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Modelling soybean markets in Eastern and Southern Africa

Regional Network of Agricultural Policy Research Institutes (ReNAPRI)

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Short abstract
This report presents both methodology and results of a medium-term outlook for soybean markets in South Africa, Zambia, Malawi and Mozambique. Soybeans are attractive crops for many economic, social and environmental reasons, and the sector appears to have a promising future in Eastern and Southern Africa. For instance it can improve soils, provide a value added processing activity and offer an alternative crop to be produced by both small holders and commercial farms. Looking the 2026/2027 horizon, this medium-term outlook takes the latest trends, policies and market information into consideration, but remains subject to many uncertainties on upcoming market development, macroeconomics or policy changes.

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Acknowledgements

While agriculture is a key sector in Africa, analysis of the potential future development of the African agricultural sector is limited, by contrast to other forward looking agricultural sector outlooks at the global level (OECD-FAO), for Europe (European Commission, including the JRC) or the USA (USDA, FAPRI). A promising initiative in this direction is the Regional Network of Agricultural Policy Research Institutes (ReNAPRI). With its long-standing experience in agri-food market outlook and uncertainty analysis, mainly for DG AGRI, the JRC is supporting this model development.

After having supported the extension of the ReNAPRI partial equilibrium model to complement its baseline with wheat and sugar (Meyer et al., 2016), the JRC put some resource to cover soybean markets. This publication presents the methodology and results of a medium-term outlook for soybean in four Eastern and Southern African countries, namely South Africa, Zambia, Malawi and Mozambique.

The authorship and responsibility for the content rest with the Regional Network of Agricultural Policy Research Institutes (ReNAPRI). For this soybean market outlook, ReNAPRI's partners involved are:

- Bureau for Food and Agricultural Policy (BFAP), University of Pretoria and University of Stellenbosch, South Africa;
- Indaba Agriculture Policy Research Institute (IAPRI), Zambia;
- Centre for Agricultural Research and Development (CARD), Lilongwe University of Agriculture and Natural Resources (LUANAR), Malawi;
- Centro de Estudo de Políticas e Programas Agroalimentares (CEPPAG), Eduardo Mondlane University, Mozambique.

Along with:

- The Food and Agricultural Policy Research Institute at the University of Missouri (FAPRI-MU), United States.

The team contributing to the model development and baseline preparation included Ferdinand Meyer (BFAP, South Africa), Lulama Ndibongo Traub (BFAP, South Africa), Tracy Davids (BFAP, South Africa), Brian Chisanga (IAPRI, Zambia), Richard Kachule (CARD, Malawi), Emílio Tostão (CEPPAG, Mozambique), Orcídia Vilanculos (CEPPAG, Mozambique) and Meizal Popat (CEPPAG, Mozambique). The project has been managed by Julian Binfield (FAPRI-MU, United States).

At the JRC, Pierre Boulanger, Robert M'barek and Emanuele Ferrari have been involved.

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Abstract

Global soybean area has increased rapidly in recent decades, with global area doubling over the last 20 years. Expansion has been driven by a growing population that has increased demand for vegetable oil for food and biofuels, and soybean meal as feed for meat production. That expansion globally is expected to continue with increasing demand and the development of new varieties and farming techniques that develop new areas where the crop can be grown.

In Eastern and Southern Africa soybean industry is expanding. Although population growth globally is slowing, populations in that region are growing rapidly and will be a major driver of the economy in these countries. This means that domestic demand for vegetable oil and soybean meal for feed are going to grow rapidly. Soybeans are attractive for these countries as they provide an alternative for producers and raise rural incomes. It can provide an input into a value added activity (crushing), improve soils and have nutritional benefits. Key specificities to take into account are listed below.

- The area of soybean has grown in each of the four countries studied in this report (South Africa, Zambia, Malawi and Mozambique) over the past decade.
- The nature of the industry is different in each of the countries, varying from a mostly commercial sector in South Africa to mostly smallholder farmers in Malawi.
- The expanding livestock sector is a driving force for the industry, through the demand for feed. This demand is growing throughout the region, reinforcing trade opportunities.
- Populations are growing rapidly in the region. In the model this leads to increased demand for soybean oil, and meal for feed. However, the increasing population change is likely to have other wider effects on the economy that could influence the sector.
- Exchange rates for the countries have shown a high degree of volatility in recent years and this will continue to impact the sector which is closely linked to world markets and where intra-regional trade is going to play an important role.
- Recent droughts in the regions have hampered the development of the sector, but are expected to recover in the coming years. This does, however, highlight the importance of climate for the evolution of the sector.
- The countries are generally net importers of oil. As soybean crushing in the countries expands, this reliance on imported vegetable oil will likely be reduced.
- Agricultural support policies do not present significant role in the soybean sector, and is mostly focussed on maize, given its importance as staple crop.

It is expected that despite a continuation of relatively low global oilseed prices, the soybean sectors in each of the countries will continue to expand, and trade in soybeans and their products will increase across the region. The expansion will depend in part on the policy pursued in the countries, in particular with respect to the livestock industries. Policy reforms in major world soybean actors, for instance change in biofuel policy or rise in protectionism, could also impact the Eastern and Southern Africa soybean industry. Looking the 2026/2027 horizon, this medium-term outlook remains subject to many uncertainties on upcoming market development, macroeconomics or policy changes.

This report provides a foundation for future development which would ideally include an examination of regional trade in soybean meal including countries not modelled here, collection of better data, and the modelling of other sectors that impact the industry especially livestock.

1 Introduction

Global soybean area has expanded rapidly over the last decades, from 26.5 million hectares in 1966 to 61.1 million hectares in 1996, and 121.5 million hectares in 2016 (FAO, 2017). Most of this expansion in area has come from the USA, Brazil and Argentina in response to the growing demand for feed from the livestock industry. During this period China has rapidly expanded meat production and increased its imports of soybean meal. Vegetable oil consumption over that period has also increased, both for food for the growing population, and as a feedstock for biofuels. In the USA soybean oil has been the major feedstock for the expansion of biodiesel production to meet the requirements of the Renewable Fuel Standard (RFS). Soybean area has grown outside of the big three exporters as well. New varieties, improved genetics and new land opening have enabled soybeans to be grown over a larger area. In the EU, a Protein Plan is expected to be published by the Commission by the end of 2018. Soybean appears here as a critical commodity with about 5% of EU soybean and soybean meal needs produced domestically.

Soybean area has expanded recently in Eastern and Southern Africa and this is expected to continue. Outstandingly, the region shares similar climatic characteristics with Cerrado region where much of Latin American soybean comes from. Similar climatic conditions include same latitude, solar radiation rates, rainfall patterns (wet summers) and total annual precipitation volumes, macro-climatic patterns driven by ocean water currents (TechnoServe, 2011; Gasparri et al., 2016). If soybean is a relatively simple crop to grow with a short growing season, room for yield improvement is still important, especially in some East African areas where soybean has the potential to be an important, viable crop (Sinclair et al., 2014).

Soybeans are attractive as a crop from a number of economic, social and environmental considerations. Soybeans provide smallholder farmers in Eastern and Southern Africa an opportunity to diversify their household income and enhance food and nutrition security. Soybeans complement the predominately carbohydrate rich diets, and diversify household income for many poor farmers. From an environmental perspective, soybeans improve soil fertility when rotated with traditional crops such as maize. Furthermore when rotated with maize, soybean improves maize yields by 10%-20% by fixing nitrogen in the soil (TechnoServe, 2011). Soybeans offer an opportunity to capture some value added through processing via the crushing process and transformation into vegetable oil or meal for feed, an input into the livestock industry.

While the soybean sector is promising for Eastern and Southern Africa, analysis of the potential future development is limited, by contrast to other forward looking agricultural sector outlooks at the global level (OECD-FAO), for Europe (European Commission, including the JRC) or the USA (USDA, FAPRI).

This publication presents the methodology and results of a medium-term outlook for soybean, for a time horizon of up to 2026/2027, in Eastern and Southern African countries, namely South Africa, Zambia, Malawi and Mozambique where area has grown over the past decade. This report was carried out by partners from the Regional Network of Agricultural Policy Research Institutes (ReNAPRI). ReNAPRI has built and maintains a partial equilibrium model of agriculture commodities in Eastern and Southern Africa. The soybean models developed here were integrated into that modelling framework and simulated to produce an outlook. The incorporation of the soybean sector enables the impact of this growing sector on other crops to be considered. It also allows the analysis of changes in policies in other sectors on soybeans to be investigated. For example, changes in policies that impact maize profitability could influence soybean area grown, crushing, and the availability and cost of meal for the livestock industry.

Section two outlines the recent development of the soybean sectors in South Africa, Zambia, Malawi and Mozambique. It highlights the differences between the industries within Eastern and Southern Africa, and the major factors that influence the evolution of the sectors. It also shows how the industries in the different countries are linked and

their connections with the global market. What emerges is a complex network of relationships that are presented in section three. Economic models are based on datasets that are compiled using a variety of data sources. As soybean production for some countries represents a relative new development, data are scarce and difficult to get. The models strive to incorporate the main biological, policy and economic relationships for the sector in the countries concerned. As such the models vary between the countries to reflect their peculiarities. Section four presents the ten year projection for the soybean sector in South Africa, Zambia, Malawi and Mozambique, given current policies, average weather, and macroeconomic assumptions. The full outlook projections are presented in the Appendix.

2 Soybean expansion in Eastern and Southern Africa

This section outlines latest soybean market development in South Africa, Zambia, Malawi and Mozambique. The area of soybean in these four countries has grown over the past decade. Interestingly, the nature of the soybean industry is different in each of the countries, varying from a mostly commercial sector in South Africa to mostly smallholder farmers in Malawi.

The expanding livestock sector is a driving force for the industry, through the demand for feed. This demand is growing throughout the region, reinforcing trade opportunities. Populations are growing rapidly in the region, and are likely to have other wider effects on the economy that could influence the sector. Exchange rates for the countries have shown a high degree of volatility in recent years and this will continue to impact the sector which is closely linked to world markets and where intra-regional trade is going to play an important role.

Recent droughts in the regions have hampered the development of the sector, but are expected to recover in the coming years. This does, however, highlight the importance of climate for the evolution of the sector. The countries are generally net importers of oil. As soybean crushing in the countries expands, this reliance on imported vegetable oil will likely be reduced. Agricultural policy in the countries is mostly focussed on maize, given its importance as staple crop. Agricultural support policies do not generally have an important role in the soybean sector, but trade can be impacted by restrictions that are often ad hoc in nature. Non-governmental organisations (NGOs) are active in the sector in many countries, promoting soybeans as a crop and often providing inputs and technical advice.

2.1 Soybeans in South Africa

Over the past decade, South Africa has experienced significant demographic change with significant numbers of consumers shifting into higher income groups, as indicated by the Living Standard Measure (LSM) segmentation of the population. Consequently, the demand for livestock products increased substantially, concomitantly increasing the demand for protein meal as feed input to the growing livestock sectors. This growth encouraged significant investment in the soybean value chain and rapid growth in soybean production. Further benefits to producers, such as its nitrogen fixation properties when produced in rotation to maize and the opportunity to diversify income and reduce risk also expanded.

As a more developed economy than most other African countries, the importance of the agricultural sector is small (relative to the other countries in this study) and provided only 2.4% of total Gross Domestic Product (GDP) in 2016. It does however provide important support and employment in rural economies. Of the gross value of agricultural output, field crops contributed 23% in 2016, compared to 29% from horticulture and 47% from livestock (DAFF, 2017). Soybeans contributed 8% to the total value of field crop output and are mainly produced by medium and large scale commercial producers. The major soybean producing regions are Mpumalanga, the Free State and KwaZulu-Natal, which produced 87% of national soybeans in 2016/17.

Soybeans are consumed in different forms, including human consumption as oil and food, animal feed consumption as soybean meal. Consumption is mainly in the form of processed soybean products such as oil and protein meal, with approximately 80% of the total supply of soybeans in South Africa being crushed over the past three years.

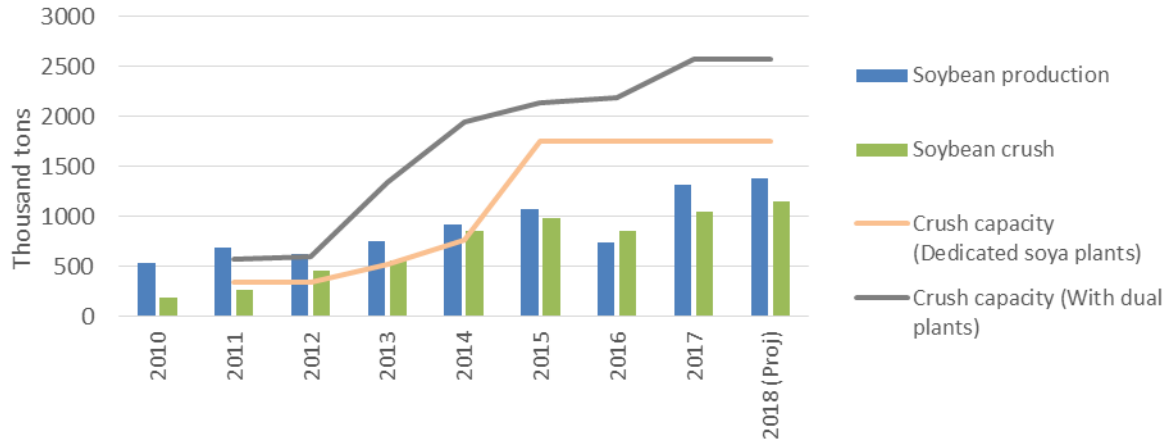
2.1.1 The South African soybean sector situation

Following a period of consistent net exports of raw soybeans, combined with net imports of soybean products into South Africa, there has been significant investment in soybean crushing over the last five years. This has been primarily as a result of increased net imports of soybeans and exports of soybean products into and out of South Africa. This

resulted from favourable crushing margins due to import parity based prices for soybean meal and oil, but export parity based pricing of soybeans. The expansion of dedicated soybean crushing facilities from 350 thousand tonnes in 2012 to 1.75 million tonnes by 2016 (Figure 1), however, was sufficient to push South Africa from a surplus to a deficit situation for soybean production, resulting in significant soybean imports since 2014. This caused a structural break in soybean prices, moving from an export parity based price to a situation where prices are derived from products (soybean meal and oil).

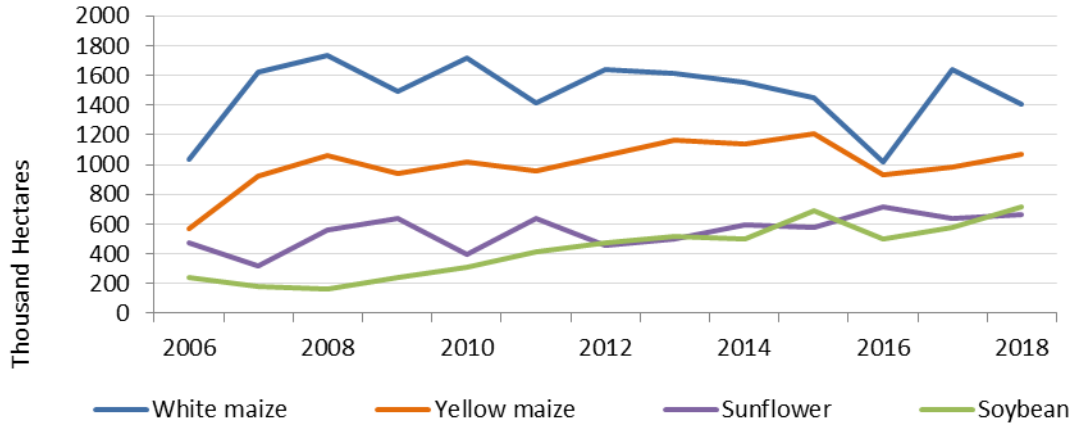
The excess demand for soybeans and the resultant higher prices further supported the trend of expanding area, which more than doubled from 311 thousand hectares in 2009/10, to 687 thousand in 2014/15 before the 2016 drought and an expected 720 thousand hectares in 2017/18 (Figure 2). The expansion of more than 11% per year since 2016 has predominantly occurred at the expense of white maize area, as the demand for white maize consumed as a food staple has remained fairly stagnant in recent years.

Figure 1. Soybean production, crush and crush capacity in South Africa



Source: South African Crop Estimates Committee.

Figure 2. Summer crop area in South Africa

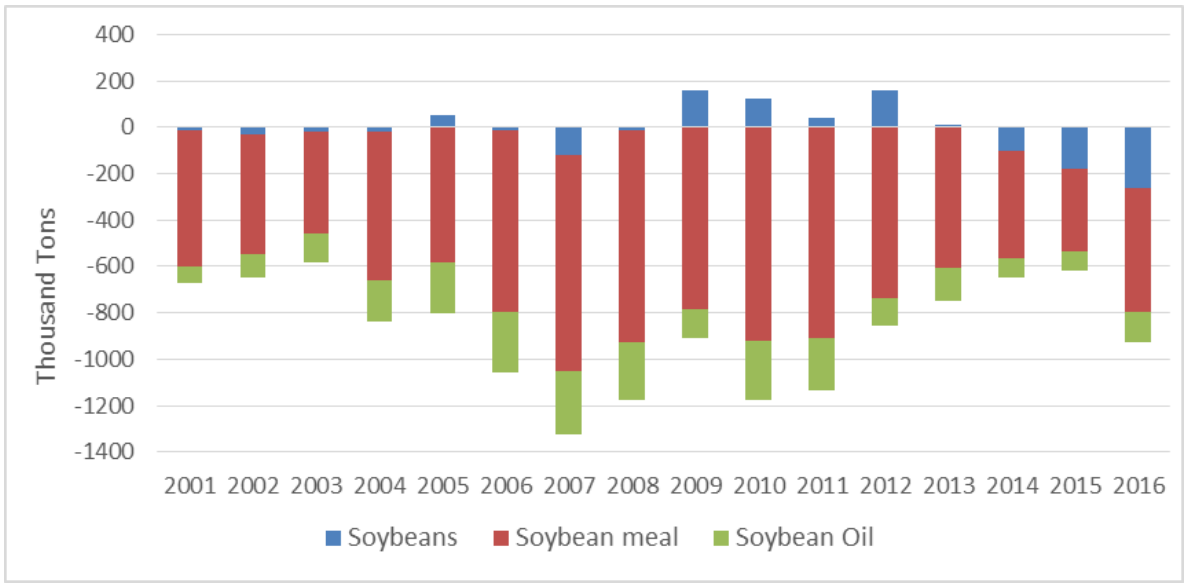


Source: South African Crop Estimates Committee.

The expansion in soybean production was well supported by economic considerations, such as the favourable soybean to maize price ratio, particularly in normal years when South Africa was a net exporter of maize. Despite the rapid expansion in area harvested,

soybean yields have also increased fairly steady since 2006, at an annual average of 1.4%. Combined with the area expansion, this resulted in a growth rate of more than 13% per year in soybean production between 2006 and 2017. The magnitude of the investment into crushing facilities was such however, that South African producers have still been unable to supply sufficient soybeans and even prior to the 2016 drought, and domestically produced beans were supplemented with imports in 2014 and 2015.

Figure 3. Net trade in soybeans and soybean products in South Africa



Source: ITC Trademap.

Despite the average annual expansion of 23% in soybean crush volumes over the past decade, South Africa remains a net importer of soybean products (Figure 3). This implies that further increases in crush volumes are possible, but the shortage of domestically produced soybeans is a constraining factor, as utilization rates of domestic crushing plants remain well below the industry benchmark of 80%. At lower utilization rates, the fixed cost component within total production costs increases and undermines profitability. Thus, it becomes a fine balancing act between increased utilization rates and the higher cost of imported beans. If utilization rates increase, coupled with improved plant efficiencies compared to global best in class standards, reduced fixed cost per tonne of produce should allow crushers to remain profitable even when soybean prices trade above export parity levels.

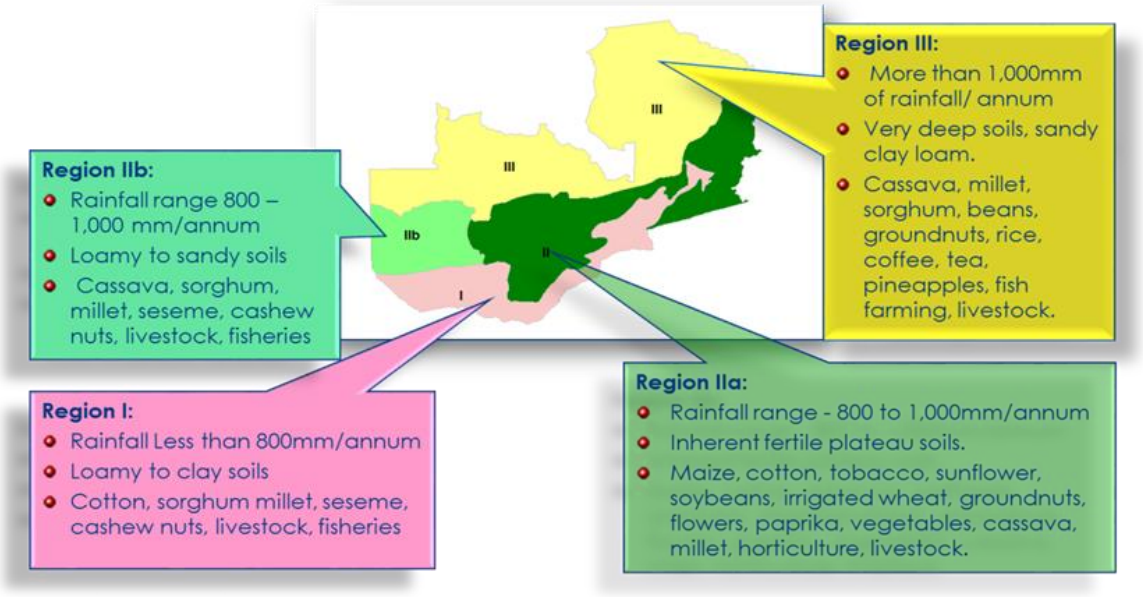
2.2 Soybeans in Zambia

Zambian soybean production has expanded rapidly over the past decade, responding to rising demand for vegetable oil and livestock feed. Soybean production has been attractive to some producers given that it can improve soil fertility when produced in rotation with maize and provides an opportunity to diversify income streams to reduce risk. The influence of government entities in the market is typically significantly less than in the maize market. Soybean production in Zambia remains dominated by larger commercial producers, who currently supply approximately 80% of national production, but an increasing number of small scale producers have also adopted the crop in recent years (Chisanga and Sitko, 2013).

Zambian agriculture is an important component of its economy, contributing 8.5% to GDP and 9.6% to national export earnings in 2015 (Chisanga and Chapoto, 2016). In a country where almost 60% of the population reside in rural areas in 2015, it also provides the main support for the rural economy and almost half of the population depends on agriculture for a livelihood. With over 750 thousand square kilometres of land, significant endowments of surface and subsurface water resources and a

population density of less than 20 people per square kilometre. As highlighted in Chisanga and Chapoto (2016), Zambia is uniquely placed to become a regional breadbasket to Southern and Central Africa given its three agro-ecological zones (Figure 4).

Figure 4. Rainfall, soil and crop suitability by agro-ecological region in Zambia



Source: Chisanga and Chapoto (2016).

Contrary to the maize sector, where small scale producers dominate, the Zambian soybean sector remains dominated by large scale, commercial producers, who account for approximately 80% of national production. In recent years however, small scale producers have also noted the benefits of soybean production and, supported by the Zambian National Farmers Union (ZNFU) and NGOs, produced a growing share of national production. Opperman and Varia (2011) indicate that most soybean consumption is in the form of oil or meal as feed, with only very limited direct human consumption of soybeans. Zambia produces soybeans free of genetically modified organism (GMO) technology, which sometimes allows it to command a premium in many export destinations. Once processed however, the premium is no longer attained for the processed products, something that it common to other countries in the region growing non-GMO soybeans.

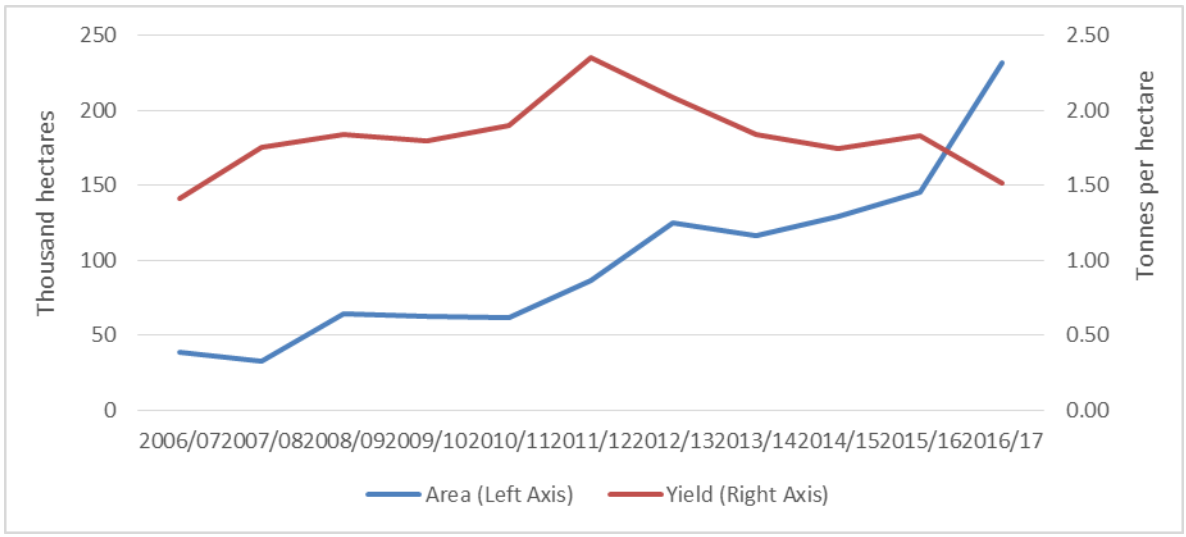
2.2.1 The Zambia soybean sector situation

Significant investment has occurred in the Zambian oilseed sector in recent years, expanding the total crushing capacity to an estimated 375 thousand tonnes (Chisanga and Sitko, 2013) from merely 125 thousand tonnes in 2010 (TechnoServe, 2011). Total oilseed crushing comprises soybean, cottonseed and sunflower and hence all capacity is not utilized for soybeans. Consequently, Zambia has exported significant quantities of raw soybeans in recent years, whilst remaining a net importer of vegetable oil. The bulk of edible oil imports used to be sourced within the Southern African Development Community (SADC), mainly South Africa, but Chisanga and Sitko (2013) note that palm oil imports from Asia are growing rapidly and that Asian imports have surpassed that of SADC origin in recent years. This is because palm oil imports are extremely price competitive compared to the local soybean oil.

The area cultivated with soybeans has expanded at a rate of almost 15% per year between 2006 and 2016. Most of the soybean grown by commercial producers before 2012 in Zambia was through irrigation. In more recent years however, the growing share of the national crop being produced by small-scale producers under dryland

conditions, combined with challenging weather conditions in 2015 and 2016, have resulted in marginally declining yield levels at national aggregate level (Figure 5). Nonetheless, the expansion in area has supported production growth from 55 thousand tonnes in 2007 to 350 thousand tonnes in 2017.

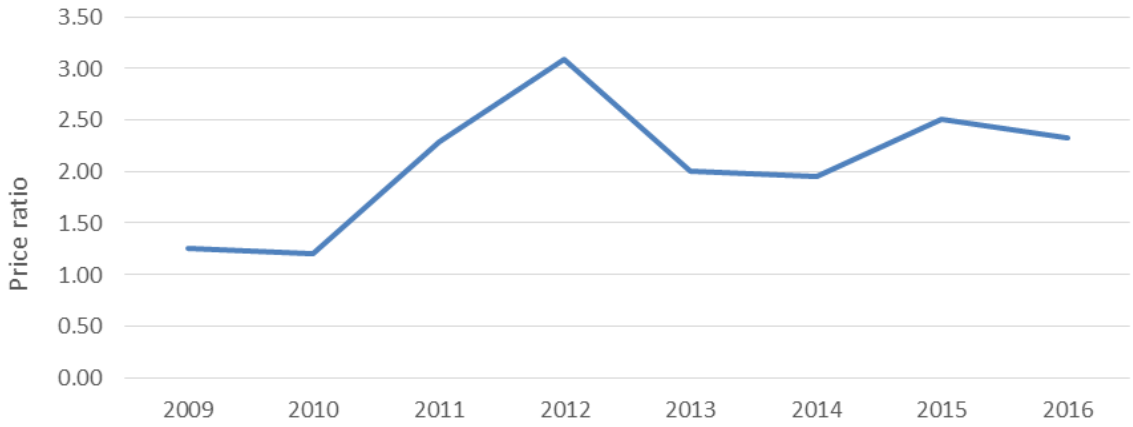
Figure 5. Soybean area and yield in Zambia



Source: Zambian Ministry of Agriculture and Livestock.

The continued expansion of soybean production has resulted from a combination of factors. Growing demand for the feed and particularly oil products have driven the expansion in crushing facilities and spurred production growth. Particularly on the commercial side, many farmers have shifted out of maize into soybean production as a result of market conditions, where high levels of government intervention in the market and the discretionary application of trade policies in particular have increased the risk associated with maize production (Chisanga and Sitko, 2013; Davids, Meyer and Westhoff, 2017). Zambia having become a consistent surplus producer of maize and this has caused maize prices to decline towards and sometimes below export parity levels and the soybean to maize price ratio has been favourable towards soybean production in recent years (Figure 6).

Figure 6. Soybean to maize price ratio in Zambia

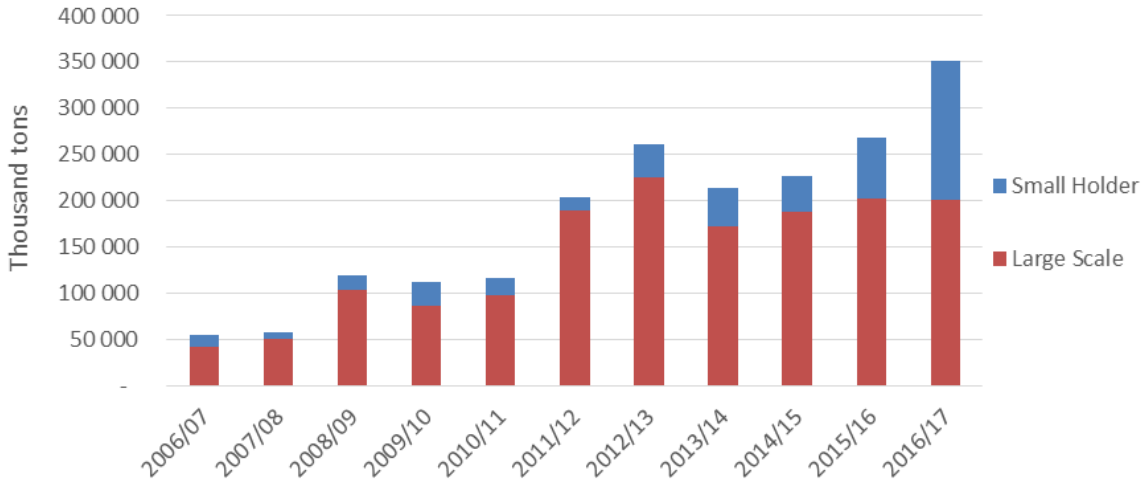


Source: ZNFU.

Large scale, commercial producers continue to constitute the bulk of soybean production in Zambia, although the past three years reflect a growing appeal to small-scale producers as well (Figure 7). Smaller producers have also responded to favourable economic prospects from soybeans. Soybean marketing is perceived to be advantageous

relative to maize, as producers receive cash on delivery as opposed to payments often delayed for maize when supplying to the Food Reserve Agency (FRA). The growing share of national production being produced by small-scale producers is also attributed to deliberate efforts from organizations such as the ZNFU and USAID funded programs to promote soybean production amongst small-scale producers (Chisanga and Sitko, 2013). The introduction of a credit scheme by the ZNFU in 2012/13 for instance resulted in a rising number of small-scale producers taking up soybean production – many of them for the first time. About 80 farmers were recipients of the scheme in the Serenje District.

Figure 7. Soybean production by small and large-scale producers in Zambia



Source: Ministry of Agriculture and Food Security.

Despite the recent expansion in crushing facilities, Zambia continues to export surplus soybeans while importing significant quantities of soybean oil (Figure 8). Further expansion of crushing is therefore a possibility, but although the livestock industry has expanded rapidly as well there is still surplus soybean meal. Presently, the bulk of soybean meal exports are destined to South Africa. Furthermore, poultry production is expanding and intensifying, with potential implications in the coming years.

Figure 8. Net trade in soybeans and soybean products in Zambia

Source: ITC Trademap.

2.3 Soybeans in Malawi

Soybean production has increased over the last decade in Malawi. This increase has been attributed to the growing demand for soybeans as a food and feed crop as well as current policy inclinations that promoted special crops such as soybeans to address declining soil fertility, malnutrition and poverty. Malawi is one of the poorest countries in Africa. According World Development Indicators (World Bank, 2017), more than 83% of Malawian live in the rural areas and over half of the population is reported below poverty (US$3.20 a day).

Frequent flooding, droughts and other weather-related shocks over the last decade have negatively impacted the agricultural sector which employs over 80% of the labour force and contributes at least 30% to the GDP (World Bank, 2017). Tea, sugar, coffee, tobacco, and maize comprise the main cash crops grown primarily for exports. Malawi has 3.8 million hectares of arable land and is densely populated. Agriculture production is constrained by population density and lack of access to fertilizers, improved seed, credit and markets. The population density estimates show that there are approximately 180 people per square kilometre. This is almost 19 times more compared to the neighbouring Mozambique which has approximately 34 people per square kilometre. FAO (2017) estimates total land size for Malawi at 95.776 square kilometres and Mozambique at 801,590 square kilometres.

Contrary to the rest of the Eastern and Southern Africa region where commercial farmers dominate soybean production, smallholder farmers in Malawi account for 95% of the soybean produced in the country (Opperman and Varia, 2011). These soybeans are non-GMO and can command a premium price in some export markets. Studies on Malawi's soybean production attribute this development to the various NGO supported efforts and the government led Farm Input Subsidy Program (FISP) which provides farmers access to fertilizers and credit (Opperman and Varia, 2011; Walker and Cunguara, 2016).

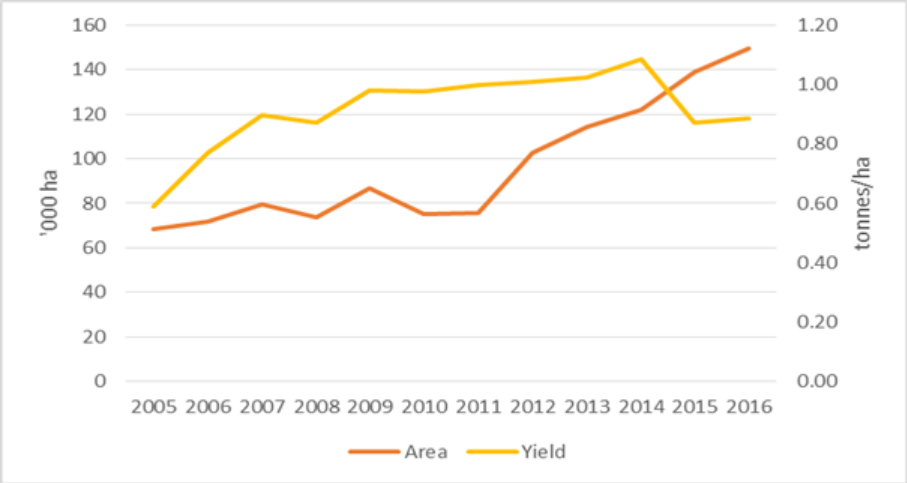
2.3.1 The Malawi soybean sector situation

The soybean sector has seen significant development in recent years with a rapid expansion of crushing capacity. Although the capacity for the country as a whole was estimated at around 400 thousand tonnes, only about 60 thousand tonnes was crushed in 2016. A time series of crushing volume data is not available, although industry estimates suggest there is a likelihood that the increased availability of soybeans from the post-drought harvest will correspond with higher crush levels in the near future.

The area under soybean production has doubled over the last five years. Similarly, yields grew steadily until 2015 and 2016 where drought in the region reduced yields dramatically (for soybeans and other crops as well). As a result of higher area and yields production of soybeans in Malawi grew by 100 thousand tonnes or nearly 300% between 2004 and 2014. Figure 9 shows a slow growth in the amount of land allocated to soybeans up until 2011 followed by a sharp increase of approximately 15 thousand hectares per year between 2011 and 2016.

This sharp increase is attributed to cash crop switching and policy. The cash crop switching is seen as some of the tobacco producers switched over to soybeans which are considered less labour intensive and have higher returns compared to tobacco. The Figure 9 below illustrates both the area and yield growth for soybeans over the last decade.

Figure 9. Soybean area and yield in Malawi



Source: FAOSTAT.

Soybean production in Malawi is constrained by various economic and political factors. The current market structure is limited. Hence access to infrastructure for storing soybeans, credit, and other farm inputs is limited. Because of the issues with infrastructure most of the soybeans are purchased in the open market. To improve the supply and quality of these beans, some of the soybean crushers are attempting to contract with producers. Although soybean meal produced in Malawi is non-GMO sourced, it does not fetch a premium price (like the beans). Instead, it competes directly with meal from the southern African region and the world market.

Although Malawi is part of the SADC, which theoretically shares a free trade policy in soybean, Opperman and Varia (2011) note that Malawi along with Zambia often sets administrative restrictions on soybean exports. This not only limits production and the national export potential but also allows the government to influence domestic prices.

Since 2008 Malawi has been a net exporter of soybeans, with the beans achieving a premium price above those sourced from the world market given their GMO free status. The Malawi Oilseeds Sector Transformation (MOST) estimated that Malawi produced at least 5% of Africa's soybeans despite the recent decline in production. The level of net exports has fluctuated with production, at 2,279 tonnes in 2012 and 22,133 in 2014. The drought between 2015 and 2016 has further exacerbated the situation.

Although a recovery of the sector is likely in 2017, this leaves a significant volume of soybeans that are consumed directly as food (although the data presented here needs to be treated with caution). Much of this is milled and consumed in schools as part of a nutritional program, estimated at 26 thousand tonnes for 2016.

Most vegetable oil consumed in Malawi is imported, but the expansion of soybean crush has meant that net imports of oil are on a downward trend. Domestic vegetable oil has in the past been viewed as inferior to imported oil but recently attempts have been made to improve the quality that should close the price gap.

The soybean sector has up until now been meal driven, with growth in meat production, especially poultry driving demand for feed. Soybean meal is exported to neighbouring countries (such as Tanzania and Mozambique) for use in their poultry industry. It presents critical potential for enhancing household food and nutrition security, and raising rural incomes.

2.4 Soybeans in Mozambique

Although history shows soybeans were first cultivated in Mozambique in 1915, the expansion of soybean as a cash crop began in the 1980's (Shurtleff and Aoyagi 2009;Di Matteo, Otsuki and Schoneveld, 2016). Currently, soybean production is mainly driven by demand from the poultry industry (USAID/SPEED, 2011). Soybean is mainly produced by large farms, together with sugar cane, tea, banana, tobacco and rice (Walker and Cunguara, 2016).

The role of agriculture in the economy is incontestable, since it employs about 80% of the population. According to CGAP (2016) 40% of the Gross National Product (GNP) and 60% of export revenues comes from the sector. The country has reached high economic growth over the last decade, averaging 7.5% annually between 2000 and 2015. This makes the country one of the highest nonpetroleum growth performers in Sub-Saharan Africa (SSA) (Deloitte, 2016).

While the growth of the soybean sector is remarkable, the potential for agricultural led growth in Mozambique is far from being concretised, with a sector dominated by small-scale and subsistence sector. Country statistics suggest that only 10% of total arable land (36 million hectares) is under cultivation, with small-scale farmers accounting to nearly 90% of total domestic food supply, (FAO, 2007; CGAP, 2016). Despite a significant contribution, small scale farmers in Mozambique face low yield returns and have limited access to agricultural mechanization (CGAP, 2016).

2.4.1 The Mozambique soybean sector situation

Recently produced in Mozambique, soybean has become a key crop for thousands of farmers. This highlights how the introduction of a new crop can be promoted by small and medium commercial farmers (Smart and Hanlon, 2014).

The country's regions have distinct roles over the soybean value chain. Whilst the Northern and Central regions are soybean production regions, the South is mostly a consumption region. This, in part, is mainly due to unfavourable agro-ecological conditions to grow soybean in the South of Mozambique.

Large commercial farms, those cultivating more than 50 hectares, account for about 16% of total soybean acreage, and cultivate about 14,085 hectares. This production system is capital intensive and consists of farmers usually managing around one thousand ha of land. About 5% of soybean area is logged for emerging commercial farmers who operate on a medium scale (20–50 ha), and rely on the use of mechanized agriculture and commercial inputs such as seed and soil inoculants. Both, large and medium-scale farmers are responsible for approximately 50% of Mozambique's soybean production, which according to data provided by the Ministry of Agriculture and Food Security, is slightly above 17,714 tonnes. The other 50% of soybean production is attributed to small-scale commercial farmers who operate in the he remaining area under production (USAID, 2011). Small-scale commercial farmers manage no more than four hectares of soybeans in average (Pereira, 2015).

Among other factors, soybean production is constrained by non-availability of improved varieties adapted to various production systems, lack of resistant varieties to foliar diseases, lack of organized seed production and delivery systems, poor seed viability from one season to the next, lack of drought tolerant varieties and weak market linkage among stakeholders in the soybean value chain (ICRISAT, 2013). The crop yield is highly dependent on climatic factors such as temperature and precipitation, therefore, extreme climatic events, may affect the profitability of the soybean sector in the future (Talacuece et al., 2016). Interventions in the soybeans sector in Mozambique have contributed to the reduction of the yield gap, however, observed yields are still well below soybean yield potential in the region (NAMC, 2011).

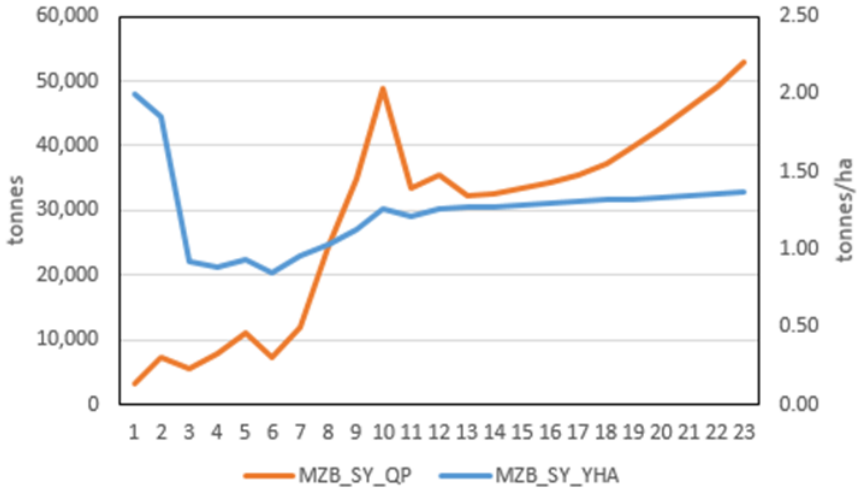
On average, soybean production in Mozambique is between 30 and 40 thousand tonnes per year with an average yield of 1.2 tonnes per hectare. From 2008/09 a group of

NGOS have promoted the expansion of soybean production to supply the poultry industry as a substitution of imported soybean meal. From that, soybean production has tripled, growing from 11 thousand tonnes in 2008 to about 35 thousand tonnes in 2016.

As shown in Figure 10, the production of soybeans in Mozambique has experienced rapid growth. This growth was driven, on one hand, by the growth of the poultry industry, which has triggered a greater demand for soybeans and, on the other, by the systematic assistance provided by several international organizations to promote this crop among small scale and emerging farmers. Year 2014, was the only year were the local soybean production was slightly above the local consumption, a similar situation is only expected for the two last years of the projected period, 2026 and 2027. Therefore, it is expected production volumes, will continue to be less than consumption.

It should also be noted that there has been a 32% decline in production in 2015 from about 49 to 33 thousand tonnes, attributed to the heavy rains that have affected the harvest on that particular year. Over the projected period production is expected to increase steadily up to 53 thousand tonnes, however the country will still relay o imports to satisfy the domestic demand for human as well as animal consumption.

Figure 10. Soybean production and yield in Mozambique



Source: Ministry of Agriculture and Food Security.

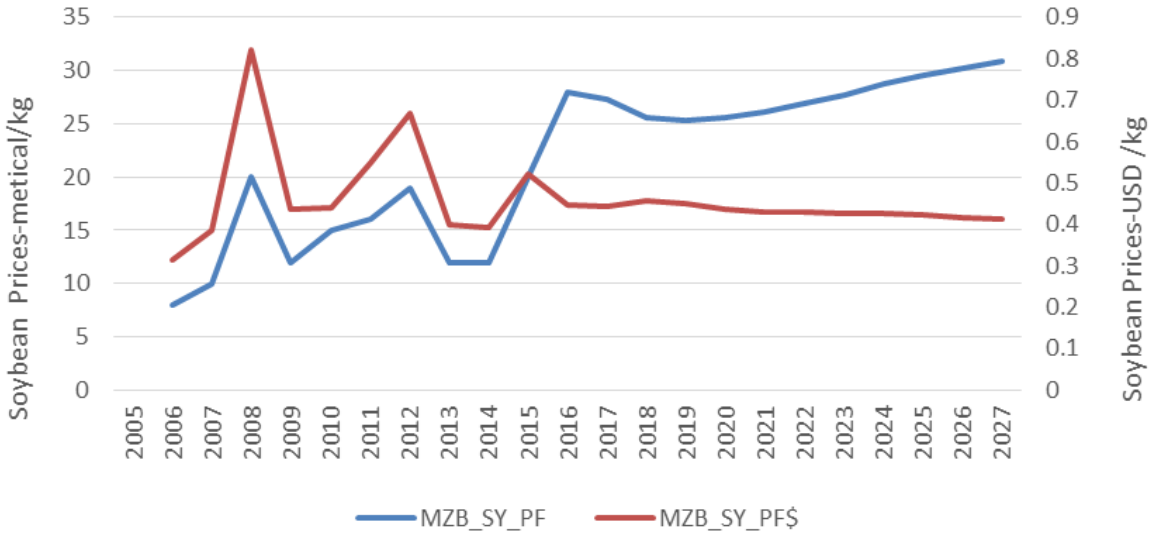
The country currently meets its demand for soybeans in the North and Centre regions with some surplus, however there is a large deficit in the South that is satisfied by imports from South Africa, Argentina, India and Malawi (NAMC, 2011). Domestic market for animal feed is the main market for soybean. Manica province is reported to be responsible for about 30% of feed demand in the country (USAID, 2011).

Demand for soybean meal is surpassing soybean production growth. Indeed, the country's growing poultry industry needs soybean meal for its use in poultry feed almost 30% of raw feed material (USAID, 2011). The poultry sector has increased in recent years, and is spurring production and import of soybeans and soybean meal for feed production. The soybean meal market has been driven by the growth of the poultry industry, which drives demand for poultry feed. This is expected to continue, with the rise in soybean meal market (NAMC, 2011).

Figure 11 indicates that over the past decade, Mozambican soybean prices have shown large fluctuations. At the end of 2008, donor funded programs were introduced in Manica and Tete provinces to support private initiatives in the agricultural sector, to leverage the actors in the promising agricultural value chains and to support commercial production of some agriculture commodities such as soybeans. The programs introduced a line of funding to support small scale farmers, by removing constraints on access to inputs, production, marketing and consumption. Within the same year a significant rise

in soybeans demand was observed, with the farm gate prices reaching about 20 meticals per kilogram in some parts of the country.

Figure 11. Soybean prices in Mozambique



Source: SDAE Zambézia.

The price increase was the driving force for adoption of soybean production by small-scale producers, resulting in an increase in soybean production. However, in 2009, market related programs emerged, which contributed to reduce soybean prices by about 40% (Noticias, 2015). This decline was followed by a sharp increase, up to a peak of 19 meticals per kilogram by 2012. On the following two year prices steady declined before reaching a peak of 28 meticals per kilogram in 2016.

In Mozambique, soybean production among small scale producers has been influenced mainly by NGO programs rather than government-sponsored programs (Mubichi, 2017). Notwithstanding, the Mozambican government has given some incentives and tax benefits to the agricultural sector in order to turn it more profitable and address food security concerns. Examples of these incentives and benefits include an exemption of Value Added Tax (VAT) on the internal transmission of goods and services in the agricultural sector, including inputs. In addition, imports of raw materials required for animal feed production, including soybeans and soybean meals, were VAT exempt (USAID/SPEED, 2012). Additionally, in order to encourage commercial farming, the government has simplified the process of registering land for commercial production (Opperman and Varia, 2011). Finally it applied a VAT exemption for fertilizer companies, leaving only an import tariff rate of 2.5% (World Bank, 2012).

To foster the soybean sector in Mozambique the government has created a subprogram to support the soybean value chain under the 2013-2017 national investment plan of the agricultural sector (PNISA). This subprogram aimed to increase both productivity and production. The priority actions defined in the soybean subprogram included (i) provision of credit, trough financial institutions; (ii) enabling access to inputs and technologies such as improved seed, fertilizer, pesticides and inoculants using pre-defined technological packages; (iii) extension services and enabling conditions for agro-processing; and (iv) enabling environment for soybean commercialization and improvement of storage conditions (Government of the Republic of Mozambique, 2013).

Mozambique is well placed to export its soybeans from the North and Center to neighbouring Malawi, Tanzania and Zimbabwe, while continuing to import soybean meal from South Africa and other international markets for demand in the South. However despite the increase in the production of soybean during the last decade, the volume of exports of soybean continues to be insignificant, and the country remains net importer.

3 Integrating soybeans into the modelling framework

The ReNAPRI regional modelling system comprises of a set of individual partial equilibrium models of the agricultural sector. These models are similar in that they are formed of a system of equations for the agricultural sectors of the countries concerned. The models are designed to incorporate the main economic, biological and policy relationships within the markets. As such, the detail of the models will vary between countries. Data availability is a main constraint on the models, and limits both the scope of the models and the calibration. Where sufficient data is available the models have been estimated econometrically, but in many cases parameters come from literature and expert judgement.

The models generally take as exogenous macroeconomic projections, world prices, and policy assumptions. Macroeconomic data comes from the International Monetary Fund (IMF) and other sources including those from within the countries concerned. World prices can be sourced from one of the global modelling systems that produce ten year projections, such as those from the Food and Agriculture Policy Research Institute (FAPRI), or Organisation for Economic Co-operation and Development (OECD) and Food and Agriculture Organization of the United Nations (FAO). Policy assumptions come from the analysts in the countries concerned.

In general the models started with the maize sector, given its importance in this region as a staple crop and a target of policy. The models have expanded over time to include additional commodities and broaden the policy proposals that can be considered. For instance, wheat and sugar were added for some Eastern and Southern African countries as part of a former European Commission supported effort (Meyer et al., 2016).

ReNAPRI has member institutes in nine different countries in Eastern and Southern Africa. For the purposes of this work only four of those partners were involved, for the countries where the soybean sector is significant. The models that are presented here can be used as a starting point for other countries where the soybean sector is emerging.

As soybean sectors have developed in a short period of time data is an issue for the construction of economic models. In particular crushing levels are usually not publically available and can hold private information. Nonetheless some levels have been assumed here. Given the paucity of data it is not possible to econometrically estimate these models, and instead models are mostly calibrated using parameters taken from theory, literature, analyst judgement, and the input of industry experts.

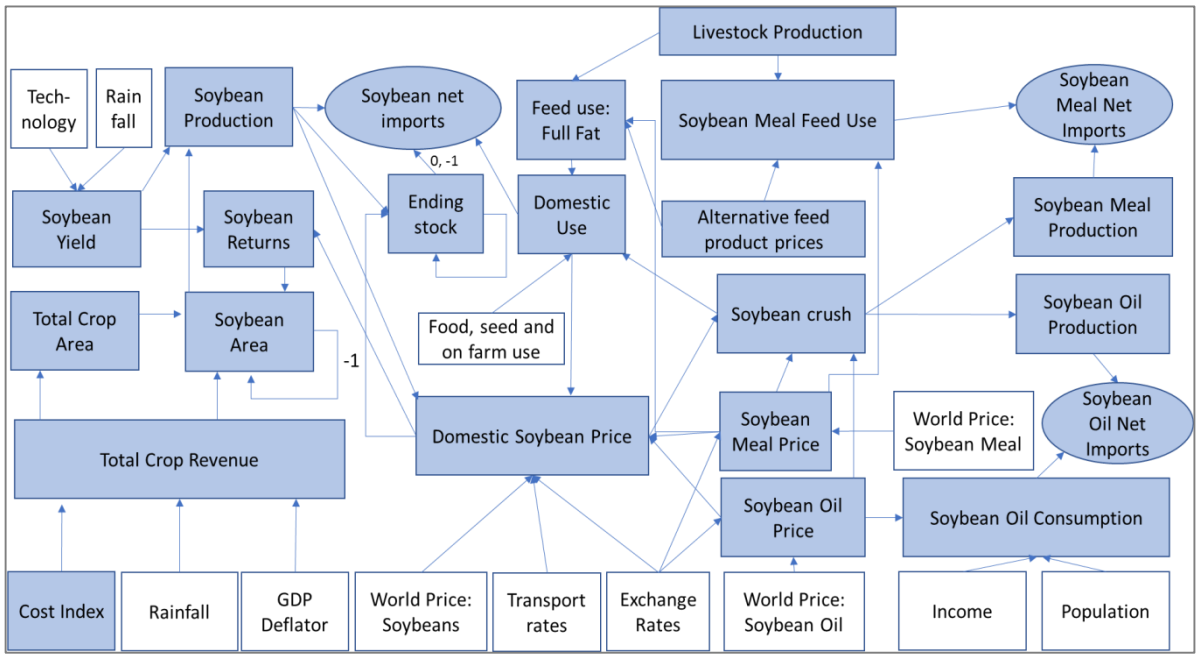
3.1 The South Africa model

South Africa is by far the largest African country in terms of soybean production (Figure 16). It has a large commercial sector that is relatively well developed. Soybeans compete with other crops for area on a commercial basis with minimal policy interference.

3.1.1 Modelling the sector in South Africa

A flow diagram of the South Africa soybean model is shown in Figure 12. It illustrates the modification of the model undertaken to provide a tool capable of capturing the particular circumstances of South Africa. The soybean sector model is split into three parts; soybeans, soybean oil and soybean meal that are linked through crushing and the crushing margin. There are three separate balances. In Figure 12, market clearing equations are indicated by a circle, blue fill represents endogenous variables, whilst white fill represents exogenous variables within the South African context.

Figure 12. Flow diagram of the South Africa's soybean model



Source: Own elaboration.

Area is determined by the returns to the sector, along with those for sunflower, sorghum and importantly maize, the largest user of land amongst the different summer crops. Within the summer rainfall area allocation system, the total area equation is driven by total gross returns from the modelled crops, rainfall during key planting months and a production cost index, before relative returns for the different crops drive the area share allocation system. Yields are estimated using a trend yield that is based on the historical growth in yields, rainfall during key months through the crop development period and returns to the sector. A positive increase in returns has a small but positive impact on yields.

The South African soybean price is derived in the model from a combination of the import parity of soybeans from the global market, a domestic production to consumption ratio as measure of surplus or deficit in the local market and the returns from soybean products, both meal and oil. The world prices are taken from the FAPRI global outlook and are exogenous to the South African market. Prices for soybean meal and soybean oil are both modelled as price linkage equations from the global market.

In South Africa, the available data allows for the compilation of a detailed balance sheet, including use as direct human consumption, full fat soybean in the animal feed market

and crush volumes. Having accounted for production, trade and ending stocks, seed and on-farm use is derived as a balancing figure. Within the modelling system, soybean crush capacity is modelled as a function of lagged crush capacity and the real returns from soybean products based on an extraction of 74% meal and 17.5% oil. Capacity utilization is then modelled separately as a function of the real crushing margin. The demand for full fat soybean in the animal feed market is derived from the livestock production system and the relative inclusion rates of full fat soybean in typical rations of different livestock species. Given the small share in total soybean consumption, food use, as well as seed and on farm use is retained exogenously at historic levels.

Ending stocks are modelled as a function of beginning stocks, production and real soybean prices, with net imports derived as a market clearing identity to close the system. Trade data has also been sourced for soybean products, though the rest of the product balance sheets are harder to come by and hence derived. The production of soybean meal and soybean oil is derived from the crush volumes, based on a yield of 74% for meal and 17.5% for oil. It is then assumed that the production plus net imports is available for use. In this case the only use that is assumed is human consumption in the form of soybean oil, and animal feed in the case of soybean meal. Feed use of soybean meal is derived from the livestock production system, based on inclusion rates in typical feed rations. Human consumption in turn is modelled from income, price and population projections. Net imports clear the market for both soybean meal and soybean oil.

The dynamic nature of the sector in recent years means that it is not possible to completely parameterize the system through an econometric approach. Some simple regression analysis was undertaken (using ordinary least squares), but this is supplemented by analyst judgement based on economic theory and the feedback of experts in the determination of behavioural parameters for use in the calibration process.

3.1.2 Interaction with the rest of the ReNAPRI system

In order to generate the outlook the South African soybean model is simulated at the same time as the rest of the ReNAPRI regional modeling system. This allows developments in other parts of the agriculture of the region to feed into the soybean model.

Presently, within the South African country module soybean area is determined through an area share allocation system and is therefore influenced by the relative profitability of maize, sunflower and sorghum. In addition, soybean crush and feed use is influenced by a livestock production system.

Interactions take place through price transmission as well. Indeed soybean and soybean product prices in the South African model are influenced by the world prices that are generated in the FAPRI global modelling system. They are the main determinants of prices in Zambia, Malawi and Mozambique.

3.2 The Zambia model

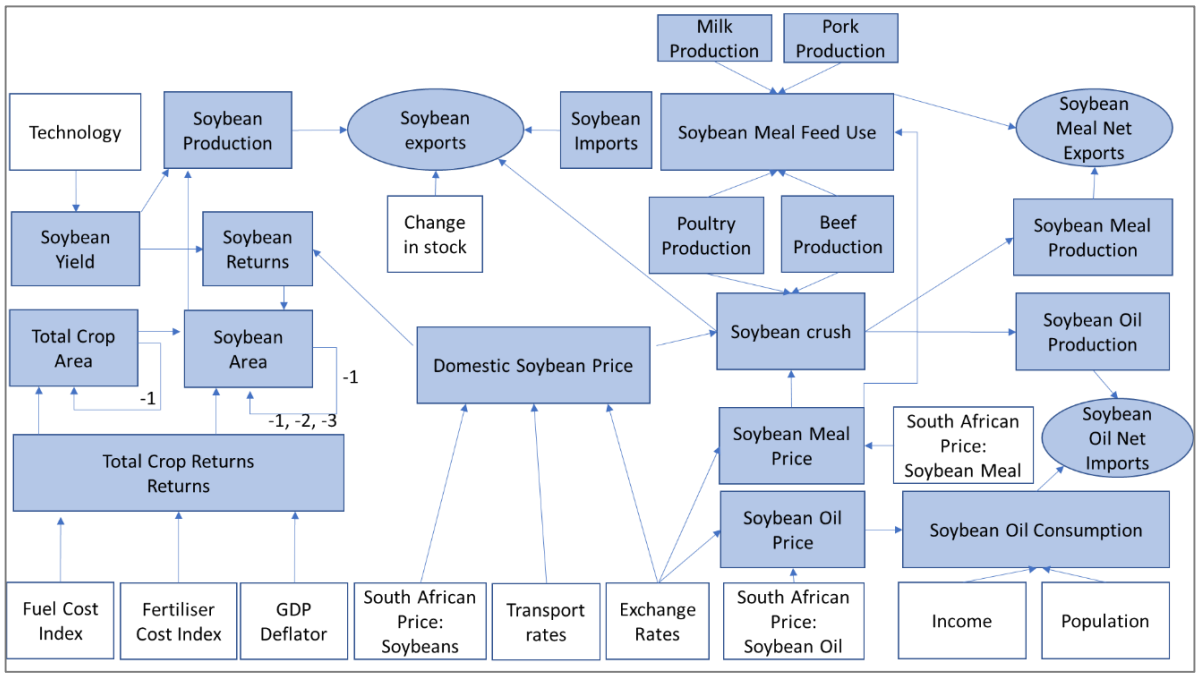
The other countries in this study differ from the South African model in a number of important ways. The sector is usually not as evolved as in South Africa. A greater proportion of production comes from small scale producers. South African markets are more closely linked to global markets. These features are reflected in the structure of the different models.

3.2.1 Modelling the sector in Zambia

A flow diagram of the Zambian soybean model is shown in Figure 13. It illustrates the modification of the model undertaken to provide a tool capable of capturing the particular circumstances of Zambia. The soybean sector model is split into three parts; soybeans, soybean oil and soybean meal that are linked through crushing and the crushing margin. There are three separate balances. In Figure 13, market clearing

equations are indicated by a circle, blue fill represents endogenous variables, whilst white fill represents exogenous variables within the Zambian context.

Figure 13. Flow diagram of the Zambia's soybean model



Source: Own elaboration.

Area is determined by the returns to the sector, along with those for wheat and importantly maize, the largest user of land. Within the area allocation system, total returns from the modelled crops drive the total area equation, before relative returns for the different crops drive the area share allocation system. Yields are estimated using a trend yield that is based on the historical growth in yields, and returns to the sector. A positive increase in returns has a small but positive impact on yields. Significant differences in yield levels are evident for large scale, commercial producers cultivating soybean under irrigation and small-scale producers under dryland conditions. In the present system they are not modelled separately, but this could represent useful further refinements. As small-scale farming practices improve, yield growth for this segment of production has scope to improve as well.

The Zambian soybean price is determined in the model using a price linkage equation by the South African soybean price. The South African prices are available from the ReNAPRI modelling system. Being the biggest trader in the region, South Africa exerts significant price influence. South African prices in turn are determined by a combination of international soybean prices and South African soybean product prices. Prices for soybean meal are available from 2012, but soybean oil prices are not available historically. Thus earlier meal prices and all oil prices are simply the South African prices converted into Kwacha in the current version of the model.

Soybean crush data is not available, but a rough estimate is used in the model, to be replaced if better data can be sourced. Data for soybeans consumed as food is also not available, but based on Opperman and Varia (2011), this comprises a very small share of consumption. Crush is estimated using the size of the poultry and beef sectors, which are major users of meal, and the real crush margin. The major driver of the future evolution of crush is therefore at present driven by livestock output, which is expected to continue to grow as a result of increasing population and incomes in Zambia. In the projections crush exceeds current crushing capacity, which has recently been expanded and is expected to expand further as the sector continues to grow.

Imports are negligible in the current soybean balance sheet, but are estimated as a function of a domestic production to consumption ration and an international price to domestic price ratio. The model closes on exports, which balances the market. In the historical data, Zambia has remained a net exporter of soybeans for most years since 2006.

It has been possible to source trade data for the soybean products, but it is harder to find the other part of these balance sheets, so these are just derived. From the crush number (remember this is only a rough estimate), and given assumptions on crushing coefficients, the production of meal and oil can be interpolated. It is then assumed that the production plus net imports is available for use. In this case the only use that is assumed is human consumption in the form of soybean oil, and animal feed in the case of soybean meal. Feed use is derived from the livestock production system, and human consumption from income, price and population projections. If data becomes available this would be an area where more careful estimation would be appropriate.

The lack of data and the significant changes in the sector in recent years means that it is not possible to completely parameterize the system through an econometric approach. Some simple regression analysis was undertaken (using ordinary least squares), but this is supplemented by analyst judgement based on economic theory and the feedback of experts in the determination of behavioural parameters for use in the calibration process.

3.2.2 Interaction with the rest of the ReNAPRI system

The Zambian soybean model is simulated at the same time as the rest of the ReNAPRI regional modelling system. This allows developments in other parts of the agriculture of the region to feed into the soybean model.

Presently, interactions include soybean area determined through an area share allocation system, relative profitability of maize and wheat, soybean crush and feed use (as influenced by a simple livestock production system).

Interactions take place through price transmission, i.e. soybean product prices in the South African model (main determinants of prices in Zambia) and world prices that are generated in the FAPRI global modelling system.

As the ReNAPRI model becomes more complex the interactions will become more extensive. For example, more commodities could influence the evolution of soybean area and production in Zambia. The sector's development is highly linked to the livestock sectors in the country, and in future these livestock components in the model will need to be refined. Trade in soybean meal is important for Zambia and a more comprehensive framework of regional livestock production would be useful in the determination of the industry there.

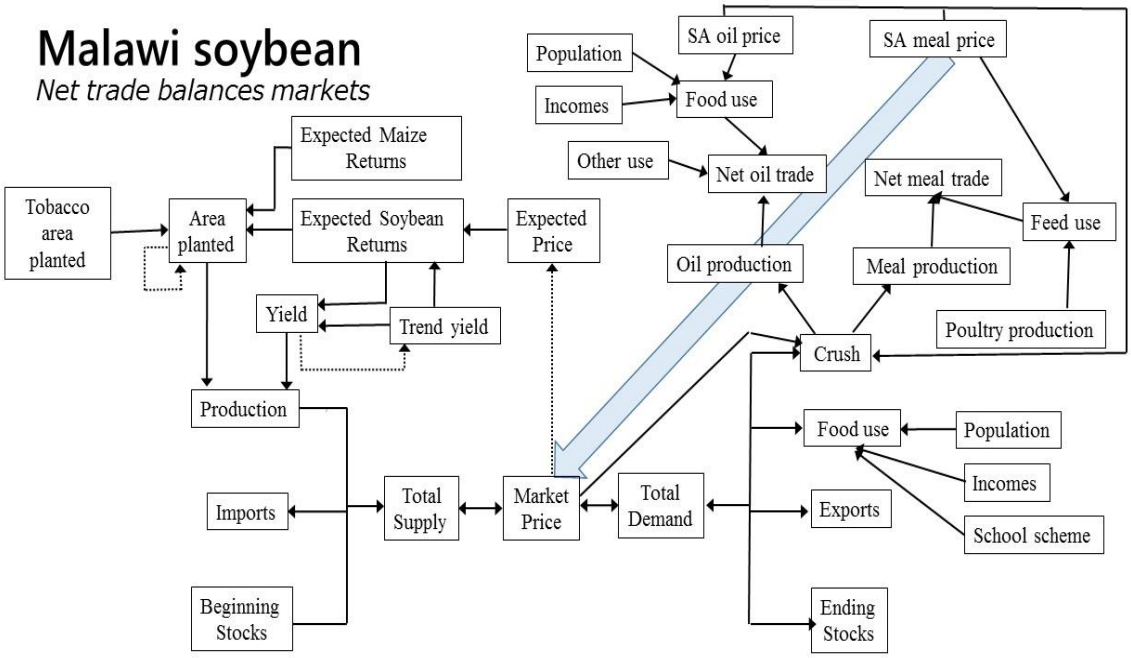
3.3 The Malawi model

For the countries other than South Africa, the determination of the influences on the expansion of soybean area can be hard to disentangle. There are commercial drivers in the form of the relative profitability of the crop, but there are also policies in the countries, and the actions of NGOs that can influence the industry. A good example of a challenge to the modelling of the sector is the interaction between the soybean sector and tobacco in Malawi. It is clear that a decline in tobacco area has occurred at the same time as an increase in soybean area, but quantifying this impact is difficult.

3.3.1 Modelling the sector in Malawi[1]

A flow diagram of the Malawi soybean model is shown in Figure 14. It illustrates the modification of the model undertaken to provide a tool capable of capturing the particular circumstances of Malawi. The soybean sector model is split into three parts; soybean seed, soybean oil and soybean meal that are linked through crushing and the crushing margin. There are three separate balances.

Figure 14. Flow diagram of the Malawi's soybean model



Source: Own elaboration.

Area is determined by the returns to the sector, along with those for maize, the largest user of land. The interaction between soybean area and tobacco was identified as an important driver for the sector, reinforced with discussions from industry experts. At present there is no tobacco model as part of the ReNAPRI system, and this could be an area for future work. Soybean area has replaced tobacco area as opportunities for marketing soybeans have arisen, given the lower labour intensity of soybean production and low prices for tobacco. Tobacco area is incorporated directly into the system through the area equation.

Yields are estimated using a trend yield that is based on the historical growth in yields, and returns to the sector. A positive increase in returns has a small but positive impact on yields. Yields are relatively low in Malawi, and there is scope for significant increase. As part of their contractual arrangement some processors are attempting to increase the productivity of their farmers through better practices.

The Malawi soybean price is determined in the model using a price linkage equation by the South African oilseed product prices, in particular the meal price. The South African prices are available from the ReNAPRI modelling system, and although it is not the most important country that Malawi trades with, South Africa is a major trader in the region. Prices for the oilseed products are not available and are simply the South African prices converted into Kwacha in the current version of the model. Given the fact that these products are highly traded this may not be an unreasonable assumption. It would be

[1] The model was greatly improved through the comments of a team of industry experts assembled as part of the innovation Lab for Food Security Policy week long course in Partial Equilibrium Modelling in Lilongwe, Malawi.

preferable to have a matrix of prices, however, in order to capture things like quality differences and the different relative profitability of different markets.

Soybean crush data is not available but a rough estimate is used in the model, to be replaced if better data can be sourced. Crush estimates are driven partially using the size of the poultry sector, which is a major user of meal, and the real crush margin. The major driver of the future evolution of crush is therefore at present driven by poultry output, which is expected to continue to grow as a result of increasing population and incomes in Malawi. In the projections crush remains below estimated current crushing capacity.

Soybean food and other use is derived historically as the balancing term in supply and use. It appears to have grown steadily over time, in part due to the government scheme that provides milled soybeans to schools to improve nutrition. Future consumption depends on population (the elasticity of consumption with respect to population is equal to one) and on the real soybean price.

The model closes on net trade, which balances the market. In the historical data, Malawi has always been a net exporter of soybeans, which expanded rapidly with the sector in 2013 and 2014 but the droughts in 2015 and 2016 reduced the surplus. It is expected that under more normal weather conditions Malawi will return to being a significant net exporter to the region.

It has been possible to source trade data for the soybean products, but it is harder to find the other part of these balance sheets, so these are just derived. From the crush number (remember this is only a rough estimate), and given assumptions on crushing coefficients, the production of meal and oil can be interpolated. It is then assumed that the production plus net imports is available for use. In this case the only use that is assumed is human consumption in the form of soybean oil, and animal feed in the case of soybean meal. Feed use is assumed to change in line with poultry consumption, and human consumption with population changes. If data becomes available this would be an area where more careful estimation would be appropriate.

3.3.2 Interaction with the rest of the ReNAPRI system

In order to generate the outlook the Malawi soybean model is simulated at the same time as the rest of the ReNAPRI regional modeling system. This allows developments in other parts of the agriculture of the region to feed into the soybean model.

Presently, within Malawi, soybean area is partly determined by returns in the maize sector. Soybean product prices in South African model are influenced by the world prices that are generated in the FAPRI global modelling system. They are the main determinants of prices in Malawi

As the ReNAPRI model becomes more complex the interactions will become more extensive. For example more commodities could influence the evolution of soybean area and production in Malawi. The sector's development is highly linked to the livestock sectors in the country, and in future when these models are developed the link will be important. Trade in soybean meal is important for Malawi and a more comprehensive framework of regional livestock production would be useful in the determination of the industry there.

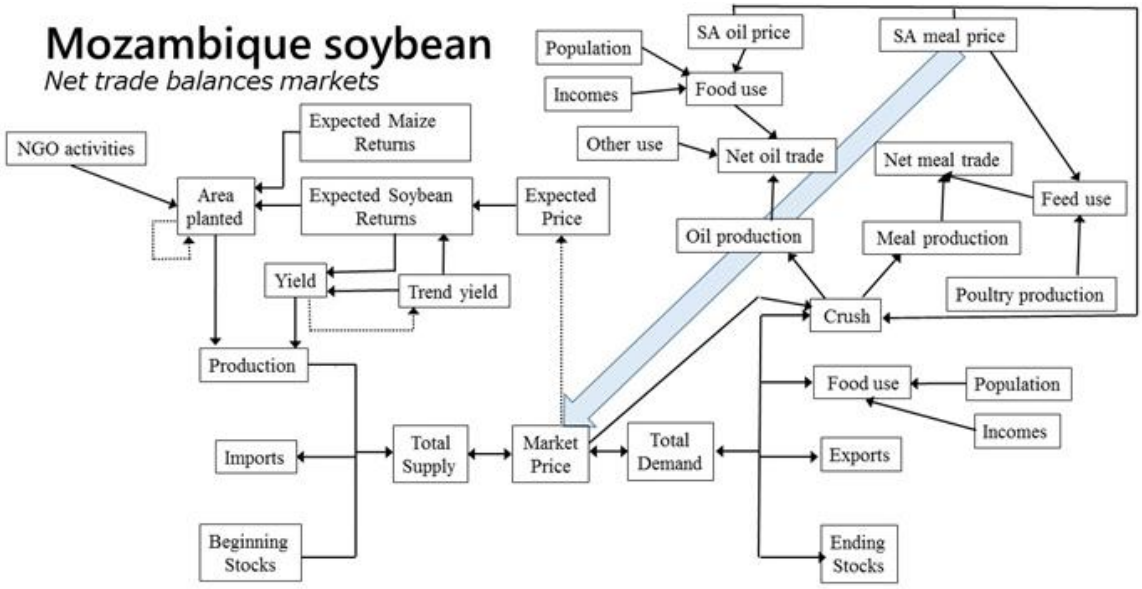
3.4 The Mozambique model

The structure of the Mozambique model is similar to that of the Malawi model. All the models that are presented here are just the starting point for the modelling process that is ongoing and evolving. Over time the specification of the models for the countries will converge. This can be a challenge for the modeller who must balance the need for the model to reflect the characteristics that are particular to that country with the requirement that the underlying theoretical structure of the models be consistent.

3.4.1 Modelling the soybean sector in Mozambique

The structure of the Mozambique model (Figure 15) is comparable to that of Malawi. Area is determined by soybean returns. Maize returns are also included in the area decision equation, but the competition for this land is small and that is reflected in the elasticity for that variable. Outside of South Africa, maize and soybean areas do not exhibit the level of competition for land that is common in the USA or Brazil given the nature of farming. Many smallholder farmers produce for their own consumption and will plant maize regardless of the level of prices of soybeans and maize, and in fact may not participate in markets to a great extent.

Figure 15. Flow diagram of the Mozambique's soybean model



Source: Own elaboration.

South Africa prices drive the sector in Mozambique, although the pass through of South African prices to domestic markets is small. Area planted is driven primarily by returns to soybeans (itself based on the price and trend yields). The impact of NGO activities is currently incorporated in the model as part of the trend term. It is hard to project NGO activity in the sector. Soybean production is an identity from yield and area. Soybean crush is determined in part by crushing margins. It is also linked in this model to the poultry sector. As with the other countries crush data is not available and estimates are used.

Given crush and the available trade data for each of the products a balance sheet is constructed. The model is driven by the soybean area equation, and the livestock sector. Crush rises as the livestock sector expands. Since the livestock sector projections are also linked to population then many of the key variables of the model evolve in a similar direction.

3.4.2 Interaction with the rest of the ReNAPRI system

As with the other country models there is a link with the maize and livestock sectors within Mozambique. The model also links through soybean complex prices with the rest of the ReNAPRI model. The soybean industry in Mozambique is linked with the rest of the countries in the region and the ReNAPRI model provides a framework for that interaction. The model shows robust capacity in examining policy impacts in the maize market for the region (Davids et al., 2017).

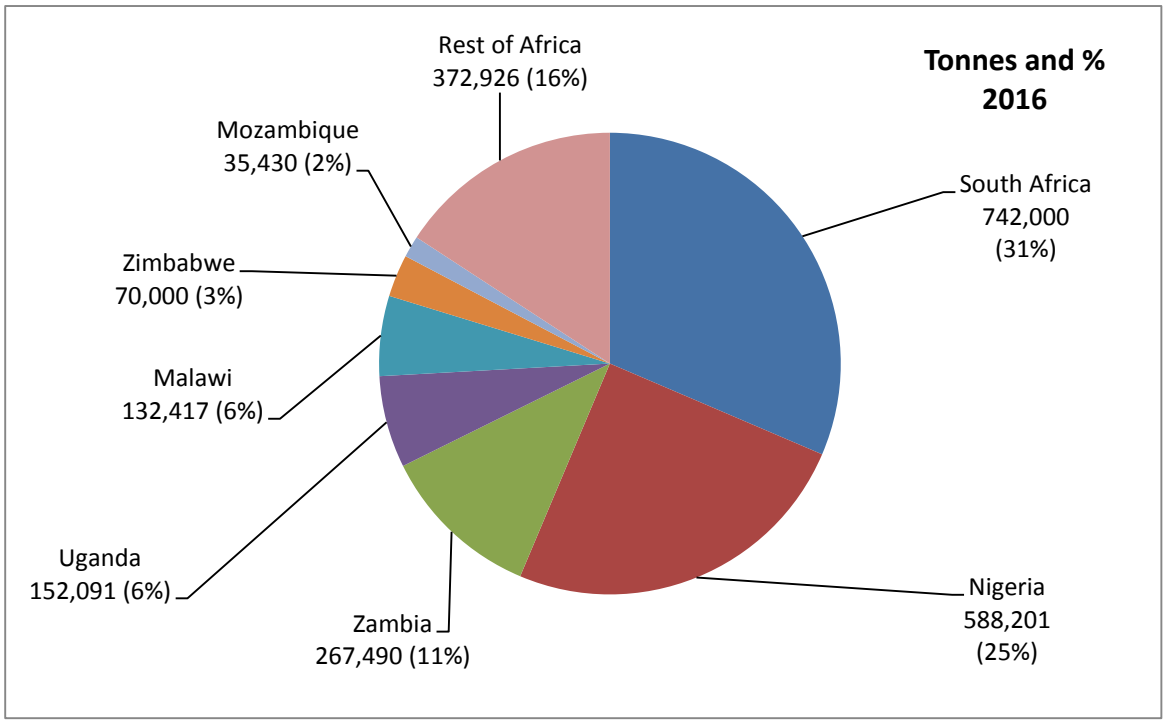
4 The outlook for soybeans

This section presents the medium-term outlook for soybean markets in South Africa, Zambia, Malawi and Mozambique for a time horizon of up to 2026/2027, given current policies, average weather, and macroeconomic assumptions. It is expected that despite a continuation of relatively low global oilseed prices, the soybean sectors in each of the countries will continue to expand, including trade across the region. The Appendix shows the full outlook projections.

4.1 Global soybean markets

Africa contributes to less than 1% of global soybean output in 2016. There are 22 countries in SSA involved in soybean production. Nigeria and South Africa are the largest soybean producers in Africa followed by Zambia and smaller producers (Figure 16).

Figure 16. Soybean production in Africa, by countries



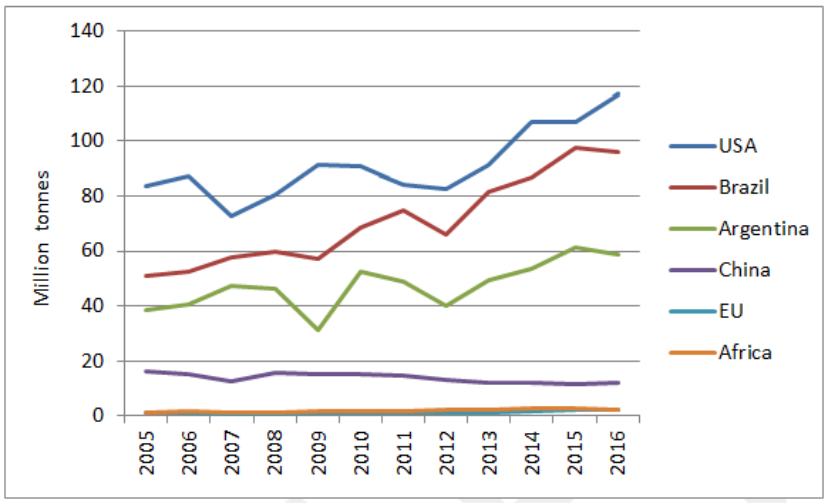
Note: For Zambia, adjusted data from FAOSTAT; for Zimbabwe, unofficial figure from FAOSTAT; for Mozambique, data from Mozambican Ministry of Agriculture and Food Security (no data in FAOSTAT).
Source: FAOSTAT.

Main producers are the USA, Brazil and Argentina (Figure 17). Despite the low soybean production rates observed in Africa, the current output is expected to double between 2010 and 2020 and continue growing due to a growing poultry and aquaculture feed industry and increasing need for improved human nutrition in the region (Walker and Cunguara, 2016). Quantity produced in Africa and the EU is rather similar. Soybean production in the EU over the 2017-2026 period is expected to hardly increase from 2.2 million tonnes to 2.4 million tonnes (European Commission, 2016).

The EU has a substantial protein deficit. Indeed it faces a 5% self-sufficiency rate in soybean and soybean meal, in other words, the EU produces domestically about 5% of its needs. The EU imports around 10 % of world soybeans traded, but also import a large share of meals (32 % of protein meals traded, mainly soybean meal). Over the 2017-2026 period, it is expected the EU will increase further the quantities of imported soybeans, especially soybean meal (European Commission, 2016). One should consider that most of soybean and soybean meal imports are duty-free.

Under the current Common Agricultural Policy (CAP), most of the support is decoupled from productions and prices. However soybean production can benefit from voluntary coupled payments, as well as greening support through crop diversification and crop rotation that favours protein crops. Looking more specifically on the rural development pillar, soybean sector can benefit from targeted measures such as agri-environmental measures, on-farm investment in production and processing or support to organic farming. Expected by the end of 2018, an EU Protein Plan should be proposed by the EU Commission, focusing mainly on research, innovation and technical cooperation.

Figure 17. Soybean production in the USA, Brazil, Argentina, China (mainland), EU and Africa

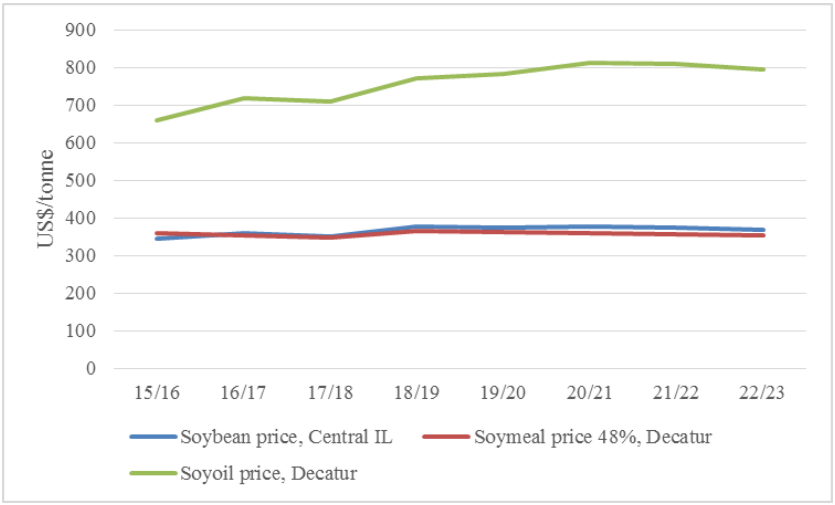


Source: FAOSTAT.

Oilseed prices have experienced the same level of volatility that almost all commodity prices have experienced over the last decade. Commodity prices initially spiked in 2007 and 2008, and then rose again in 2012 as crop yields in several important producing regions were poor and stocks fell. At the same time demand from the growing biofuel industry, booming Chinese economy, and high oil prices all contributed to record prices.

Price projections for soybeans from FAPRI are shown in Figure 18. A series of above average years for global yields has led to record production and increasing stocks for many crops with a resulting drop in prices. At the same time as the increase in production there has been a slowdown in the Chinese economy, biofuels use in the USA, and oil prices have fallen.

Figure 18. Soybeans and soybean products' price projections



Source: FAPRI.

It is expected that these developments will continue into the projection period. After averaging close to 10%, growth in China is forecast to be around 6%. Between 2005 and 2015 Chinese soybean meal imports grew at over 5 million tonnes per year. In FAPRI's projections for the next decade this is projected to fall to less than 3 million tonnes per year (although this is still significant). There does not appear to be enthusiasm for expanding biofuel consumption in the USA and the EU. Oil prices are projected by IHS Market to grow slowly over the next decade but not to exceed 100 US$/barrel. Global population growth is expected to fall. The combination of these factors explains why FAPRI's projections for the soybean markets show little growth.

In reality prices will not follow the path shown in Figure 18. It is expected that the high levels of volatility in commodity prices experienced in the last decade will continue, and so the price projections should be interpreted as average prices. They are made given a particular set of assumptions. If the oil price were to rise faster than projected this would result in higher commodity prices. Changes in biofuels policy, for example if China were to pursue an increase in mandated biofuel use, would also impact global oilseed complex prices. A rise in global protectionism by major world soybean trade actors could also affect world prices. Given the nature of the markets outlined above, these price changes would be transmitted into the African countries.

4.2 The outlook in South Africa

The macroeconomic projections for the soybean sector are exogenous and taken from the October update of the IMF World Economic Outlook.

The South Africa economy is a largely resource based economy influenced by the lower commodity price cycle and operating in an environment characterized by significant uncertainty and diminishing business confidence in the current political environment. Economic growth in South Africa has slowed significantly in recent years.

For the same reasons, economic growth in the coming decade is expected to remain weak relative to the past decade. Total real income growth is expected to average merely 1.88% per year over the outlook period. Population growth is also expected to slow, averaging 0.7% per year over the next decade – well below most other African countries. This results in a total population of almost 60 million by 2026, from about 56 million in 2016. The impact of both population and income growth is reflected in the model, though it is mostly felt on consumption of agricultural products.

Having grown exceptionally quickly over the past decade from a smaller base, the rate of soybean area expansion is projected to slow significantly over the outlook period, but remains robust at 4.2% per year (Figure 19 and Figure 20). This reflects a continued shift towards soybeans, where the excess demand from the expanded crushing sector has led to a favourable price ratio relative to alternatives such as maize.

The benefits of soybeans to soil properties when produced in rotation with maize further support this shift. Area growth slows relative to the past decade however, as further expansion will need to occur in the Western production regions, which have a lower soybean yield potential than the Eastern regions, where the initial rapid expansion occurred. Continued development and the introduction of new varieties into these Western production regions is showing potential for improved yields going forward. The introduction of new technologies over the next few years, enabled by the expected approval of an end point royalty system for seed companies, supports yield growth of 1.6% per year from 2017 to 2026, compared to 1.4% per year over the past decade. This combination of area and yield growth results in an estimated 2.2 million tonnes production of soybean by 2026 (Figure 19).

Figure 19. Soybean price and area harvested in South Africa

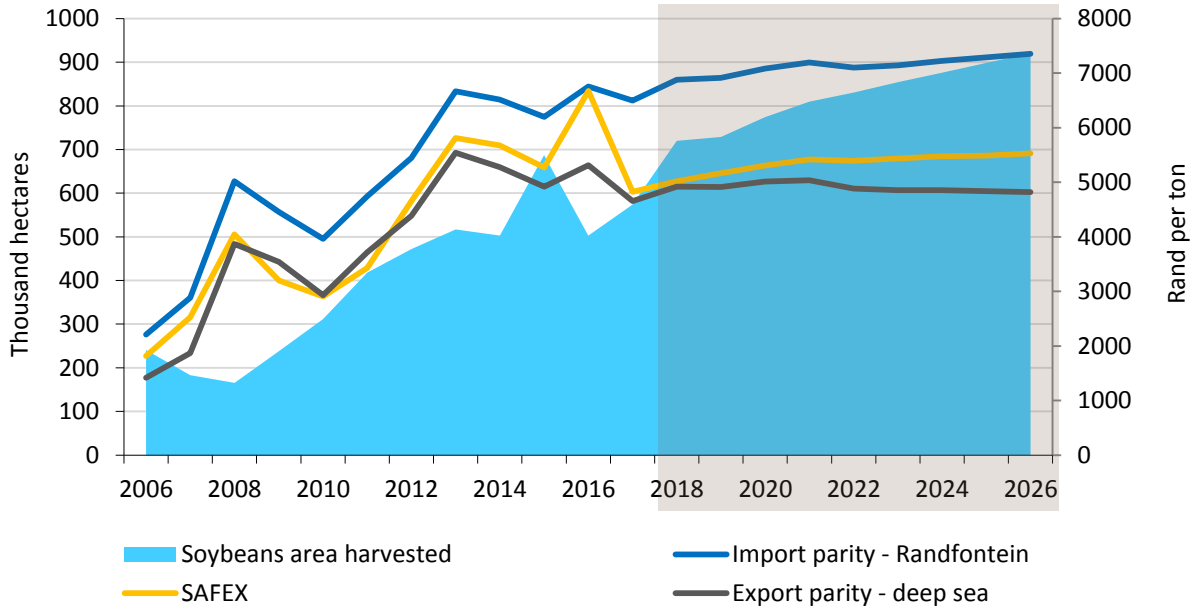
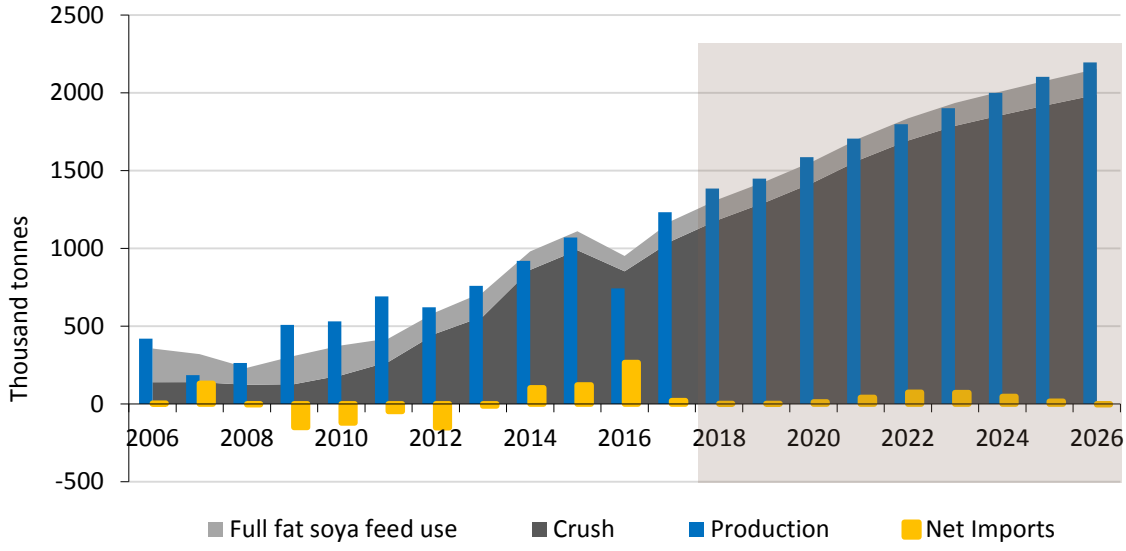


Figure 20. Soybean production, consumption and net imports in South Africa

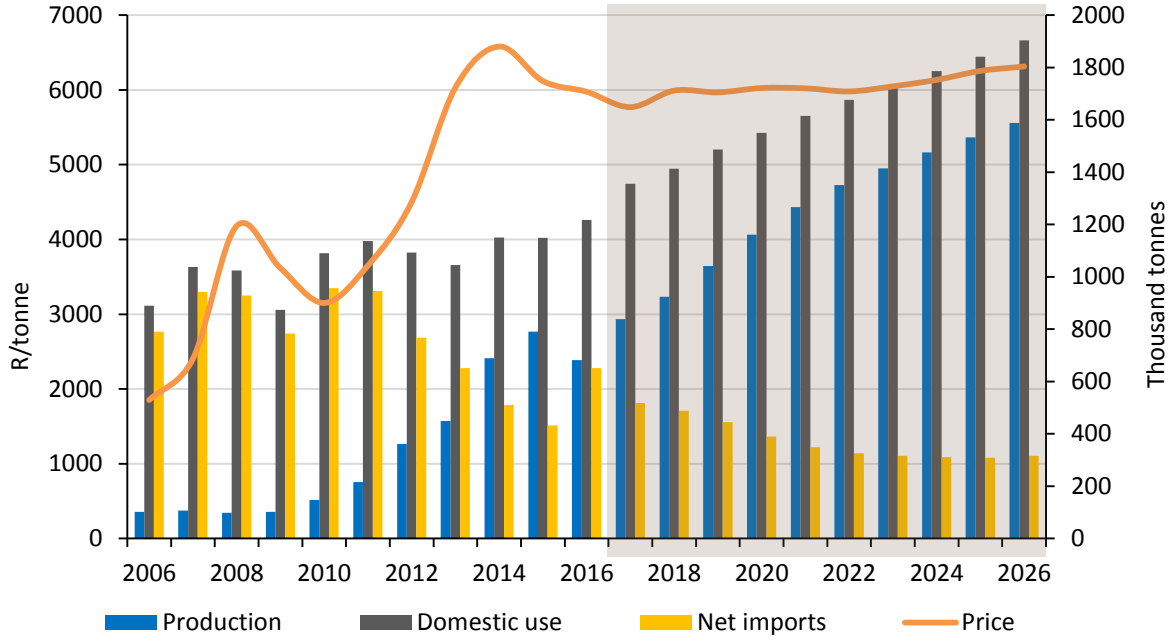


In 2018, the initial intentions to plant point to an expansion of 25% in area cultivated to soybeans, which relates to a 5% increase in production at trend yield levels. This is expected to push the price closer to export parity in the short term, but in the medium term, prices are expected to continue trading a little bit above export parity levels, in line with the value of soybean meal and oil (Figure 19). In line with the global cycle, this trend is largely side-ways in the absence of weather related supply shocks.

Following the expansion in 2018, South Africa is expected to trade close to self-sufficiency over the next few years, importing only small volumes as crushing plants strive to improve utilization rates. Imports become more relevant from 2021 onwards because of crushing constraints (Figure 20). The growth in soybean crush of just over 7% per year remains insufficient to supply the domestic demand for soybean meal from a growing livestock sector and while a declining trend is evident, South Africa is expected to remain a net importer of soybean meal over the outlook period (Figure 21).

The continued need to supplement domestic production with imports implies that soybean meal prices are likely to continue trading at import parity based levels. In line with expanded crushing and a general slowdown in demand, net soybean oil imports are expected to decline by an annual average of 11% per year over the projection period, implying that South Africa will be self-sufficient in soybean oil production by 2026.

Figure 21. Soybean meal production, consumption, net imports and prices in South Africa



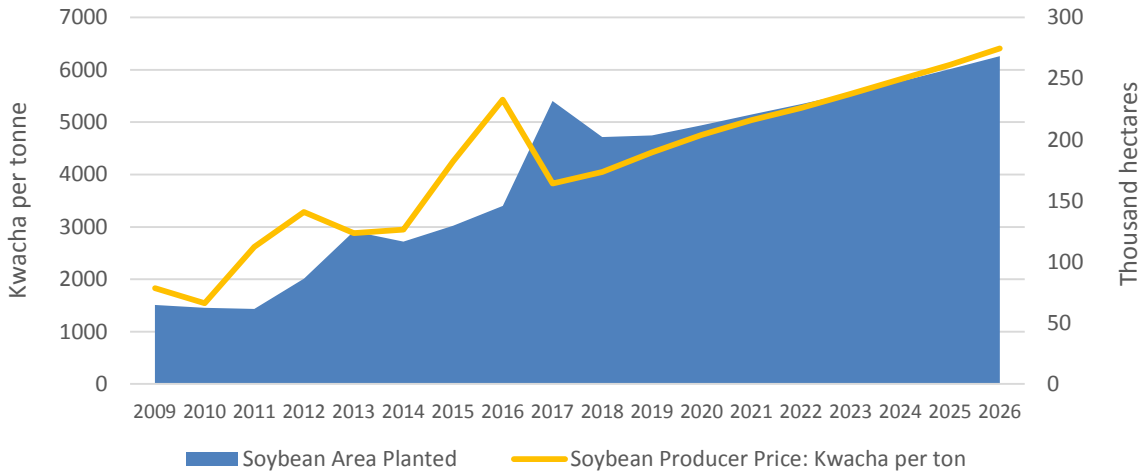
The outlook assumes that current policies remain in place and by implication, that intervention in soybean markets remains limited. The recent reduction in import tariffs applied by South Africa to Mercosur, following the ratification of the trade agreement with the region, is incorporated in the outlook.

4.3 The outlook in Zambia

Macroeconomic projections for the sector are currently exogenous and taken from the October update of the IMF world economic outlook. Given the dependence on exported commodities, economic growth in Zambia has slowed significantly in the lower commodity price cycle. For the same reason, economic growth in the coming decade is expected to slow significantly from the past. Total income growth is expected to average approximately 4.5% per year over the outlook period. As in many other countries in Africa, Zambia has a young and rapidly expanding population that is expected to exceed 22 million people by 2026, from almost 17 million in 2017. This implies an average annual growth rate of 3.2%. Although the impact of the population growth is reflected by the model, the impact of this growth is mostly felt on consumption of agricultural products, but this will also have wider impacts on the country and rural areas. Rapid population growth also dilutes income growth on a per capita basis.

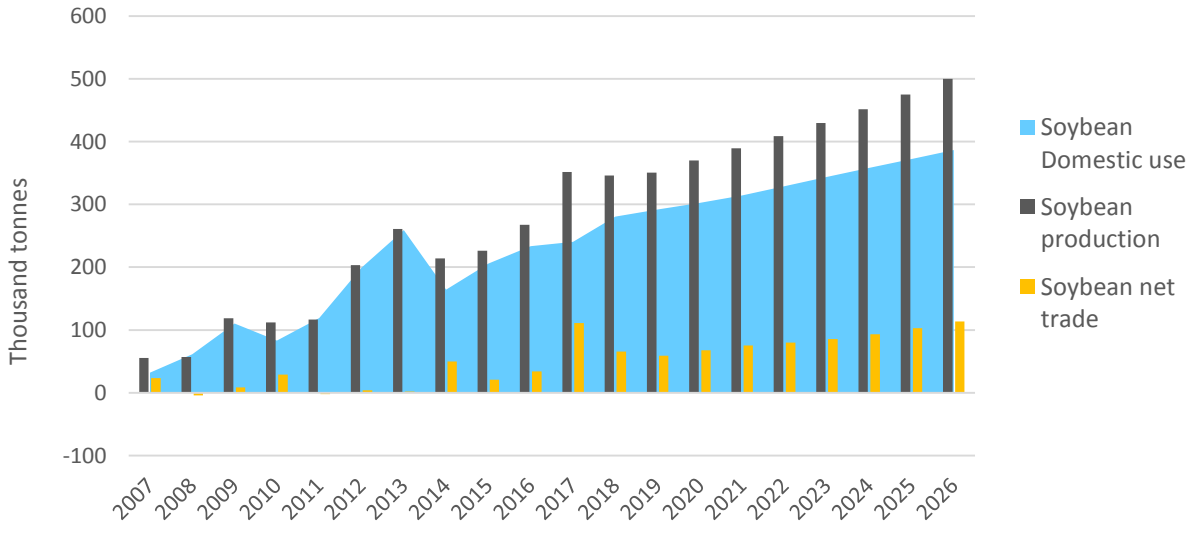
Having grown exceptionally quickly over the past decade from a very small base, the rate of soybean area expansion is projected to slow significantly over the outlook period, but remains robust at 2.7% per year. This reflects a continued shift towards soybeans, which is perceived as a more stable market than maize. Soybean area increased by almost 60% in 2017, pushing prices down to export parity levels. As a result, some consolidation is expected in 2018 before returning to a stable growth path over the projection period (Figure 22).

Figure 22. Soybean price and area harvested in Zambia



Considering the expansion, Zambia is projected to remain a surplus producer of soybeans over the next decade (Figure 23), with the bulk of the exports destined for the Southern African region – mainly South Africa. As such, the Zambian soybean price is well integrated with the South African price, which in turn is well integrated in the global market. Consequently, in US$ terms, prices trend marginally downwards, as projections from FAPRI indicate that a slowdown in the expansion of the biofuel industry and population growth rates together imply that commodity prices will stay at levels that are significantly below their peaks. Continued increases in the nominal soybean price in Zambia going forward are mainly attributed to further depreciation in the Zambian Kwacha relative to the US$.

Figure 23. Soybean production, consumption and net trade in Zambia



The combination of area and yield expansion results in production growth of 4% by year over the next decade. A significant share of this growth is expected to be crushed domestically, owing to expansion of poultry and beef production, with both industries having started to use feed more intensively in the production process. Crushing capacity will however have to expand to reach the projected crush levels, which is expected to occur, particularly with a growing number of vertically integrated poultry producing companies investing in Zambia.

Despite increased crushing, surplus soybeans remain, and Zambian soybean exports are expected to grow continuously from 2018 onwards. The bulk of the surplus will likely remain in the region, predominantly to South Africa, which currently has excess crushing capacity. As South African soybean production also continues to expand, Zambia may need to look elsewhere to export surplus production. In this regard, high transportation rates and its landlocked nature remains a challenge, but possible premiums could be attained in the Asian market for its non-GMO soybeans. Interestingly, Soybean ranks first in total GMO crops planted followed by maize and cotton. Worldwide, more than 80% of the soybean area is planted with GMO varieties (Atici, 2014). Non-GMO soybean can provide considerable price premium compared to conventional product on specific export markets (ITC, 2017).

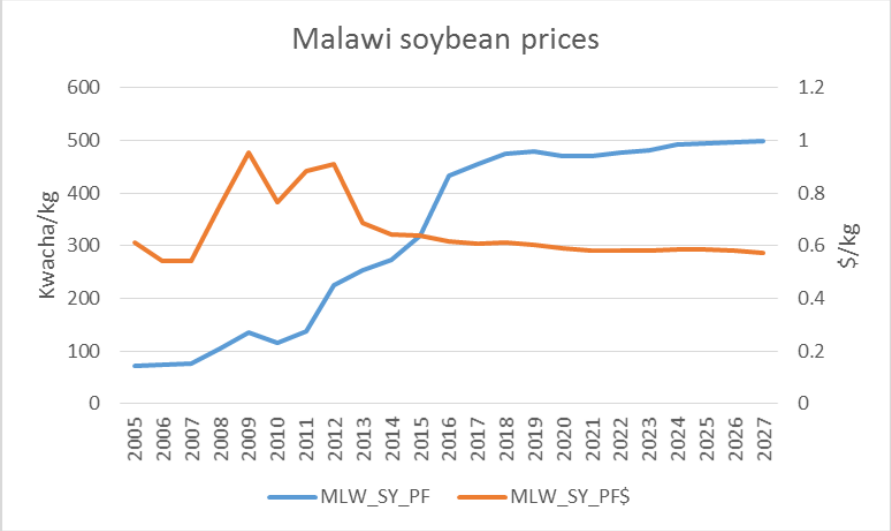
The outlook assumes that current policies remain in place and by implication that soybean markets are still subject to less policy intervention and particularly discretionary application of trade policies going forward. Should the continued entry of small scale producers into soybean production result in a greater extent of government intervention in the market, the outlook could change significantly.

The outlook for soybean products, relates closely to the soybean outlook, with production derived from soybeans crushed. As such, production of soybean meal and soybean oil both expand by 4.7% per year over the ten-year period. Net exports of soybean meal continue to rise towards 2026, with growth in intensive livestock production insufficient to take up all of the additional meal produced, but the rate of growth in net exports is less than production. Additional crush is also sufficient to result in fairly stable soybean meal imports over the outlook, but remains insufficient to reduce imports markedly given strong population growth and a rising soybean oil requirement.

4.4 The outlook in Malawi

Macroeconomic projections for the sector are exogenous and taken from various sources. The main external driver for the sector is likely to be population growth. In common with many countries in the region Malawi has a relatively young population that is growing rapidly and projected here to reach 24.5 million by 2027. In 2016, Malawi had an estimated population of 17.7 million people, and population is projected to grow by about 3% per year. Although the impact of the population growth on soybean and soybean product consumption is reflected by the model, the impact of this demographic change will obviously have wider impacts on the country and rural areas. Income growth of about 4% per year is expected over the projection period.

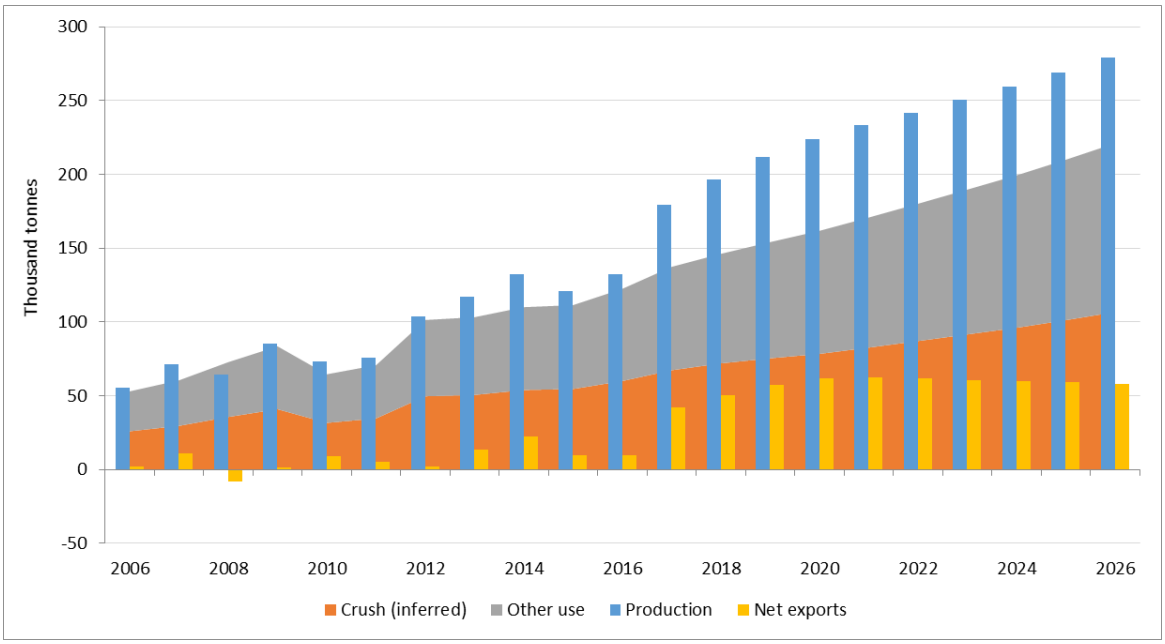
Figure 24. Soybean price in Malawi



Projected soybean prices for Malawi are also given in both US$ and Kwacha (Figure 24). The impact of the exchange rate can be clearly seen in the different path of prices.

The Kwacha has depreciated rapidly against the US$ in recent years, and in the projection period this depreciation is expected to continue, but at a slower rate. The Malawi price expressed in US$ reflects the evolution of the South African soybean product prices.

Figure 25. Soybean supply and demand in Malawi



The growth of crushing and the poultry industry in Malawi is expected to encourage a further increase in soybean area in Malawi. Area is estimated to have expanded by over 20% in 2017 and is projected to continue to increase. In part this will depend on the evolution of the tobacco sector, with these projections assuming stable tobacco area. Yields are also expected to grow, and so production grows from about 180 thousand tonnes in 2017 to close to 289 thousand tonnes in 2027 (Figure 25).

Crush is projected to grow with the expansion of the livestock industry. It grows from about 60 thousand tonnes in 2016 to 112 thousand tonnes in 2027. Food use grows with population. The net effect of these changes is that exports from Malawi are expected to expand rapidly, and finish the projection period at about 57 thousand tonnes.

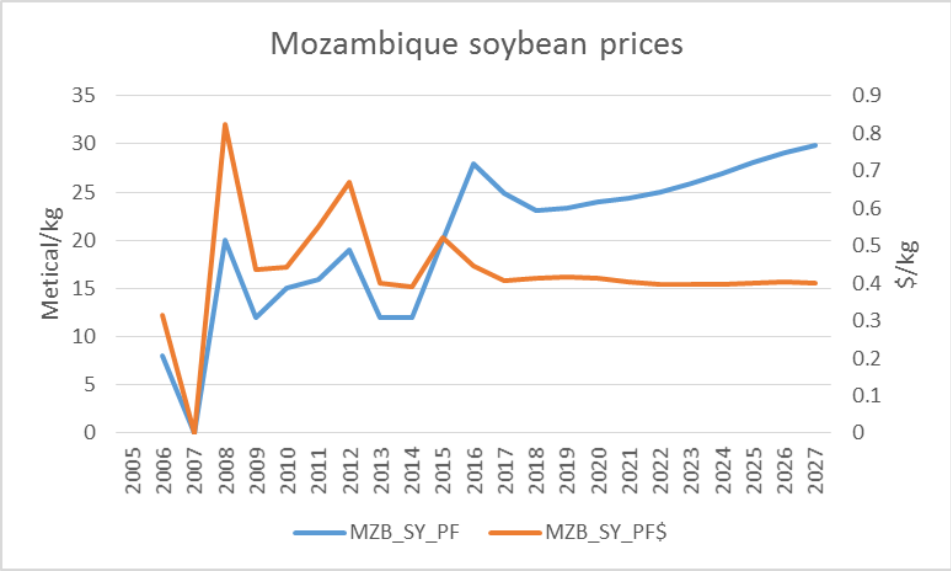
Given the structure of the model, projections for the balance sheet for products flow from the soybean equations. Meal and oil production increase with crush, and are projected to increase by 87% between 2016 and 2027. Crush is linked in the model to poultry production as is feed use and so net exports only grow slowly. Imports of meal have been negligible with the exception of years that are impacted by drought. Imports of oil are constant at about 8 thousand tonnes as consumption increases at approximately the same rate as production.

There is a high degree of uncertainty around all of these projections. Soybean area will be influenced by developments in other sectors, particularly in maize and tobacco. Yields have potential for significant increase with the adoption of improved farming practices. Population growth and the associated increase in meat production will be a central determination of the evolution of the sector, along with changes in neighbouring countries.

4.5 The outlook in Mozambique

Mozambique's population grew by 32% over the last decade and is estimated at 28.8 million in 2016. This growth is expected to continue at a rate of about 2.7% per year to end the period at 38.4 million. Growth of GDP was around 4% in 2016, the lowest observed in 15 years. Key export earnings dropped due to depressed global demand and the recent El Niño that affect agricultural production. In the meantime the economy faced logistical constraints related to internal security issues (AfDB, 2017). In the projections, the economy is expected to recover, growing by around 7% per year by the end of the projected period. The metical has depreciated rapidly against the US$ in recent years, and is expected to continue depreciating in slower rate in the coming decade after strengthening slightly in the near future.

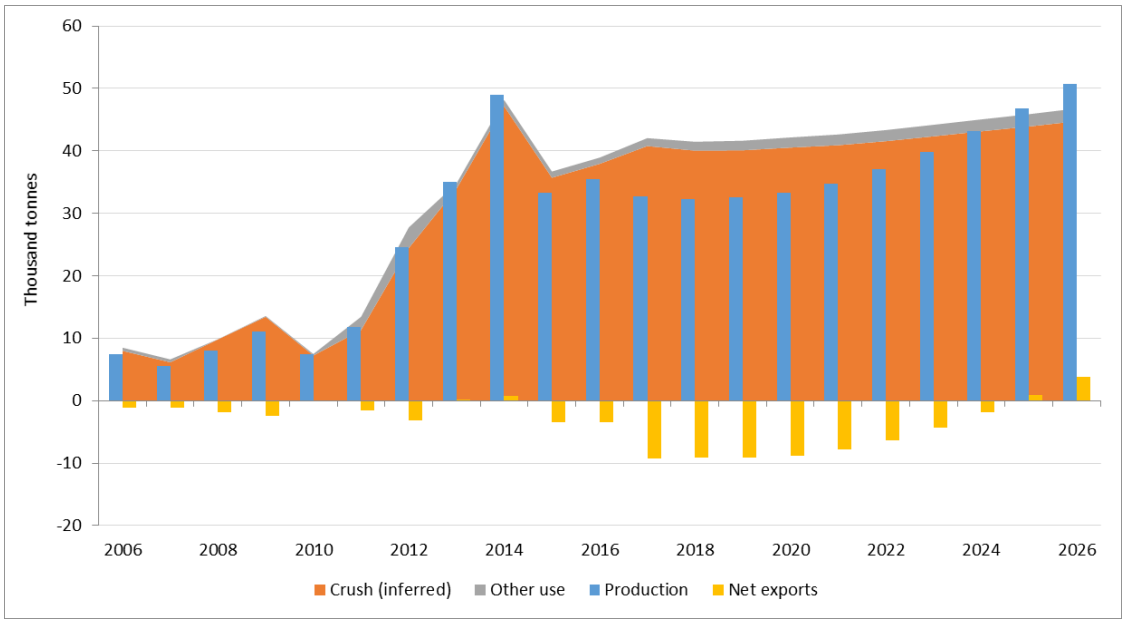
Figure 26. Soybean price in Mozambique



As for the other countries in the region soybean prices (Figure 26) are determined by South African prices. The path of prices in meticals reflects the evolution of the currency against the US$ and illustrates how this will play a central role in the evolution of the sector in coming years. This will be a source of uncertainty for the industry. I will impact the relative competitiveness of the sector, and regional trade will play an important role in its development.

The area of soybeans in Mozambique is projected to grow steadily to around 40 thousand hectares in 2027. Although this appears as a large increase in percentage terms, this corresponds to a small amount in relation to the total area in Mozambique. In the near term area expansion is impacted negatively by the projected development of the exchange rate.

Figure 27. Soybean supply and demand in Mozambique



Yields are projected to grow 0.7% per year. The combined growth in yields and area means that production increases from 35.4 thousand tonnes in 2017 to 55 thousand tonnes in 2027 (Figure 27). Again, this seems a large increase in production, but rather small if considering potentiality.

Crush of soybeans is projected to grow, and Mozambique continues to be a net importer of soybeans for most of the period. At the end of the projection period, however, the growth in production of soybeans exceeds the expansion in crush, generating some exports.

The production of soybean meal and oil is projected to increase by 18% over the period. For the production of meal, the expansion of the poultry sector (here tied to population growth) is expected to outstrip production of meal. Therefore imports of meal are projected to expand from around 30 thousand tonnes to 48 thousand tonnes by 2027. For soybean oil, production does not keep pace with the rapidly expanding population, generating net imports of oil grow, from around 28 thousand tonnes to around 39 thousand tonnes. The rate of increase in net imports of meal and oil is projected to be slower than in the last decade as production and crush of soybeans expand.

As for all of the countries studied, there is a lot of uncertainty regarding these projections. Even if the models could be right on average, in any particular year, some developments in the macro-economy or weather can change the situation of the industry dramatically. Furthermore, it does not require too much variation in a variable to change projections significantly. An unanticipated modification in soybean area or yield, for example, or the opening of a new crushing plant, given the small size of the industry, could qualitatively or quantitatively change results of the outlook.

5 Concluding remarks

This report presents a medium-term outlook for soybean markets in South Africa, Zambia, Malawi and Mozambique. It relies on a project whose aim was to produce partial equilibrium models of the soybean sector that could be used to produce projections in the sector and help to evaluate policy developments in conjunction with the ReNAPRI model. The first step was to produce an analysis of the recent history of the industry. In the four countries that are covered by this report, the sector has grown rapidly, although it is still small compared to other sectors in the countries concerned. The evolution of the sectors in each of the countries has taken different paths, with important differences in underlying drivers. Drought in the region has slowed progress in recent years, but the sector is expected to continue its expansion over the next decade.

In some of the countries the planting of GMO seeds is not permitted. This can lead to a premium for the seeds, although it seems once they are crushed the products tend to trade at close to world prices. Nevertheless, non-GMO soybean can provide considerable price premium compared to conventional product on specific export markets.

For meal, the growing livestock sector provides promising markets. With populations growing, and getting richer, it is likely that the demand for meat will continue to rise. How much of that meat will be produced in the region versus imported from outside it will be a large determinant of the future growth of the industry. The countries in this report are all projected here to produce a surplus of meal and therefore export some to other countries in the region.

Although soybeans produce a lot of meal (relative to other oilseeds) it is important to also consider the oil market. Most of the countries are oil importers, and this is projected to continue even with increased domestic production of oil. Producers of soybean oil also have to compete with imports of other oils, particularly palm oil.

In the report it is shown how the models have been constructed to help answering some of the questions regarding the development of the soybean sector. Partial equilibrium models allow the analyst to structure the sector model in detail and incorporate some of the characteristics of the particular industry or country concerned. For soybeans the process is hampered by the infancy of the industry in much of the region and the lack of data. Clearly the models will be improved as more data becomes available.

The ReNAPRI framework allows regional trade to be considered. Until now this has focused on the maize sector, where disruptions in one country have implications for others in the region. In a near future it is expected that the soybean models presented here can be further integrated with other country models developed. This would allow intra-regional trade to be fully represented.

The soybean sector appears to have a promising future in terms of its contribution to the agricultural sectors of the region. It can improve soils, provide a value added processing activity, and offer an alternative crop for both small holders and commercial farms. It is hoped that the models developed here can help policy makers and other participants in the sector better anticipate the challenges as the sector grows.

There remains a great deal of uncertainty in the industry. Projecting out ten years for agriculture is always difficult. For a small, developing industry such as soybean in Eastern and Southern Africa to do so accurately is almost impossible. Indeed, a new crushing plant or a large poultry operation can impact both production and net trade. Under these circumstances it is expected that the models can capture some of the underlying relationships and trends, and provide valuable information to policy makers on the impact and magnitude of changes on the soybean industry and related sectors.

As a final remark, in the coming years, the scope of the ReNAPRI models will be expanded and the interlinkages between commodities extended. Indeed soybean expansion will depend in part on the policy pursued in the countries, in particular with respect to the livestock industries. This report provides a foundation for future work

which would ideally include an examination of regional trade in soybean meal including countries not modelled here, collection of better data, and the modelling of other sectors that impact the industry especially livestock.

References

AfDB, 2017. Mozambique Economic Outlook, African Economic Outlook Country Note, Abidjan. https://www.afdb.org/en/countries/southern-africa/mozambique/mozambique-economic-outlook

Atici, C., 2014. Low Levels of Genetically Modified Crops in International Food and Feed Trade: FAO International Survey and Economic Analysis, FAO Commodity and Trade Policy Research Working Paper #44, Roma. http://www.fao.org/docrep/019/i3734e/i3734e.pdf

CGAP, 2016. National Survey and Segmentation of Smallholder Households in Mozambique: Understanding Their Demand for Financial, Agricultural, and Digital Solutions, Consultative Group to Assist the Poor, Washington DC. https://www.cgap.org/sites/default/files/Working-Paper-National-Survey-and-Segmentation-Mozambique-March-2016.pdf

Chisanga, B., Chapoto, A., 2016. Zambia agriculture status report 2016, Indaba Agricultural Policy Research Institute (IAPRI), Lusaka.

Chisanga, B., Sitko, N., 2013. The National Consumption Requirement Study for Edible Oils in Zambia, Indaba Agricultural Policy Research Institute (IAPRI), Lusaka.

DAFF, 2017. Abstract of agricultural statistics 2016, South African Department of Agriculture, Forestry and Fisheries (DAFF), Pretoria. http://www.daff.gov.za/daffweb3/Home/Crop-Estimates/Statistical-Information

Davids, P., Meyer, F.H., Westhoff, P.C., 2017. Impact of trade controls on price transmission between Southern African maize markets, Agrekon 56 (3):223-232.

Deloitte, 2016. Mozambique's Economic Outlook: Governance Challenges Holding Back Economic Potential, December. https://www2.deloitte.com/content/dam/Deloitte/za/Documents/africa/ZA_Mozambique%20country_report_25012017.pdf

Di Matteo, F., Otsuki, K., Schoneveld, V., 2016. Soya bean expansion in Mozambique: exploring the inclusiveness and viability of soya business models as an alternative to the land grab, The Public Sphere 2016:63-86. http://www.cifor.org/publications/pdf_files/articles/ASchoneveld1601.pdf

European Commission, 2016. EU Agricultural Outlook, Prospect for the EU agricultural markets and income 2016-2026, Directorate-General for Agriculture and Rural Development, December. https://ec.europa.eu/agriculture/sites/agriculture/files/markets-and-prices/medium-term-outlook/2016/2016-fullrep_en.pdf

FAO, 2017. Food and agriculture data, FAOSTAT, Roma. http://www.fao.org/faostat

FAO, 2007. Promoting Integrated and Diversified Horticulture Production in Maputo Green Zones towards a stable Food Security System, Roma. http://www.fao.org/fileadmin/templates/tc/tce/pdf/Mozambique_factsheet.pdf

FAPRI, 2017. International Crops Baseline Update, FAPRI Missouri. https://www.unr.edu/business/research-and-outreach/uced/food-and-agricultural-policy-research-institute-(fapri)/international-crops-baseline-update-(sept-2017)

Gasparri, N.I., Kuemmerle, T., Meyfroidt, P., le Polain de Waroux, Y., Kreft, H., 2016. The Emerging Soybean Production Frontier in Southern Africa: Conservation Challenges and the Role of South-South Telecouplings, Conservation Letters 9(1):21-31.

Government of the Republic of Mozambique, 2013. Plano Nacional de Investimento do Sector Agrário PNISA 2013-2017, Maputo.

ISCRISAT, 2013. Tropical legume farming in Mozambique, Bulletin of Tropical Legumes 18/2013. http://www.icrisat.org/TropicalLegumesII/pdfs/Bulletin-of-the-Tropical.pdf

ITC, 2017. Togolese soybean producers find new markets in Vietnam and Europe, ITC news, 21 June, Geneva. http://www.intracen.org/news/Togolese-soybean-producers-find-new-markets-in-Vietnam-and-Europe/

Meyer, F., Traub, L.N., Davids, T., Kirimi, L., Gitau, R., Mpenda, Z., Chisanga, B., Binfield, J., Boulanger, P., 2016. Modelling wheat and sugar markets in Eastern and Southern Africa, Regional Network of Agricultural Policy Research Institutes (ReNAPRI), JRC Technical Report, EUR 28254 EN. doi:10.2788/437123. https://ec.europa.eu/jrc/en/publication/modelling-wheat-and-sugar-markets-eastern-and-southern-africa-regional-network-agricultural-policy

Mubichi, F.M., 2017. A Comparative Study Between Mozambique and Malawi Soybean Adoption Among Smallholder Farmers. Journal of Rural Social Sciences, 32(1):21-39.

NAMC, 2011. The South African Soybean Value Chain, National Agricultural Marketing Council, Markets and Economic Research Centre, March, Pretoria.

Noticias, 2015. Comercialização agrícola - a chave para o desenvolvimento, 14 April. http://www.jornalnoticias.co.mz/index.php/analise/34734-comercializacao-agricola-a-chave-para-o-desenvolvimento.htm

Opperman, C., Varia, N., 2011. Soybean Value Chain. Southern Africa Trade Hub, Technical Report, submitted by AECOM International Development, Gaborone. http://www.tropicalsoybean.com/sites/default/files/Southern%20Africa%20Soybean%20Value%20Chain_Opperman,%202011.pdf

Pereira, L., 2015. Soy Value Chain in Mozambique: Results and Challenges. Feed the Future Scaling Agricultural Technology/GLEE, 3-5 Dec 2013, Addis Ababa. https://agrilinks.org/sites/default/files/resource/files/Luis%20Pereira%20GLEE%20Addis.pdf

Shurtleff, W., Aoyagi, A., 2009. History of soybeans and soyfoods in Africa (1857-2009), SoyInfo Center, Lafayette, CA. http://www.soyinfocenter.com/books/134

Sinclair, T.R., Marrou, H., Soltani, A., Vadez, V., Chandolu, K.C., 2014. Soybean production potential in Africa, Global Food Security 3(1):31-40. http://www.sciencedirect.com/science/article/pii/S2211912413000552

Smart, T., Hanlon, J., 2014. Chickens and Beer: Recipe for Agricultural Growth in Mozambique. http://www.open.ac.uk/technology/mozambique/sites/www.open.ac.uk.technologymozambique/files/files/Chickens_and_beer-a_recipe_for_growth_in_Mozambique.pdf

Talacuece, M.A.D., Justino, F.B., Rodrigues, R.Á., Flores, M.E.P., Nascimento, J.G., Santos, E.A., 2016. Modeling of Soybean under Present and Future Climates in Mozambique, Climate 2016, 4(2). doi:10.3390/cli4020031.

TechnoServe, 2011. Southern Africa Regional Soybean Roadmap: Final presentation. http://www.technoserve.org/files/downloads/technoserve-bmgf-regional-report.pdf

USAID, 2011. Mozambique agricultural value chain analysis, Leveraging Economic Opportunities (LEO) Report #31. http://www.acdivoca.org/wp-content/uploads/2016/09/Report-No31-Mozambique-VCA-Report.pdf

USAID/SPEED, 2012. O Iva no Sector da Agricultura em Mozambique, Maputo. http://www.speed-program.com/wp-content/uploads/2012/09/SPEED-Reports-2012-002IVAnoSectordaAgricultura-Dec2011_FinalReport.pdf

USAID/SPEED, 2011. Mozambique's Natural Resource Boom What potential impacts on the competitiveness of Mozambique's Soybean industry?, Maputo. http://www.speed-program.com/wp-content/uploads/2014/09/2015-SPEED-Presentation-013-Mozambiques-natural-resource-boom-what-potential-impacts-on-the-competitiveness-of-the-soybean-industry-EN.pdf

Walker, T., Cunguara, B., 2016. Taking Stock of Soybean R&D and USAID's Feed the Future Program in Mozambique, Modernizing Extension and Advisory Services (MEAS) Project Report, March 17. https://dev.meas.illinois.edu/wp-content/uploads/2015/04/MEAS-EVAL-2016-Mozambique-Soybean-RD-Walker-March-2016.pdf

World Bank, 2017. World Development Indicators, Washington DC. http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators

World Bank, 2012. Agribusiness indicators: Mozambique, Report #68241-MZ, April, Washington DC. http://siteresources.worldbank.org/INTARD/825826-1111044795683/23184690/ARD_ESW_Agribusiness_Indicators_Mozambique_final.pdf

Appendix

Important: Note, data in the Appendix have been compiled from a variety of sources, and some of it has been derived or estimated from other figures (see body of the text). In particular crush numbers are not official data and have often been derived in a rudimentary fashion.

South African Soybean Sector

Soybeans										
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
						Thousand Hectares				
Area	183.00	165.40	237.75	311.45	418.00	472.00	517.00	502.90	687.30	502.80
						Tonne per Hectare				
Yield	1.01	1.60	2.14	1.71	1.70	1.32	1.47	1.83	1.56	1.48
						Thousand Tonnes				
Production	185.40	264.00	508.20	531.50	690.30	621.89	759.15	920.00	1070.00	742.00
Net Imports	131.20	-3.80	-150.00	-121.10	-46.90	-152.32	-12.13	102.40	120.30	264.35
Consumption	345.40	269.30	350.90	420.20	463.80	626.49	754.09	1020.50	1164.88	1010.69
Crush	140.00	122.60	126.80	184.10	270.10	451.95	561.59	861.63	988.02	852.31
Full Fat	179.90	109.30	181.80	191.80	150.20	137.41	155.65	118.60	121.76	98.72
Ending Stock	57.80	48.70	56.00	46.20	225.80	68.88	61.81	63.70	89.13	84.79
						R / ton				
Soybean Price	2526.40	4042.81	3201.73	2910.00	3431.00	4655.00	5814.00	5676.75	5269.16	6672.07
Soybean Meal										
						Thousand Tonnes				
Production	106.96	98.08	101.44	147.28	216.08	361.56	449.27	689.30	790.42	681.85
Net Imports	931.29	926.50	771.76	943.43	920.68	731.69	595.73	461.30	358.35	535.29
Feed Use	1038.25	1024.58	873.20	1090.71	1136.76	1093.25	1045.00	1150.60	1148.77	1217.13
						R / ton				
Soybean Meal Price	2291.60	3876.14	4150.00	3661.00	3455.00	5001.00	6187.00	6249.01	5184.40	6588.75
Soybean Oil										
						Thousand Tonnes				
Production	24.07	22.07	22.82	33.14	54.02	81.35	101.09	155.09	177.84	153.42
Net Imports	271.98	245.95	129.80	249.96	222.13	119.44	141.10	83.90	104.33	125.67
Food Use	296.05	268.02	152.62	283.09	276.15	200.79	242.18	238.99	282.17	279.09
						R / ton				
Soybean Oil Price	7039.09	13344.52	8657.53	7936.27	11366.71	12182.19	12702.57	12200.22	12010.39	13555.26

South African Soybean Sector

Soybeans	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
					Thousand Hectares					
Area	573.95	720.00	729.09	774.54	810.06	830.57	854.07	875.68	898.20	920.16
					Tonne per Hectare					
Yield	2.29	1.92	1.99	2.05	2.11	2.16	2.22	2.28	2.34	2.38
					Thousand Tonnes					
Production	1316.37	1385.58	1448.30	1586.06	1706.98	1797.97	1898.83	1998.25	2101.95	2193.25
Net Imports	3.31	-32.45	26.57	33.38	44.78	63.58	51.69	39.49	17.08	1.33
Consumption	1216.37	1321.56	1471.02	1623.15	1757.29	1867.07	1951.86	2033.01	2111.87	2187.22
Crush	1048.07	1155.10	1301.78	1451.13	1583.01	1688.30	1768.32	1844.34	1916.56	1985.17
Full Fat	132.51	130.67	133.45	136.23	138.49	142.98	147.75	152.88	159.52	166.26
Ending Stock	188.10	219.68	223.53	219.82	214.29	208.77	207.43	212.16	219.31	226.68
					R / ton					
Soybean Price	4715.96	5046.16	5191.73	5335.29	5431.62	5390.24	5416.28	5462.15	5484.30	5525.87
Soybean Meal										
					Thousand Tonnes					
Production	838.45	924.08	1041.43	1160.91	1266.41	1350.64	1414.66	1475.47	1533.25	1588.14
Net Imports	517.32	488.58	444.94	389.84	349.15	325.20	316.20	310.82	308.35	315.48
Feed Use	1355.78	1412.66	1486.37	1550.75	1615.56	1675.84	1730.86	1786.30	1841.60	1903.62
					R / ton					
Soybean Meal Price	5291.63	5479.91	5473.86	5550.74	5568.85	5558.80	5669.56	5804.23	5979.53	6101.65
Soybean Oil										
					Thousand Tonnes					
Production	188.65	207.92	234.32	261.20	284.94	303.89	318.30	331.98	344.98	357.33
Net Imports	97.62	78.08	57.21	33.70	16.48	8.44	1.99	-3.74	-6.09	-11.48
Food Use	286.27	286.00	291.53	294.90	301.42	312.34	320.29	328.24	338.89	345.85
					R / ton					
Soybean Oil Price	13896.50	14962.05	15355.73	16106.39	16628.73	16468.16	16676.19	16867.73	16620.66	16918.73

Zambia Soybean Sector

Soybeans	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
					Thousand hectares					
Area	38.9	32.4	64.7	62.3	61.4	86.2	124.9	116.5	129.5	145.8
					Tonnes per hectare					
Yield	1.4	1.8	1.8	1.8	1.9	2.4	2.1	1.8	1.7	1.8
					Thousand tonnes					
Production	55.2	56.8	118.8	111.9	116.5	203.0	261.1	214.2	226.3	267.5
Imports	1.2	4.9	0.4	0.1	4.9	1.0	2.9	1.8	3.1	0.9
Consumption	32.0	61.3	110.3	83.1	118.9	199.2	259.1	164.2	205.8	233.5
Crush	32.0	61.3	110.3	83.1	118.9	199.2	259.1	164.2	205.8	233.5
Exports	24.5	0.4	8.9	28.9	2.5	4.9	4.9	51.7	23.6	34.9
Stock change	0.0	0.0	-0.1	0.0	0.0	-0.1	0.0	0.0	0.0	0.0
					Thousand tonnes					
Net Exports	23.2	-4.4	8.6	28.8	-2.4	3.9	2.0	49.9	20.6	34.0
					Kwacha per 100 kg					
Soybean Price			183.0	154.4	261.5	328.3	288.0	294.9	425.3	543.0
Soybean Meal										
					Thousand Tonnes					
Production	25.6	49.0	88.2	66.4	95.1	159.4	207.3	131.4	164.6	186.8
Imports	0.5	9.0	2.6	0.7	16.0	15.5	1.2	0.9	1.1	0.4
Exports	4.5	0.0	7.5	15.1	4.3	7.1	41.7	36.4	24.2	19.3
Net Exports	4.0	-9.0	4.9	14.4	-11.7	-8.4	40.5	35.5	23.1	19.0
Feed Use	21.6	58.1	83.3	52.1	106.8	167.8	166.8	95.9	141.5	167.8
Soybean Oil										
					Thousand Tonnes					
Production	6.4	12.3	22.1	16.6	23.8	39.8	51.8	32.8	41.2	46.7
Imports	16.5	13.4	8.7	7.5	11.8	26.2	10.6	19.0	17.5	15.6
Exports	0.1	0.4	0.0	0.1	0.1	0.0	0.2	0.0	0.2	0.5
Net Exports	-16.5	-13.0	-8.7	-7.4	-11.7	-26.2	-10.4	-19.0	-17.3	-15.1
Feed Use	22.8	25.2	30.7	24.0	35.5	66.0	62.2	51.8	58.5	61.8

Zambia Soybean Sector

Soybeans	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
					Thousand hectares					
Area	231.6	202.1	203.4	211.7	220.5	229.1	238.0	247.6	257.8	268.3
					Tonnes per hectare					
Yield	1.5	1.7	1.7	1.7	1.8	1.8	1.8	1.8	1.8	1.9
					Thousand tonnes					
Production	351.4	346.3	350.9	370.0	389.6	408.9	429.5	451.6	475.1	499.9
Imports	2.7	4.1	4.2	4.0	3.9	3.8	3.7	3.6	3.4	3.3
Consumption	240.4	280.6	291.9	302.5	314.3	329.0	343.8	358.2	372.3	386.6
Crush	240.4	280.6	291.9	302.5	314.3	329.0	343.8	358.2	372.3	386.6
Exports	113.8	69.7	63.1	71.5	79.1	83.7	89.3	97.0	106.3	116.6
Stock change	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
					Thousand tonnes					
Net Exports	111.0	65.7	58.9	67.5	75.2	79.9	85.6	93.4	102.9	113.3
					Kwacha per 100 kg					
Soybean Price	383.1	404.9	442.2	475.9	503.7	527.0	554.2	581.8	609.9	640.6
Soybean Meal										
					Thousand Tonnes					
Production	192.3	224.5	233.5	242.0	251.5	263.2	275.1	286.5	297.8	309.3
Imports	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Exports	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Net Exports	55.1	67.5	75.4	78.5	78.3	78.7	80.0	81.3	81.9	82.2
Feed Use	137.2	157.0	158.2	163.5	173.1	184.5	195.1	205.2	215.9	227.1
Soybean Oil										
					Thousand Tonnes					
Production	48.1	56.1	58.4	60.5	62.9	65.8	68.8	71.6	74.5	77.3
Imports	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Exports	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Net Exports	-17.6	-12.3	-11.3	-11.3	-12.1	-13.4	-14.4	-15.8	-18.2	-19.7
Feed Use	65.6	68.4	69.7	71.8	75.0	79.2	83.2	87.4	92.7	97.0

Malawi soybean sector

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
		000 ha									
Area	79.47	73.94	86.80	75.19	75.84	102.65	114.37	121.91	139.01	149.69	183.92
		tonnes/ha									
Yield	0.90	0.87	0.98	0.98	1.00	1.01	1.02	1.08	0.87	0.88	0.97
		tonnes									
Production	71295	64489	85098	73356	75665	103617	116977	132185	120952	132417	179205
Imports	0	8437	2173	1868	90	2278	597	1108	51	50	600
Consumption	60455	72780	83485	64553	70714	101338	103241	110052	111446	122467	137346
Food	30836	37123	42583	32927	36069	51690	52660	56134	56845	62467	70065
Crush	29619	35657	40902	31626	34645	49648	50581	53918	54601	60000	67281
Exports	10840	146	3786	10671	5041	4557	14333	23241	9557	10000	42459
Ending stocks	0	0	0	0	0	0	0	0	0	0	0
Net Exports	10840	-8291	1613	8803	4951	2279	13736	22133	9506	9950	41859
		Kwacha/kg									
Soybean price	75.74	105.55	134.71	114.90	138.65	225.97	253.31	273.10	318.74	432.34	455.76
		tonnes									
Soybean meal											
Production	23695	28526	32721	25301	27716	39719	40465	43134	43680	48000	53825
Imports	7	1544	698	83	3693	1200	0	0	1650	1700	0
Exports	167	116	93	1720	116	3	120	7794	20408	20000	22640
Net exports	160	-1428	-605	1637	-3577	-1197	120	7794	18758	18300	22640
Feed use	23535	29954	33326	23664	31293	40916	40345	35340	24922	29700	31185
Soybean oil											
Production	5924	7131	8180	6325	6929	9930	10116	10784	10920	12000	13456
Imports	15821	14950	13942	14167	17444	9531	7451	10198	9388	10000	9224
Exports	0	287	0	215	0	0	0	0	0	0	0
Net exports	-15821	-14663	-13942	-13952	-17444	-9531	-7451	-10198	-9388	-10000	-9224
Food use	21745	21794	22122	20277	24373	19461	17567	20982	20308	22000	22680

Malawi soybean sector

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
			000 ha							
Area	195.98	205.59	212.57	217.32	220.84	224.04	227.44	231.22	235.00	238.56
Yield	1.00	1.03	1.05	1.07	1.10	1.12	1.14	1.16	1.19	1.21
			tonnes							
Production	196619	211566	223587	233287	241825	250360	259422	269196	279065	288754
Imports	600	600	600	600	600	600	600	600	600	600
Consumption	146170	154122	161753	170784	180095	189671	199349	209937	221068	232212
Food	74242	78702	83383	88146	93035	98089	103285	108717	114357	120214
Crush	71928	75420	78370	82638	87060	91582	96063	101220	106711	111997
Exports	51049	58045	62435	63102	62330	61289	60673	59859	58597	57142
Ending stocks	0	0	0	0	0	0	0	0	0	0
Net Exports	50449	57445	61835	62502	61730	60689	60073	59259	57997	56542
			Kwacha/kg							
Soybean price	474.06	478.28	470.52	469.98	475.95	481.93	491.66	495.01	497.20	498.88
			tonnes							
Soybean meal										
Production	57542	60336	62696	66110	69648	73265	76851	80976	85369	89598
Imports	0	0	0	0	0	0	0	0	0	0
Exports	24798	25955	26595	28205	29847	31475	32970	34902	36991	38801
Net exports	24798	25955	26595	28205	29847	31475	32970	34902	36991	38801
Feed use	32744	34381	36101	37906	39801	41791	43880	46074	48378	50797
Soybean oil										
Production	14386	15084	15674	16528	17412	18316	19213	20244	21342	22399
Imports	8992	9006	9143	9030	8901	8766	8657	8430	8154	7936
Exports	0	0	0	0	0	0	0	0	0	0
Net exports	-8992	-9006	-9143	-9030	-8901	-8766	-8657	-8430	-8154	-7936
Food use	23377	24090	24817	25558	26312	27083	27869	28674	29496	30335

Mozambique soybean sector

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
		000 ha									
Area	6.00	9.00	11.93	8.74	12.32	23.73	30.99	38.93	27.39	28.17	25.80
		tonnes/ha									
Yield	0.92	0.89	0.93	0.85	0.96	1.03	1.13	1.26	1.22	1.26	1.27
		tonnes									
Production	5500	8000	11100	7440	11855	24522	35020	48930	33315	35430	32743
Imports	1237	1881	2464	39	1614	3221	841	715	3487	3500	9311
Consumption	6619	9850	13564	7479	13441	27743	34805	48149	36712	38930	42054
Food	469	36	137	239	2129	3288	857	1000	1000	1000	1269
Crush	6150	9814	13427	7240	11312	24455	33948	47149	35712	37930	40785
Exports	118	31	0	0	28	0	1056	1496	90	0	0
Ending stocks	0	0	0	0	0	0	0	0	0	0	0
Net Exports	-1119	-1850	-2464	-39	-1586	-3221	215	781	-3397	-3500	-9311
		Metical/kg									
Soybean price	0.00	20.00	12.00	15.00	16.00	19.00	12.00	12.00	20.00	28.00	24.91
		tonnes									
Soybean meal											
Production	4920	7851	10742	5792	9050	19564	27158	37719	28570	30344	32628
Imports	12816	7644	10343	7909	11623	5034	8941	15598	28115	30000	29526
Exports	109	264	509	459	0	0	0	550	0	0	0
Net exports	-12707	-7380	-9834	-7450	-11623	-5034	-8941	-15048	-28115	-30000	-29526
Feed use	17627	15231	20576	13242	20673	24598	36099	52767	56685	60344	62154
Soybean oil											
Production	1230	1963	2685	1448	2262	4891	6790	9430	7142	7586	8157
Imports	16612	35737	10082	20527	20947	7710	31970	20932	29161	30000	28608
Exports	0	1	0	114	138	0	267	1325	1791	1800	0
Net exports	-16612	-35736	-10082	-20413	-20809	-7710	-31703	-19607	-27370	-28200	-28608
Food use	17842	37699	12767	21861	23071	12601	38493	29037	34512	35786	36765

Mozambique soybean sector

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
			000 ha							
Area	25.26	25.24	25.67	26.61	28.14	30.08	32.31	34.76	37.35	40.15
Yield	1.28	1.29	1.30	1.31	1.32	1.33	1.34	1.35	1.36	1.37
			tonnes							
Production	32302	32497	33293	34768	37046	39892	43179	46794	50659	54863
Imports	9174	9139	8868	7869	6298	4297	1870	600	600	600
Consumption	41476	41636	42162	42638	43344	44189	45049	45883	46803	47033
Food	1430	1531	1620	1713	1780	1844	1907	1970	2037	2101
Crush	40046	40104	40541	40924	41564	42345	43142	43913	44766	44931
Exports	0	0	0	0	0	0	0	1510	4456	8430
Ending stocks	0	0	0	0	0	0	0	0	0	0
Net Exports	-9174	-9139	-8868	-7869	-6298	-4297	-1870	910	3856	7830
			Metical/kg							
Soybean price	23.13	23.41	24.01	24.33	24.99	25.91	26.93	28.10	29.12	29.90
			tonnes							
Soybean meal										
Production	32037	32083	32433	32740	33251	33876	34514	35131	35813	35945
Imports	31982	33856	35484	37215	38803	40339	41928	43604	45284	47585
Exports	0	0	0	0	0	0	0	0	0	0
Net exports	-31982	-33856	-35484	-37215	-38803	-40339	-41928	-43604	-45284	-47585
Feed use	64019	65939	67918	69955	72054	74215	76442	78735	81097	83530
Soybean oil										
Production	8009	8021	8108	8185	8313	8469	8628	8783	8953	8986
Imports	29753	30759	31712	32700	33660	34615	35592	36600	37617	38797
Exports	0	0	0	0	0	0	0	0	0	0
Net exports	-29753	-30759	-31712	-32700	-33660	-34615	-35592	-36600	-37617	-38797
Food use	37762	38780	39821	40885	41973	43084	44221	45383	46570	47784

List of abbreviations

AfDB	African Developing Bank
BFAP	Bureau for Food and Agricultural Policy
CAP	Common Agricultural Policy
CARD	Centre for Agricultural Research and Development
CEPPAG	*Centro de Estudo de Políticas e Programas Agroalimentares*
CGAP	Consultative Group to Assist the Poor
DAFF	South African Department of Agriculture, Forestry and Fisheries
EU	European Union
FAPRI	Food and Agricultural Policy Research Institute
FAO	Food and Agriculture Organization of the United Nations
FISP	Farm Input Subsidy Program
FRA	Food Reserve Agency
GDP	Gross Domestic Product
GMO	Genetically Modified Organism
GNP	Gross National Product
IAPRI	Indaba Agriculture Policy Research Institute
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IMF	International Monetary Fund
ITC	International Trade Centre
JRC	Joint Research Centre
LDCs	Least Developed Countries
LSM	Living Standard Measure
LUANAR	Lilongwe University of Agriculture and Natural Resources
MOST	Malawi Oilseeds Sector Transformation
NAMC	National Agricultural Marketing Council
NGO	Non-Governmental Organisation
OECD	Organisation for Economic Co-operation and Development
PNISA	*Plano Nacional de Investimentos para o Sector Agrário*
ReNAPRI	Regional Network of Agricultural Policy Research Institutes
RFS	Renewable Fuel Standard
SADC	Southern African Development Community
SPEED	Support Program for Economic and Enterprise Development
SSA	Sub-Saharan Africa
USAID	United States Agency for International Development
VAT	Value Added Tax
ZNFU	Zambia National Farmers' Union

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