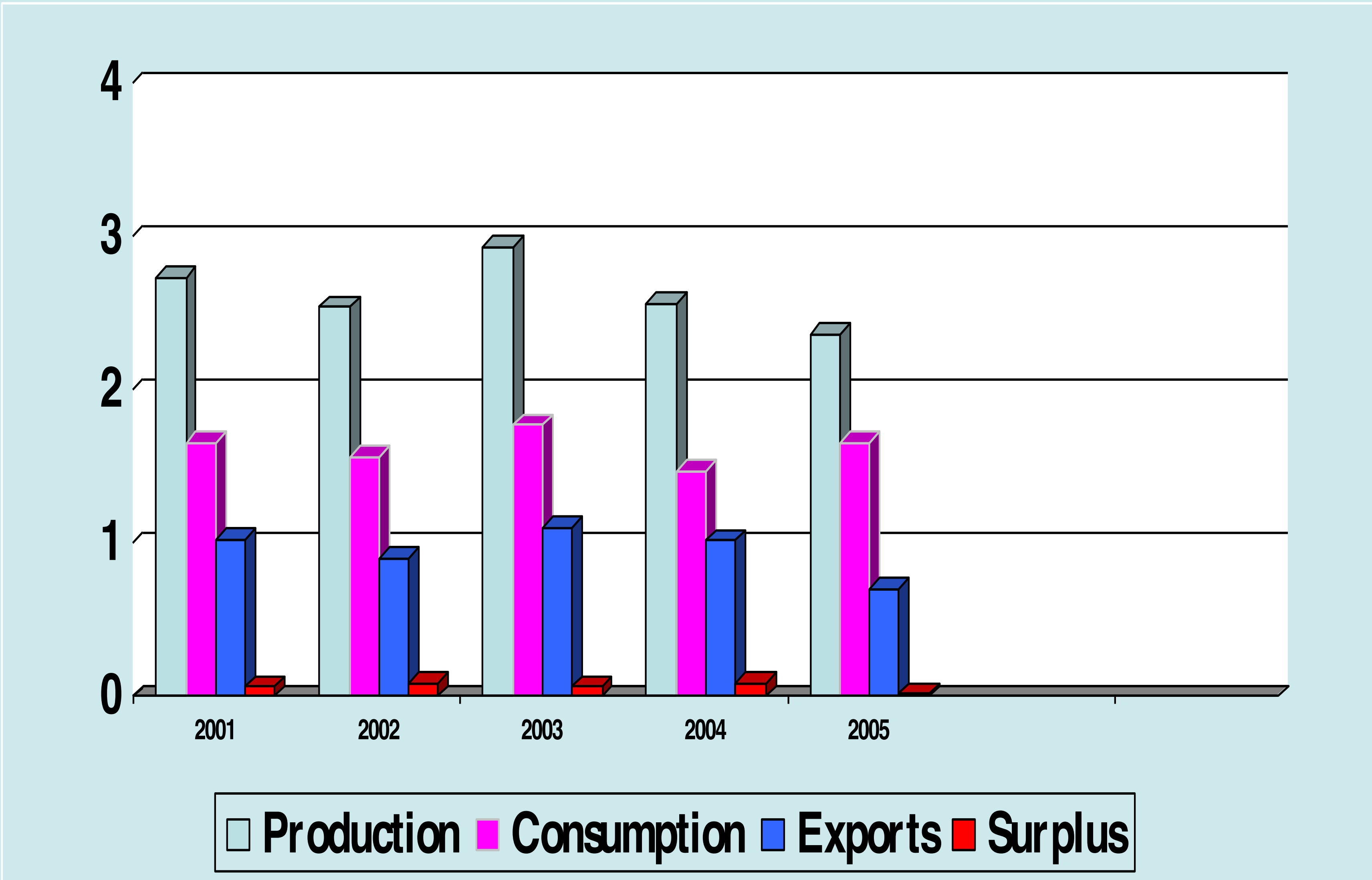
ARC • LNR

SUGARCANE

- **Perennial subtropical crop**
- **Needs annual mean temperature 26 to 32 ^{0}C**
- **Rainfall: 750 – 1 200mm.**
- **Irrigation needed where rainfall is lower.**
- **Do well on sandy loam soils with pH of 6.0 to 7.7**
- **Average yield: 66.5 t/ha**
- **Sugar content: 80%**

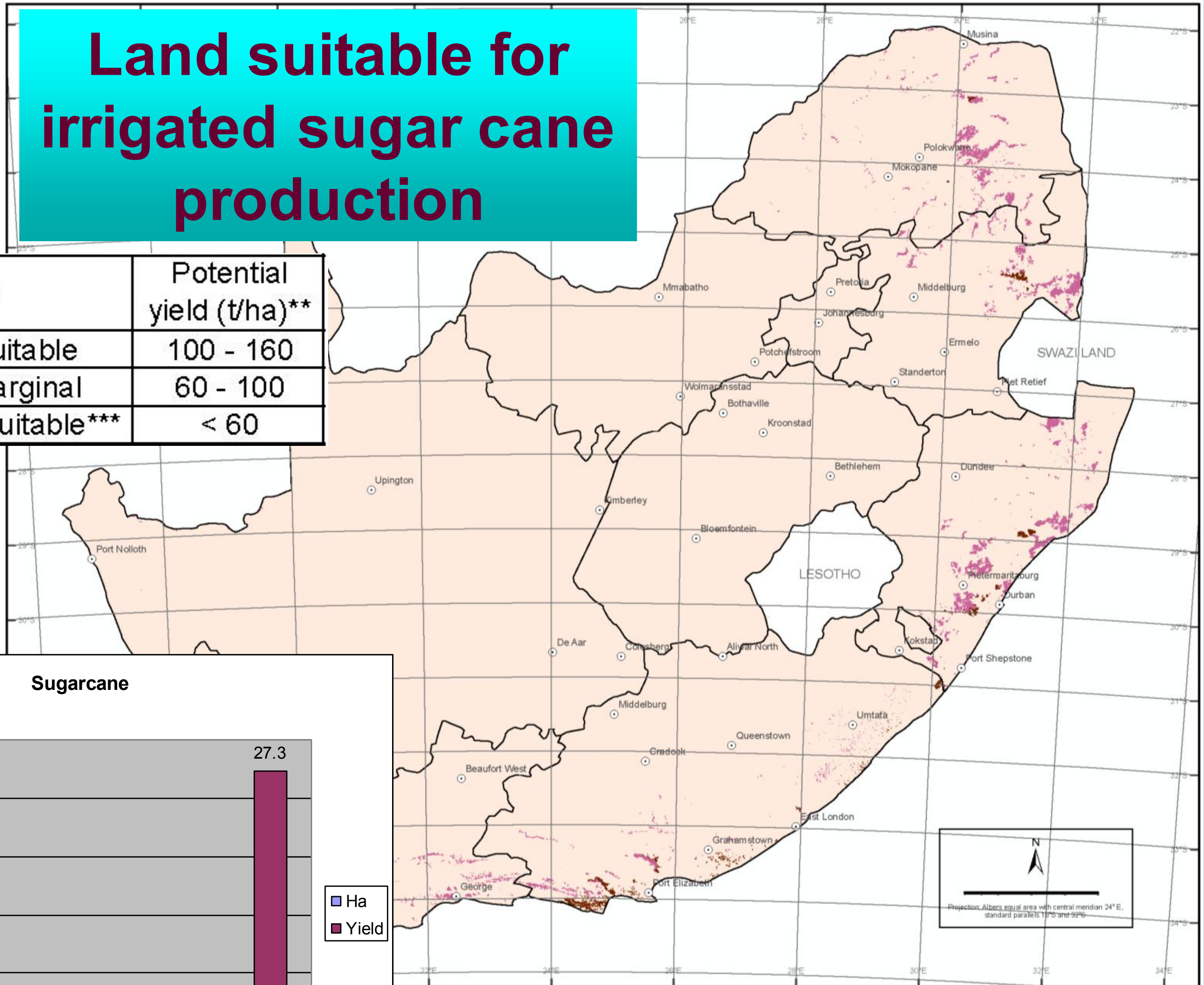
SUGARCANE PRODUCTION,

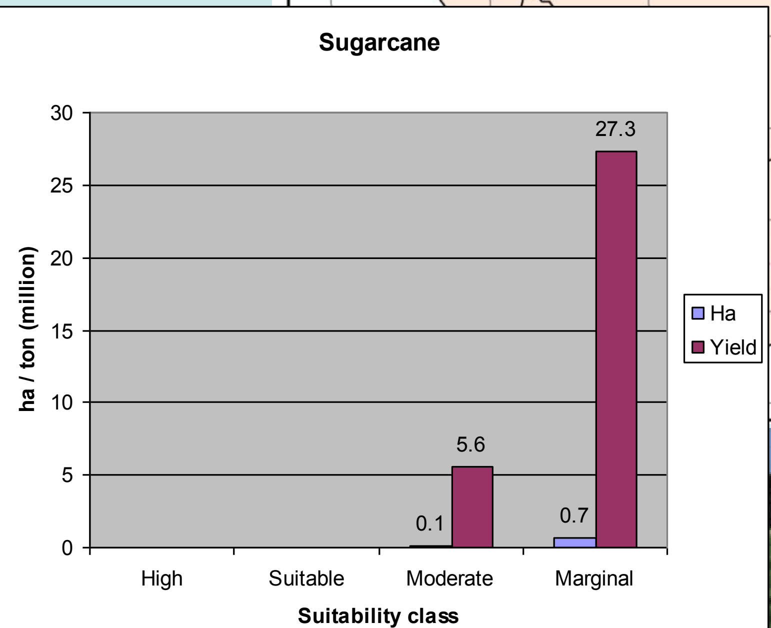
CONSUMPTION, EXPORTS AND SURPLUS IN SOUTH AFRICA
2001 TO 2005

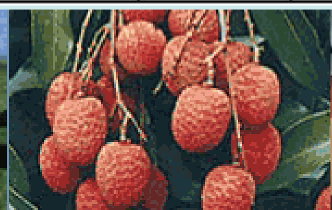


Land suitable for irrigated sugar cane production

Class		Potential yield (t/ha)**
(dark brown)	Suitable	100 - 160
(pink)	Marginal	60 - 100
(pale)	Not suitable***	< 60







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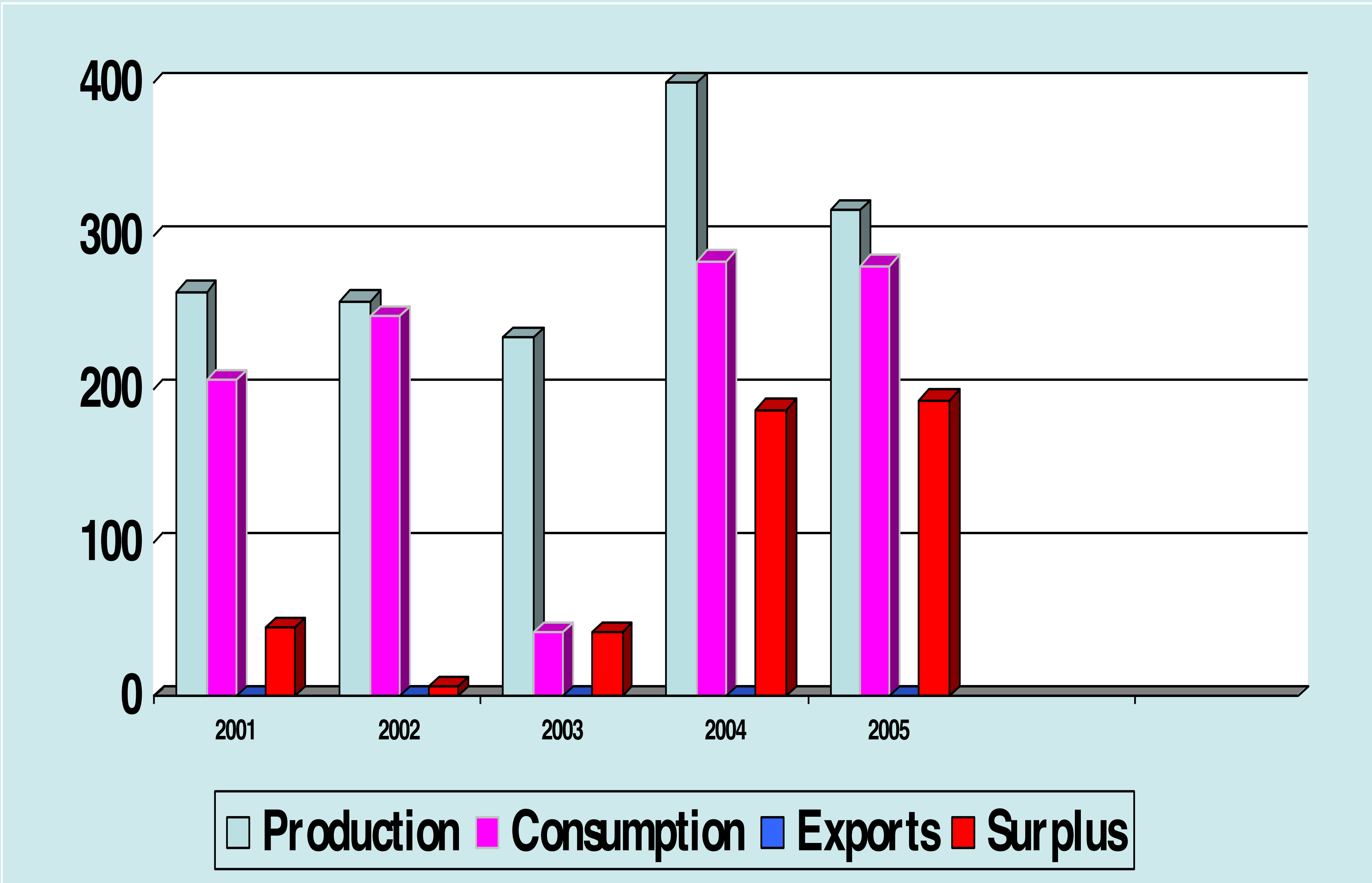
GRAIN SORGHUM

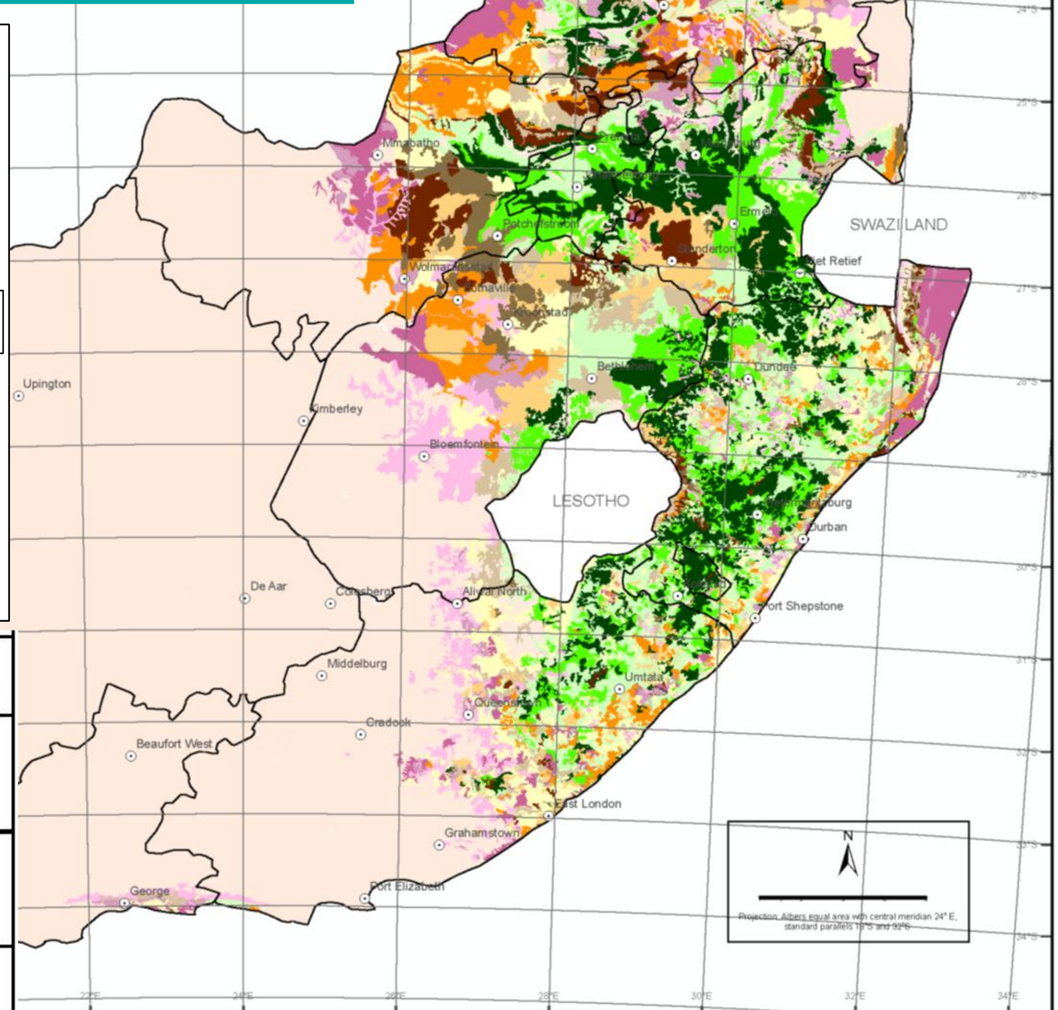
- **Annual summer grain crop**
- **Need frost free season**
- **Temperature: 20 – 35^{o}C**
- **Rainfall: 300 – 750mm**
- **Soil:**
  - **varies from sand to cracking black clay**
  - **pH: 5 – 8.5**
- **Average yield is 2.1 t/ha under dryland conditions and 3.5 t/ha under irrigation**
- **Starch content: 72%**
- **Total production: 200 000 t0 450 000 tons per annum**

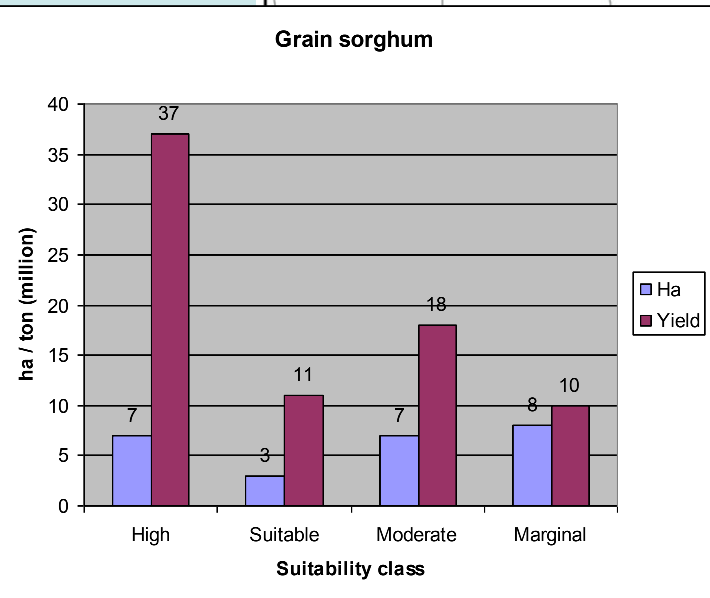
SORGHUM PRODUCTION

CONSUMPTION, EXPORTS AND SURPLUS IN SOUTH AFRICA 2001 TO 2005



Land suitable for sorghum production





	%*	Class	Potential yield (t/ha)**
	≥ 50	High	4.5 - 8.8
	30 - 50		
	10 - 30		
	≥ 50	Suitable	3.5 - 4.5
	30 - 50		
	10 - 30		
	≥ 50	Moderate	2.0 - 4.5
	30 - 50		
	10 - 30		
	≥ 50	Marginal	1.0 - 2.0
	30 - 50		
	10 - 30		
		Not suitable***	< 1.0

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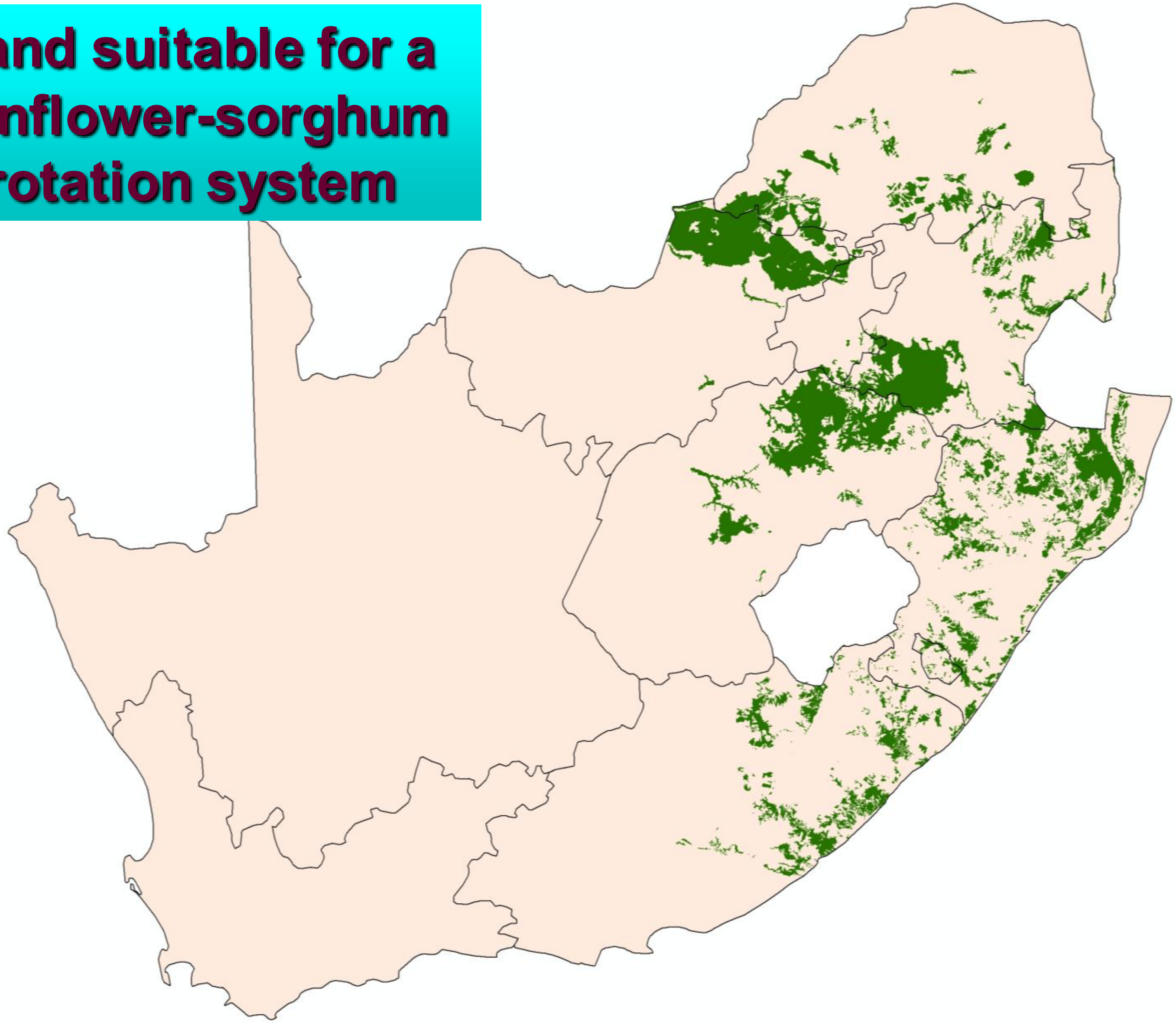
Land suitable for a sunflower-sorghum rotation system



ARC • LNR

ARC-Renewable Energy programme

This is a research programme under National Service category (ARC secondary mandate) which aims at:

- **Providing information for Solar Energy, Wind, Bio-gas, Biofuel and Hydro power plants utilization in South Africa**
- **Conducts Research on Bio-mass utilization**
- **Produces Manuals for training purposes**
- **Maintains Renewable Energy Technology Centre**

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Current ARC research areas

“Assessment of the potential of land in Limpopo for biofuel crop rotation”

“*Assessment and mapping of land suitability for bio-fuel crops”*

“A study focusing on equipment for oil processing as well as testing oil-processing equipment and quality of oil produced”

“Technical support for Limpopo Biofuel Incubator”

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Current ARC research projects

- Crop breeding options to address bio-fuel needs (sunflower, sweet sorghum and soyabean)

- Alternative crop species with potential for biofuel production (Microalgae research)

- Product development for Livestock feeds

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Future interventions and possible projects

- **Development of Appropriate Agro-processing technologies for variety of bio-fuel crops**

- **Technology development for value adding in the bio-fuel chain**

- **Enterprise and rural industry development (Socio-economic studies)**

Future interventions and possible projects

- **Promotion of crop rotation systems because a viable biofuel industry would be based on more than one crop**

- **Development of marginal land (mined land) to support production of identified crops**

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Proposed ARC Research Activities in Biofuel Research Focus Areas

Project Title	Objective	Duration	Estimated Budget
Biofuel Crop Breeding	Breed suitable crop species and cultivars for local conditions to give SA a competitive advantage in biofuel production	4 years	R2 mil
Evaluation of non edible oil crop species (alternative crops)	To identify, characterize and evaluate the economic, social and environmental impacts of alternative non-edible oil crop species Studies on the potential use of micro-algae for biodiesel production	3 years	R 2.8mil
Conservation Agriculture Biofuel production systems	To develop and promote appropriate sustainable biofuel production systems based on conservation agriculture principles and technologies for both large scale commercial and small scale emerging farmer operations.	4 years	R2.2 mil
Rehabilitation of unproductive land for Biofuel production	To map all the unproductive land and develop strategies to make the land productive for bio-fuel crops	2 years	R 1.5 mil
Mapping of Biofuel production areas	To further develop the assessment and mapping, at a more detailed scale, of areas suitable for sustainable biofuel production	2 years	R1.8 mil
Engineering technologies for biofuel value chain	To develop appropriate technologies for local conditions for the harvesting, processing, storage, transport and value adding of biofuel products.	5 years	R 4 mil
Beneficiation of Protein cake energy byproducts for livestock production	To investigate, develop and promote technologies that will utilize the protein cake byproduct from biofuel production for use in livestock and aquaculture production systems.	3 years	R 3.6 mil
Beneficiation of glycerol	To develop innovative beneficiation uses of the byproduct glycerol for livestock feed	3	R 1.5 mil
Biofuel Decision support analyses	To provide decision support for policy and strategy development surrounding the development and promotion of a biofuel industry for South Africa	3 years	R 1.5 mil
Farmer development and capacity building	To provide training and advisory services based on Biofuel incubator experience for capacity building	4 years	R 2.5 mil

Thank You

For

Your attention!

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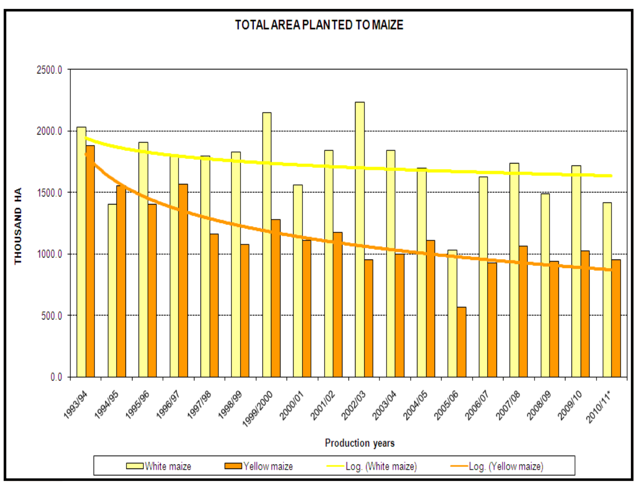
APPENDIX C: RSA Grains and oilseed, production, consumption and trade trends

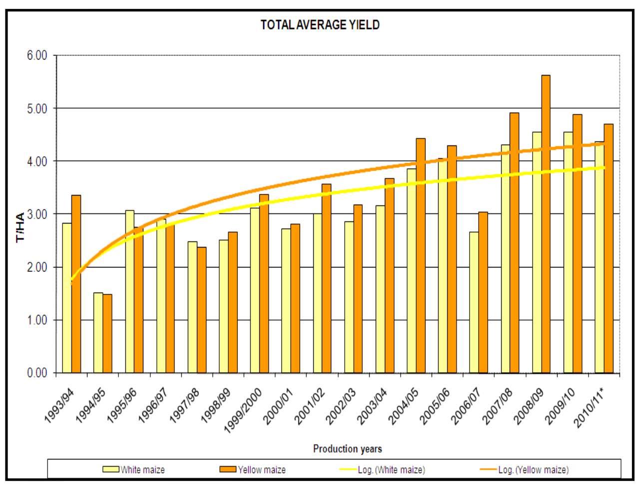
RSA GRAINS AND OILSEED

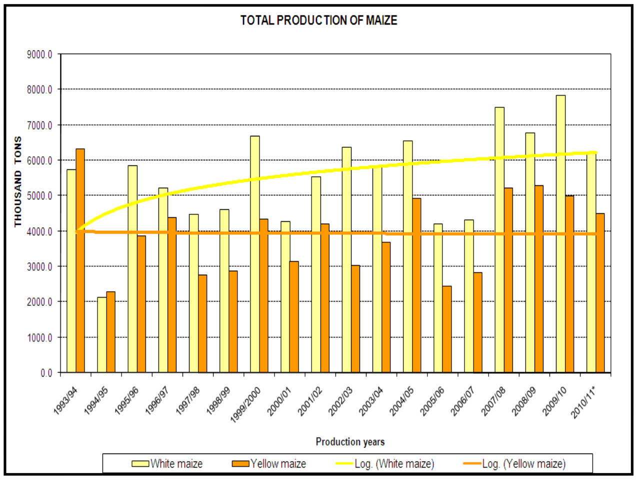
Production, consumption and trade trends

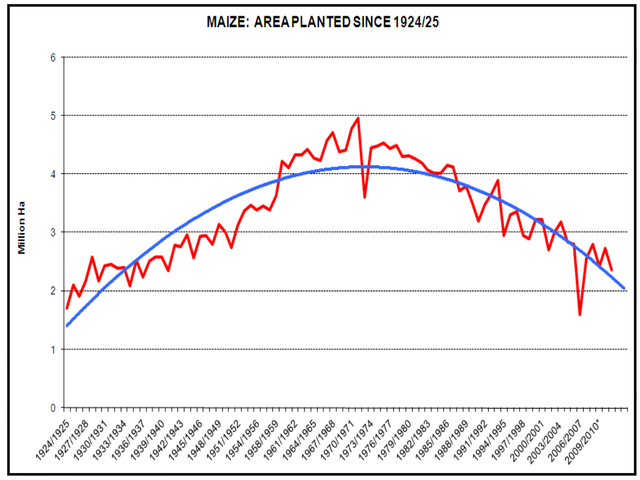
MAIZE

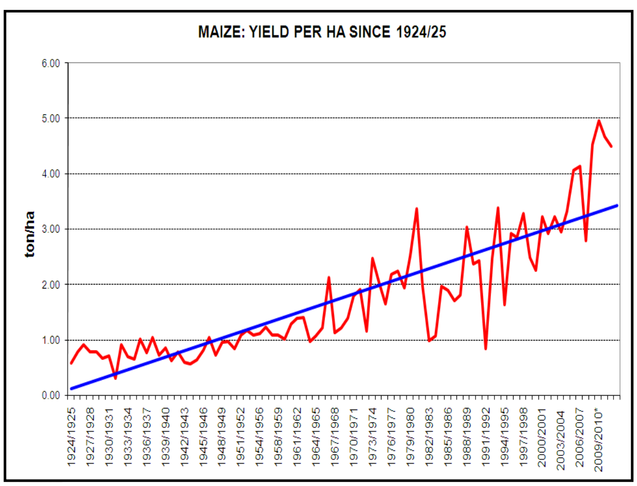
.

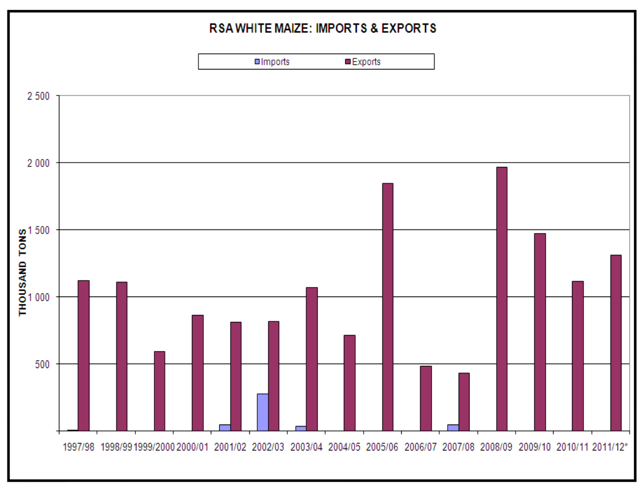


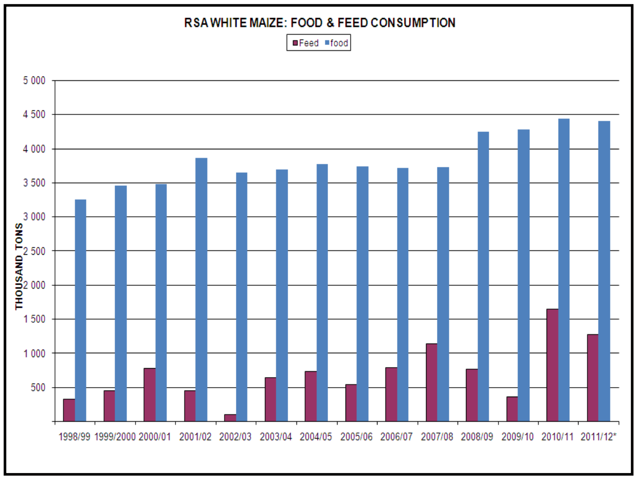


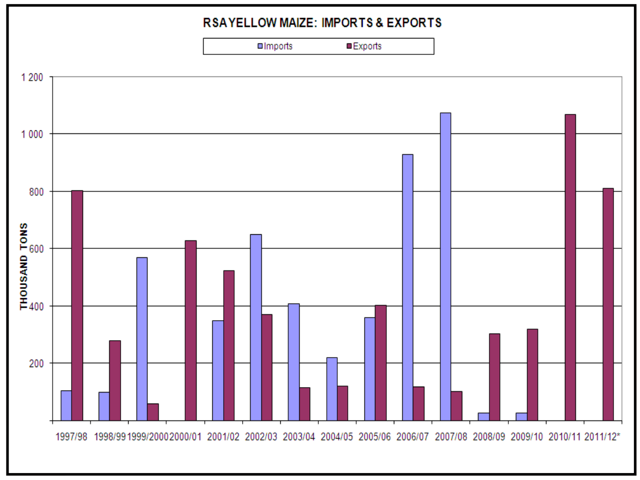

TOTAL PRODUCTION OF MAIZE
THOUSAND TONS
Production years
White maize
Yellow maize
Log. (White maize)
Log. (Yellow maize)

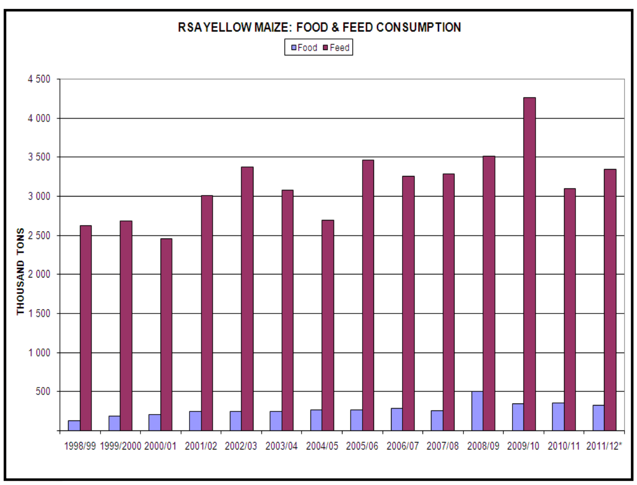

MAIZE: AREA PLANTED SINCE 1924/25
Million Ha

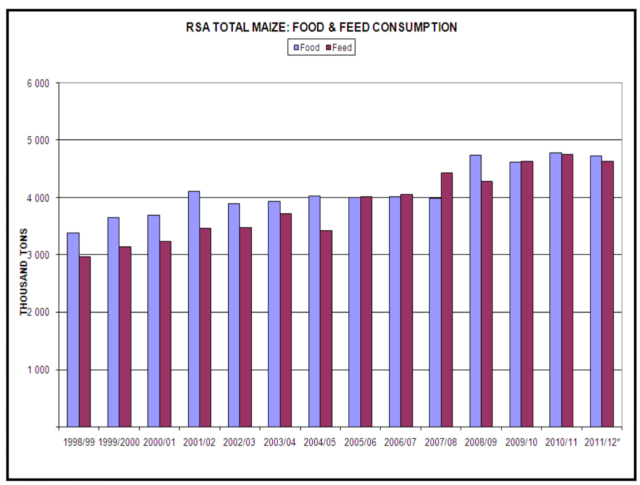

MAIZE: YIELD PER HA SINCE 1924/25
ton/ha

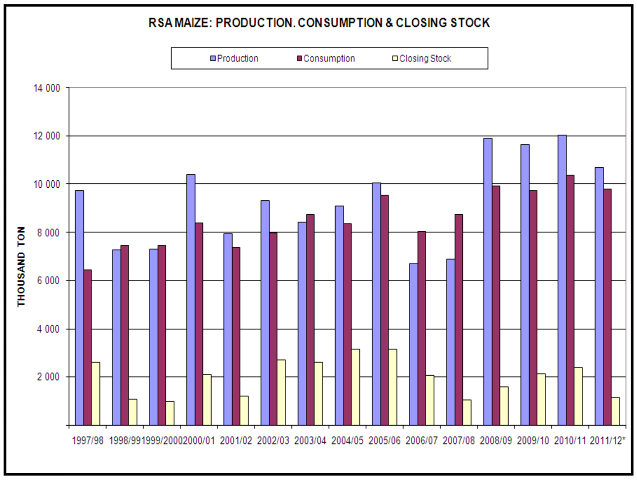

RSA WHITE MAIZE: IMPORTS & EXPORTS
Imports
Exports
THOUSAND TONS

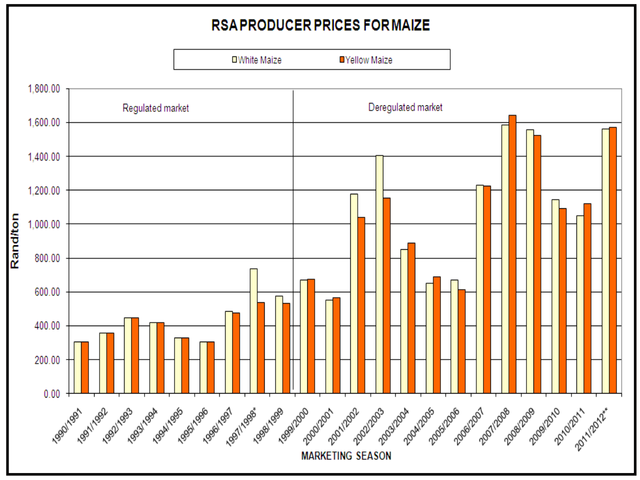

RSA WHITE MAIZE: FOOD & FEED CONSUMPTION
Feed
food
THOUSAND TONS
1998/99 1999/2000 2000/01 2001/02 2002/03 2003/04 2004/05 2005/06 2006/07 2007/08 2008/09 2009/10 2010/11 2011/12*


RSA YELLOW MAIZE: IMPORTS & EXPORTS
Imports
Exports
THOUSAND TONS
1997/98 1998/99 1999/2000 2000/01 2001/02 2002/03 2003/04 2004/05 2005/06 2006/07 2007/08 2008/09 2009/10 2010/11 2011/12*

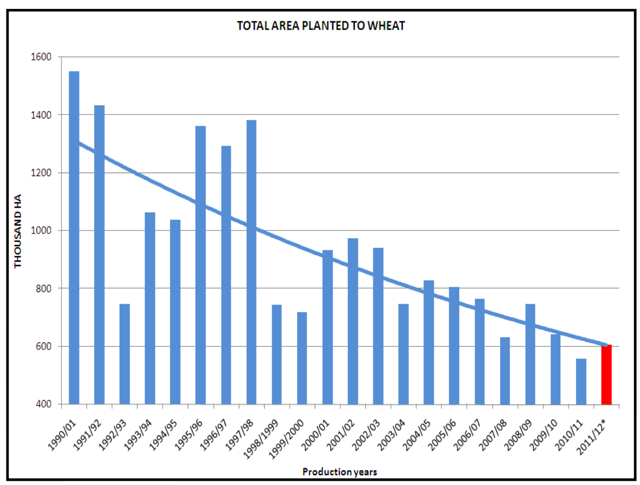

RSA YELLOW MAIZE: FOOD & FEED CONSUMPTION
Food
Feed
THOUSAND TONS
1998/99 1999/2000 2000/01 2001/02 2002/03 2003/04 2004/05 2005/06 2006/07 2007/08 2008/09 2009/10 2010/11 2011/12*

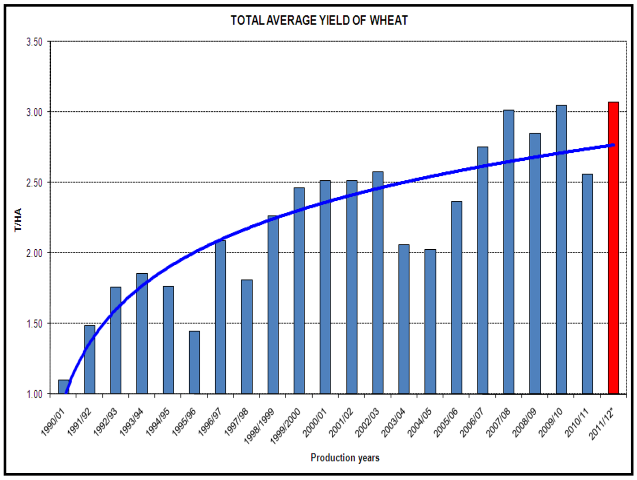

RSA TOTAL MAIZE: FOOD & FEED CONSUMPTION
Food
Feed
THOUSAND TONS
1998/99 1999/2000 2000/01 2001/02 2002/03 2003/04 2004/05 2005/06 2006/07 2007/08 2008/09 2009/10 2010/11 2011/12*

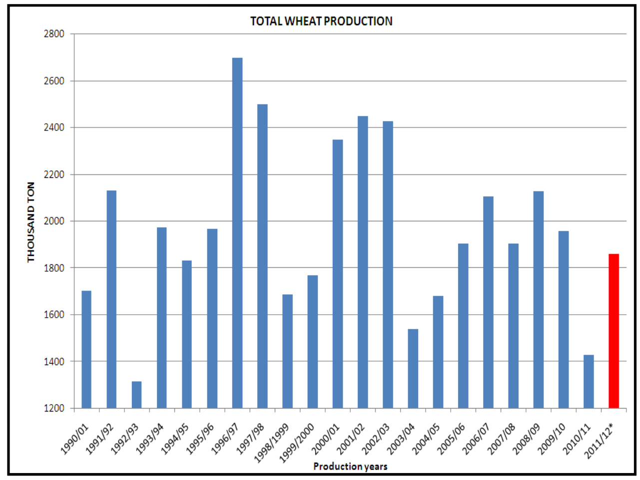

RSA MAIZE: PRODUCTION, CONSUMPTION & CLOSING STOCK
Production
Consumption
Closing Stock
THOUSAND TON
14 000
12 000
10 000
8 000
6 000
4 000
2 000
1997/98
1998/99
1999/2000
2000/01
2001/02
2002/03
2003/04
2004/05
2005/06
2006/07
2007/08
2008/09
2009/10
2010/11
2011/12*

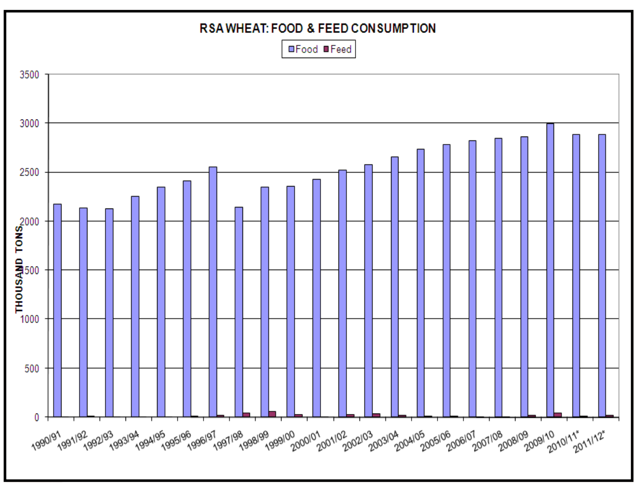

RSA PRODUCER PRICES FOR MAIZE
White Maize
Yellow Maize
Regulated market
Deregulated market
Rand/ton
1,800.00
1,600.00
1,400.00
1,200.00
1,000.00
800.00
600.00
400.00
200.00
0.00
1990/1991
1991/1992
1992/1993
1993/1994
1994/1995
1995/1996
1996/1997
1997/1998*
1998/1999
1999/2000
2000/2001
2001/2002
2002/2003
2003/2004
2004/2005
2005/2006
2006/2007
2007/2008
2008/2009
2009/2010
2010/2011
2011/2012**
MARKETING SEASON

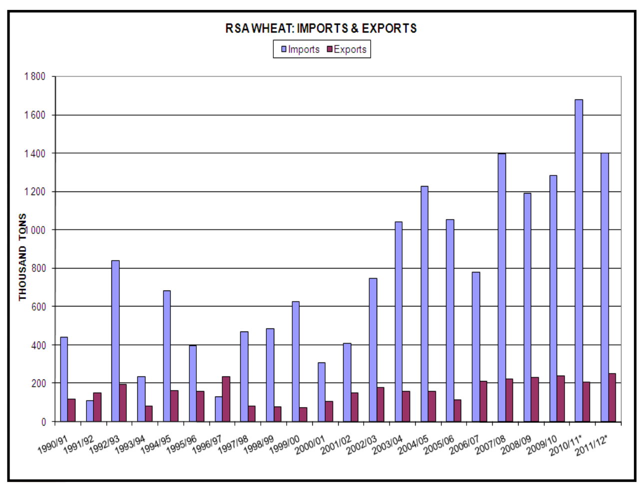
WHEAT

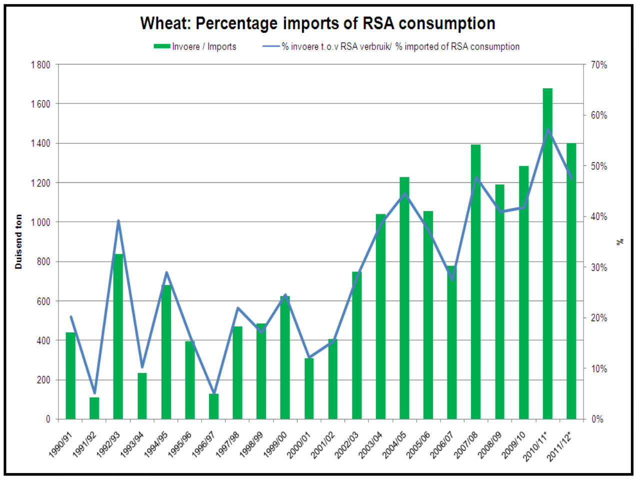

TOTAL AREA PLANTED TO WHEAT
THOUSAND HA
1600
1400
1200
1000
800
600
400
1990/01
1991/92
1992/93
1993/94
1994/95
1995/96
1996/97
1997/98
1998/1999
1999/2000
2000/01
2001/02
2002/03
2003/04
2004/05
2005/06
2006/07
2007/08
2008/09
2009/10
2010/11
2011/12*
Production years


TOTAL AVERAGE YIELD OF WHEAT
T/HA
3.50
3.00
2.50
2.00
1.50
1.00
1990/01
1991/92
1992/93
1993/94
1994/95
1995/96
1996/97
1997/98
1998/1999
1999/2000
2000/01
2001/02
2002/03
2003/04
2004/05
2005/06
2006/07
2007/08
2008/09
2009/10
2010/11
2011/12*
Production years

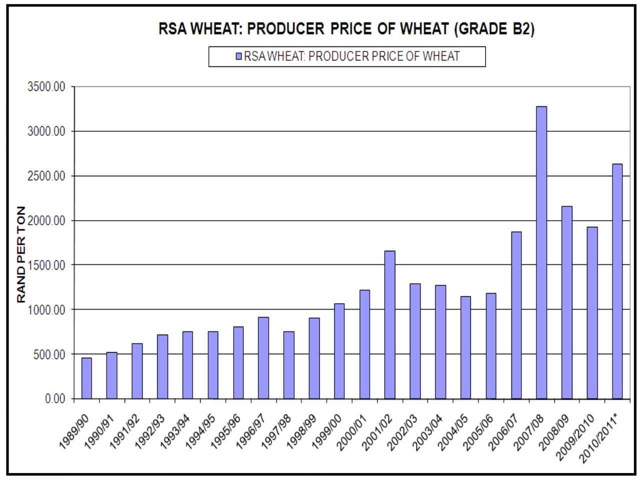

TOTAL WHEAT PRODUCTION
THOUSAND TON
2800
2600
2400
2200
2000
1800
1600
1400
1200
1990/01
1991/92
1992/93
1993/94
1994/95
1995/96
1996/97
1997/98
1998/1999
1999/2000
2000/01
2001/02
2002/03
2003/04
2004/05
2005/06
2006/07
2007/08
2008/09
2009/10
2010/11
2011/12*
Production years


RSA WHEAT: FOOD & FEED CONSUMPTION
Food
Feed
THOUSAND TONS
3500
3000
2500
2000
1500
1000
500
0
1990/91
1991/92
1992/93
1993/94
1994/95
1995/96
1996/97
1997/98
1998/99
1999/00
2000/01
2001/02
2002/03
2003/04
2004/05
2005/06
2006/07
2007/08
2008/09
2009/10
2010/11*
2011/12*


RSA WHEAT: IMPORTS & EXPORTS
Imports
Exports
THOUSAND TONS
1 800
1 600
1 400
1 200
1 000
800
600
400
200
0
1990/91
1991/92
1992/93
1993/94
1994/95
1995/96
1996/97
1997/98
1998/99
1999/00
2000/01
2001/02
2002/03
2003/04
2004/05
2005/06
2006/07
2007/08
2008/09
2009/10
2010/11*
2011/12*

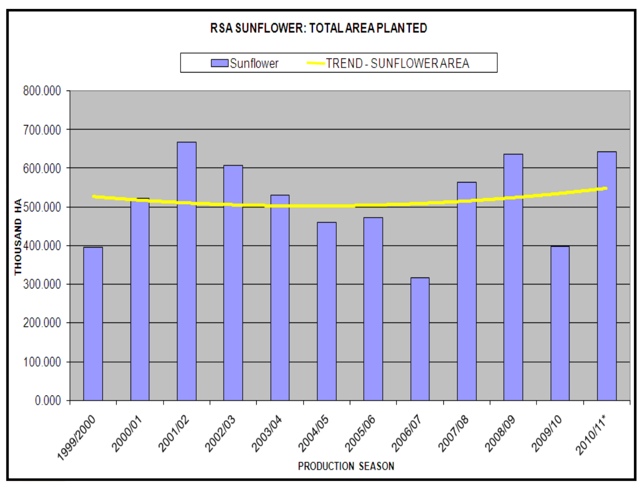


Wheat: Percentage imports of RSA consumption
Invoere / Imports
% invoere t.o.v RSA verbruik/ % imported of RSA consumption
Duisend ton
%
1 800
1 600
1 400
1 200
1 000
800
600
400
200
0
70%
60%
50%
40%
30%
20%
10%
0%
1990/91
1991/92
1992/93
1993/94
1994/95
1995/96
1996/97
1997/98
1998/99
1999/00
2000/01
2001/02
2002/03
2003/04
2004/05
2005/06
2006/07
2007/08
2008/09
2009/10
2010/11*
2011/12*

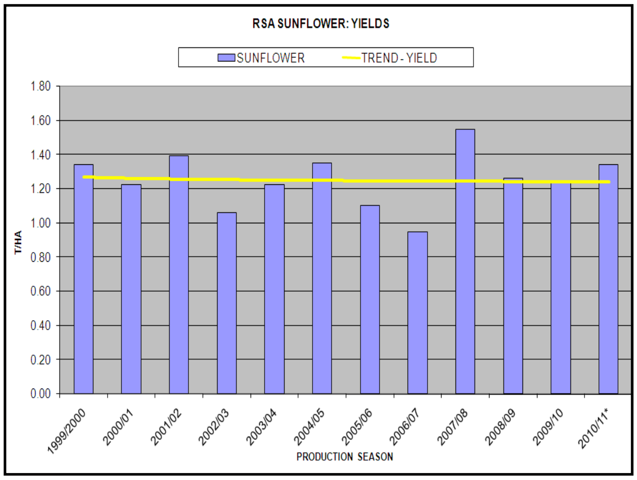


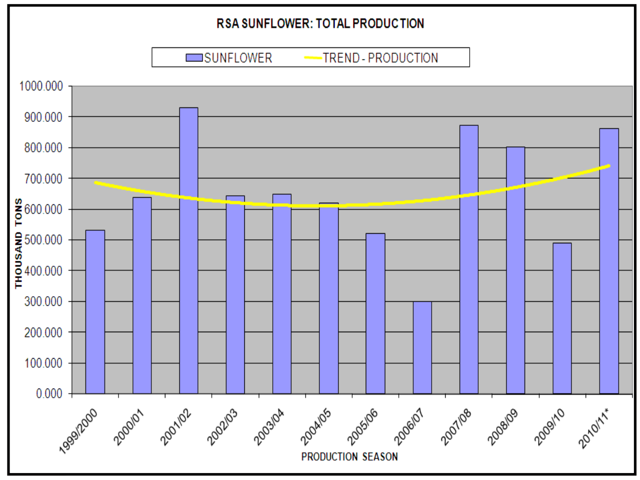
RSA WHEAT: PRODUCER PRICE OF WHEAT (GRADE B2)
RSA WHEAT: PRODUCER PRICE OF WHEAT
RAND PER TON
3500.00
3000.00
2500.00
2000.00
1500.00
1000.00
500.00
0.00
1989/90
1990/91
1991/92
1992/93
1993/94
1994/95
1995/96
1996/97
1997/98
1998/99
1999/00
2000/01
2001/02
2002/03
2003/04
2004/05
2005/06
2006/07
2007/08
2008/09
2009/2010
2010/2011*

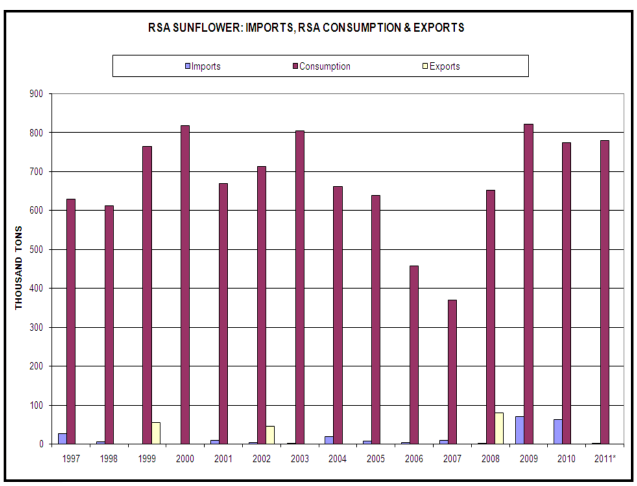
SUNFLOWER

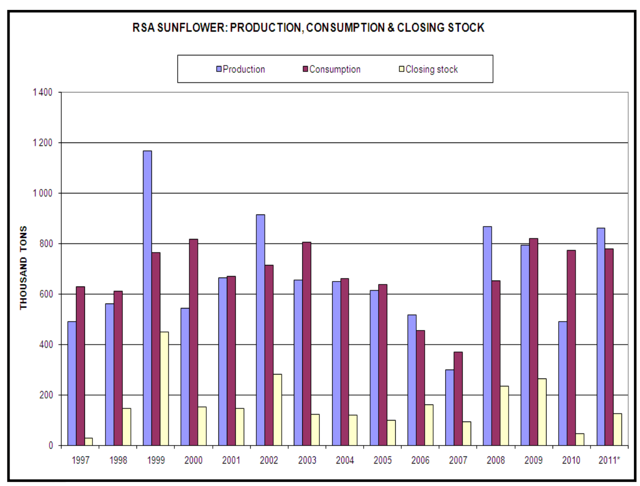


RSA SUNFLOWER: TOTAL AREA PLANTED
Sunflower
TREND - SUNFLOWER AREA
THOUSAND HA
800.000
700.000
600.000
500.000
400.000
300.000
200.000
100.000
0.000
1999/2000
2000/01
2001/02
2002/03
2003/04
2004/05
2005/06
2006/07
2007/08
2008/09
2009/10
2010/11*
PRODUCTION SEASON


RSA SUNFLOWER: YIELDS
SUNFLOWER
TREND - YIELD
T/HA
PRODUCTION SEASON
1999/2000
2000/01
2001/02
2002/03
2003/04
2004/05
2005/06
2006/07
2007/08
2008/09
2009/10
2010/11*

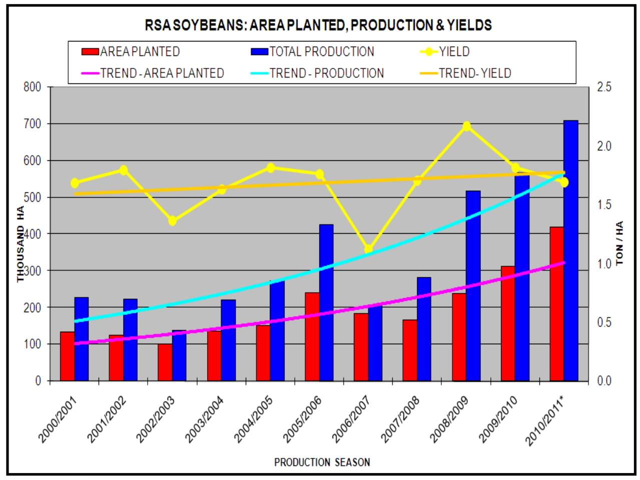

RSA SUNFLOWER: TOTAL PRODUCTION
SUNFLOWER
TREND - PRODUCTION
THOUSAND TONS
PRODUCTION SEASON

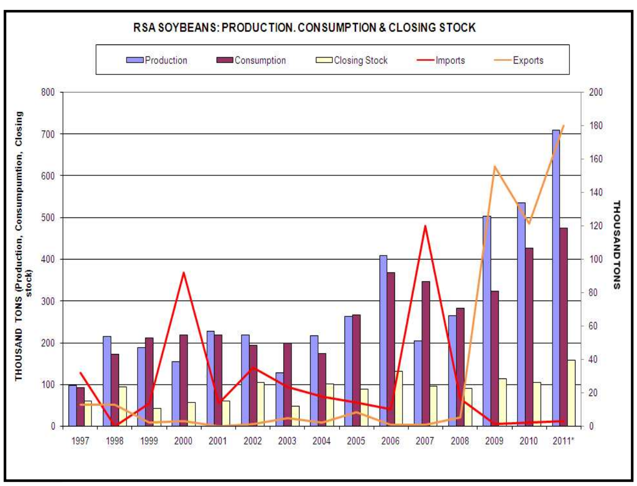

RSA SUNFLOWER: IMPORTS, RSA CONSUMPTION & EXPORTS
Imports
Consumption
Exports
THOUSAND TONS


RSA SUNFLOWER: PRODUCTION, CONSUMPTION & CLOSING STOCK
Production
Consumption
Closing stock
THOUSAND TONS

GRAIN SA
GRAAN SA

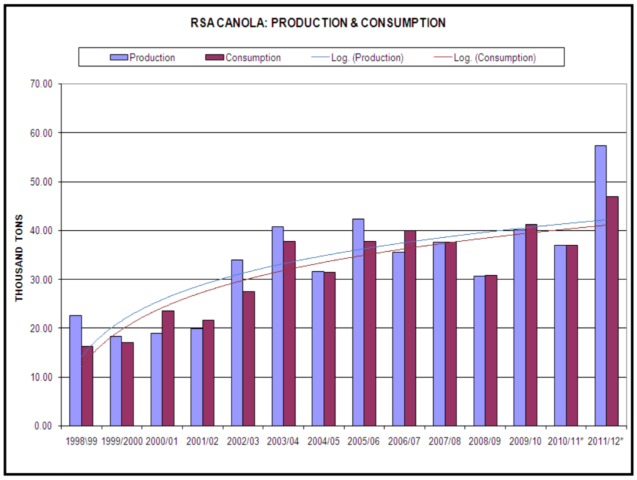
SOYBEANS



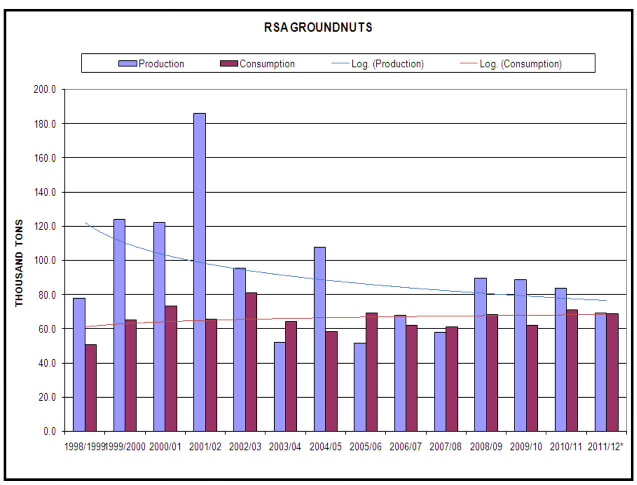


GRAIN SA
GRAAN SA

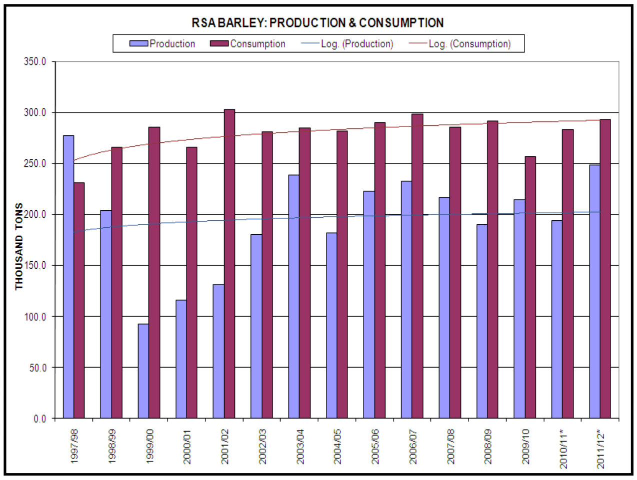
CANOLA


RSA CANOLA: PRODUCTION & CONSUMPTION
Production
Consumption
Log. (Production)
Log. (Consumption)
THOUSAND TONS
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
1998\99 1999/2000 2000/01 2001/02 2002/03 2003/04 2004/05 2005/06 2006/07 2007/08 2008/09 2009/10 2010/11* 2011/12*

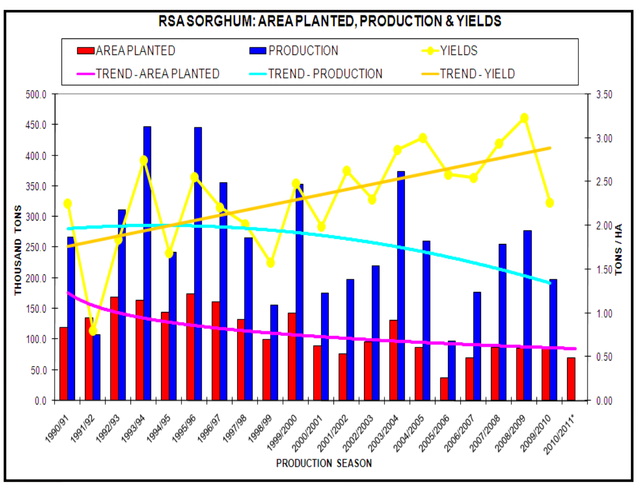

GRAIN SA
GRAAN SA
GROUNDNUTS

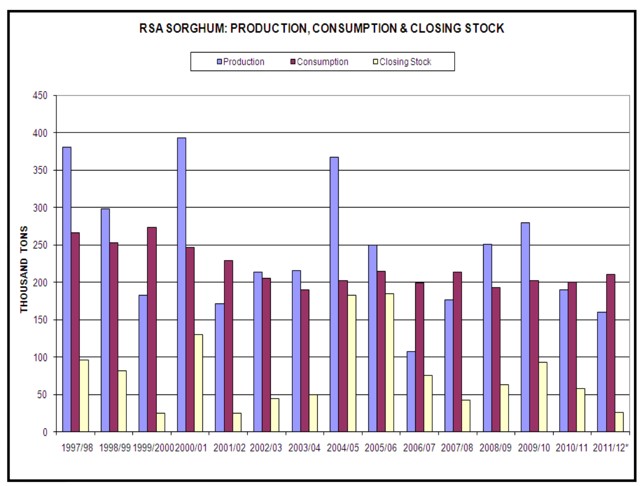

RSA GROUNDNUTS
Production
Consumption
Log. (Production)
Log. (Consumption)
THOUSAND TONS
200.0
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
1998/1999 1999/2000 2000/01 2001/02 2002/03 2003/04 2004/05 2005/06 2006/07 2007/08 2008/09 2009/10 2010/11 2011/12*


GRAIN SA
GRAAN SA
BARLEY


RSA BARLEY: PRODUCTION & CONSUMPTION
Production
Consumption
Log. (Production)
Log. (Consumption)
THOUSAND TONS
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
1997/98
1998/99
1999/00
2000/01
2001/02
2002/03
2003/04
2004/05
2005/06
2006/07
2007/08
2008/09
2009/10
2010/11*
2011/12*

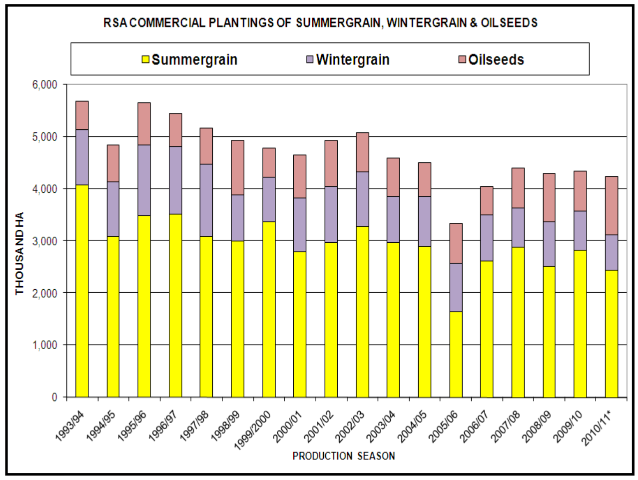
SORGHUM

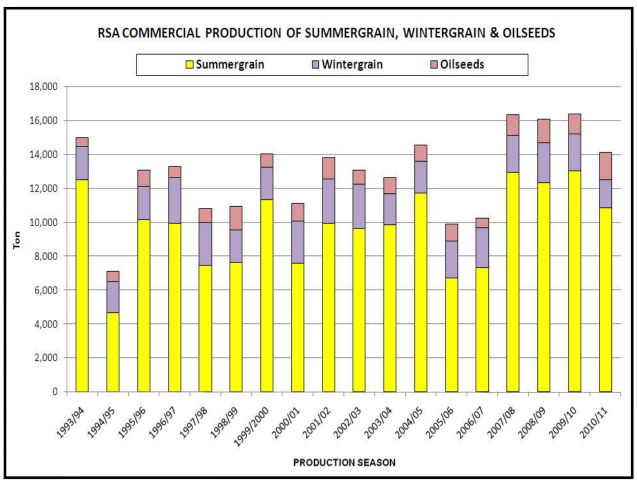

RSA SORGHUM: AREA PLANTED, PRODUCTION & YIELDS
AREA PLANTED
PRODUCTION
YIELDS
TREND - AREA PLANTED
TREND - PRODUCTION
TREND - YIELD
THOUSAND TONS
TONS / HA
PRODUCTION SEASON
1990/91
1991/92
1992/93
1993/94
1994/95
1995/96
1996/97
1997/98
1998/99
1999/2000
2000/2001
2001/2002
2002/2003
2003/2004
2004/2005
2005/2006
2006/2007
2007/2008
2008/2009
2009/2010
2010/2011*


RSA SORGHUM: PRODUCTION, CONSUMPTION & CLOSING STOCK
Production
Consumption
Closing Stock
THOUSAND TONS
1997/98
1998/99
1999/2000
2000/01
2001/02
2002/03
2003/04
2004/05
2005/06
2006/07
2007/08
2008/09
2009/10
2010/11
2011/12*

RSA TOTAL COMMERCIAL PLANTINGS:

SUMMERGRAIN
WINTERGRAIN
OILSEED





THANK YOU