An overview of derived soy products used for human consumption in South Africa

Introduction

Soybeans and its related products are used in a multitude of forms in different food products. The main soy derivative products produced for the human food market are full-fat soybean meal, white flakes (also referred to as defatted soybean meal), textured vegetable protein (TVP), soy concentrates and soy isolates. Full fat soybean meal is mainly produced for blended cereals to increase breakfast products' protein content. White flakes and TVP are typically used as meat analogues, as absorption agents and extenders to increase the protein content. TVP can also be added to meals to increase the protein content of the meal. Concentrates (65%+ protein with sugars removed) and isolates (90%+ protein with sugar and fibre removed) are generally used to enhance the protein levels in products such as breakfast's cereals and health supplements (Table 1).

Table 1: Soybean derived products

Soy product	Full fat Soybean meal	White flakes	Textured vegetable protein (TVP)	Soy protein concentrates	Soy protein isolates
Composition	40-42% Protein 20% Oil	50-54% Protein 1% Oil	50-54% Protein 1% Oil	65-70% Protein 1% Oil	90-92% Protein 1% Oil
Example of end-use products	Breakfast products, blended cereals	Meat analogues	Meat analogues or meat extenders	Meat and dairy analogues	Health supplements, protein bars

Source: Muller et al. (2018); Industry interviews

Other end-products that have different applications in which TVPs are used in South Africa include processed meats, cold meats, soy mince, soymilk, other beverages such as smoothies, milkshakes and yoghurt, infant formulas, baked goods, bread flour and baked good pre-mixes, porridges, soups, sauces, nutritional shakes, and meal replacers (Van der Merwe et al., 2013).

Despite the wide use of derived soy products in food products, the size of this market and potential for its growth in South Africa is not clear. Moreover, anecdotal evidence suggested that the processing of soybeans for the human food market could support the crush margin as products destined for the human market are marketed at a premium. Figure 1 illustrates fluctuations in the crushing margin over time.

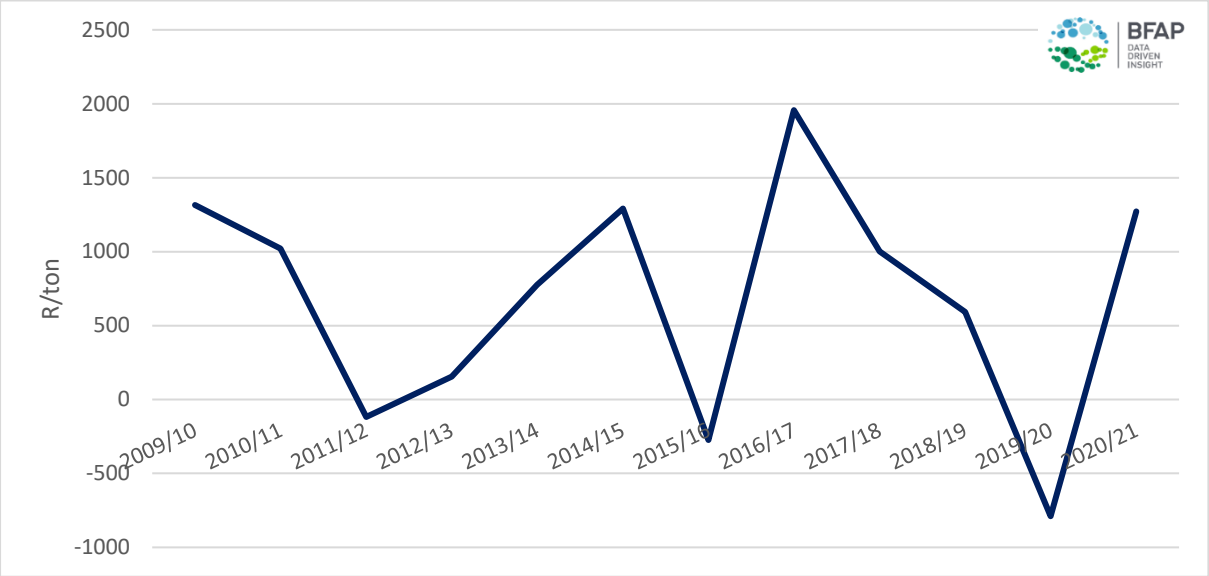

Figure 1: Soybean crushing margin (2009/10 to 2020/21)
Source: Own calculations based on industry discussions

According to industry experts, the profit margin is three times higher when processing for the human market due to the higher output prices. However, these profit margins are squeezed by storage costs when the products produced for the human market are not sold fast enough[1]. Despite this challenge, improving the crush margin is a fundamental requirement for the expanded crushing capacity in South Africa to reach its full potential.

The report sets out to systematically document the dynamics of derived soy products for the human food market in South Africa to support decisions based on the potential growth of soybean processing for the human food market. The report follows a systematic unpacking of the most important value chain nodes to understand the lay of the land in the derived soy industry. The report is based on secondary data,

[1] According to industry discussions TVPs have a shelf life of up to two years if stored correctly. However, keeping these products in storage for more than a year wipes out potential profits.

observations, and discussions with industry experts, specifically soybean crushers, producers of soybean products, and soy protein importers. The report contains a value chain map and process map that show the key role players and the soy-based products. Based on discussions with industry experts, the report also touches on output prices, volumes of production, consumption and trade associated with the various products. The report concludes with an analysis of the competitiveness of the market for soy-based products for human consumption, and a SWOT analysis to identify the key strengths, weaknesses, opportunities and threats to guide further research and industry discussions.

The growing popularity of soy-based products

Soy products have gained world-wide popularity in recent years for mainly three reasons. Firstly, it is a healthier alternative compared to other protein-rich foods, and soy health claims increased the number of soy products in global mainstream diets. According to the United Soybean Board (USB), 67% of consumers considered soy as healthy in 1998. Since then, this number increased to over 80% in 2005, to peak in 2007 at 85%, and then dropped slightly to 81%. In 2018, more than 25% of the American population consumed soy products at least once a week (Hexa Research, 2019). Soy products have a low content of saturated fat, a high content of polyunsaturated fats, a high content of omega 3 and 6 fatty acids, contains no cholesterol, is a good source of fibre, has a lower glycemic index, and has anti-cancer properties (Oldewage & Egal, 2017). Compared to other major food groups, cooked soybeans also contain more protein per serving (Table 2) which make it a good protein substitute to traditional protein sources such as meat, but also a good extender in processed meat products. However, a study conducted by Birkett (2017) revealed that consumers were most unsure of the protein content of processed meats such as polonies and viennas.

Table 2: Protein content of major food groups

Food group	One serving	Protein amount (g)
Meat	85g lean cooked beef	28
	85g cooked chicken	26
	85g anchovy canned in oil	25
Legumes	1 cup cooked soybeans	29

	1 cup boiled split peas	16
	1 cup red kidney beans	13
Dairy	1 cup milk	8
	28g cheddar cheese	7
	30g low fat cottage cheese	4
Starches and cereals	1 cup white rice	9
	1 cup oat bran	7
	1 slice wholewheat bread	3
Fruit and vegetables	1 cup spinach	5
	1 banana	1

Source: Muller et al. (2018)

Soy oil is also believed to be healthier than vegetable oil, by 77% of its consumers, as it has lower saturated fats than other oils. Although South Africans still prefer sunflower seed oil to soybean oil (Figure 2), soy oil is widely available and consumed in many parts of the world, including Asia and the USA. However, globally, palm oil remains the most consumed oil because of its relative affordability. According to Opperman and Varia (2011), palm oil is preferred by many consumers as it is up to 20% cheaper in many countries compared to, for example, soybean oil. According to Human (2017), soy oil is beneficial as it; (i) has a clean and neutral taste and a neutral smell that consumers prefer as it enhances food, (ii) is adaptable because of its high emulsifying ability, (iii) is ideal for frying, baking, confectionery, shortening and margarine, (iv) provides vitamin E and essential fatty acids, and (v) is cholesterol free, low in polyunsaturated fat, trans-fat free, and low in hydrogenated fat.

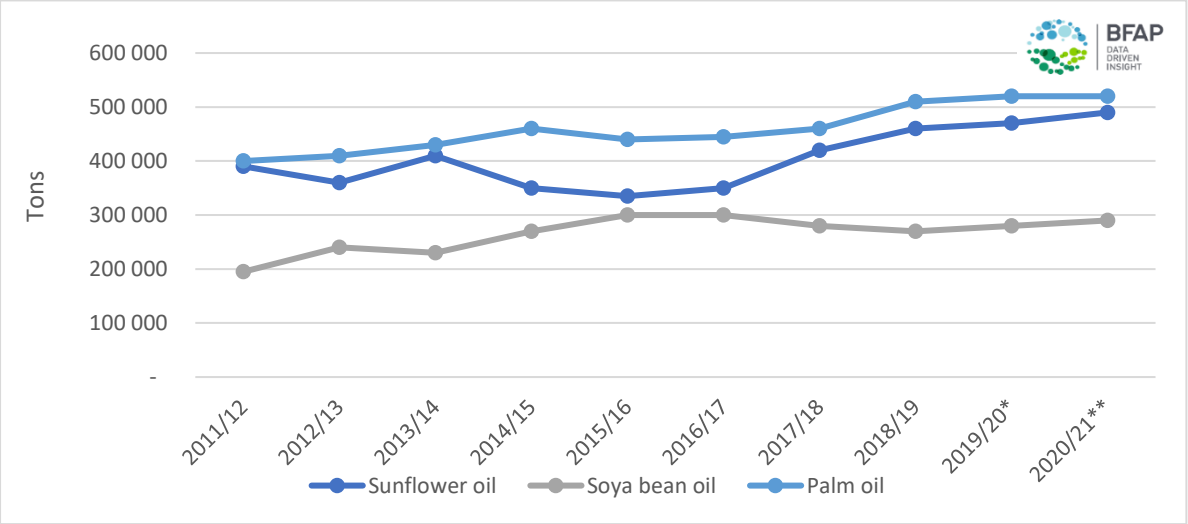

Figure 2: Soybean, sunflower and palm oil consumption in SA (2011 – 2021)

Source: USDA-FAS (2020); Manthata (2018)
*Note: ** forecasted; * estimate*

Secondly, soy-based products are a cheaper alternative compared to other protein-rich foods. In South Africa, soy-based products' appeal lies in its affordability (per gram of protein) compared to high-quality protein alternatives such as meat and eggs (Myburgh, 2020). Industry experts, in January 2021, reported that soy mince (spiced and including hydrated vegetables) cost as little as R3.50 per serving (R7 per plate feeding two people) compared to a serving of beef mince (no vegetables added) at R9.80[2]. A cup of soup made from 50g of dried and roasted soybeans, containing 18% of protein costs as little as R1 per cup (excluding other ingredients), making it the cheapest protein alternative on the market (Nortjé, 2020).

Although many Southern Africans are either obese or overweight[3], many are also undernourished; 22% has insufficient food and 12% experience chronic hunger because of rising food prices (Oldewage & Egal, 2017). Rising food prices may lead to food insecurity, insufficient protein consumption and undernourishment. Moreover, the global population's growth is expected to increase pressure on food manufacturers to ensure the correct combination of protein, carbohydrates, fats, vitamins, and minerals at affordable prices. The nutritional properties of the soybean, particularly its high protein content, make it a good protein substitute in the diet and can be beneficial to supplement diets for the undernourished, more so in a country where protein-energy malnutrition is widespread (Myburgh, 2020).

Thirdly, soy-based products are a more convenient alternative for the poor and those living in rural areas. The poor and those living in rural areas often do not have the financial means or the necessary infrastructure to store raw meat under the right conditions. Therefore, in addition to being a cheaper, more nutritious and protein-dense option, soy-based proteins' shelf life also makes it easier and less expensive to store (Van der Merwe et al., 2013).

[2] Based on a 125g serving of beef mince priced at R79 per kilogram at Shoprite on 12 February 2021 (https://www.shoprite.co.za/c-2524/All-Departments/Food/Fresh-Food/Fresh-Meat-and-Poultry/Mince)
[3] 70% women and 33% men, and 25% girls and 20% boys aged 2 to 14 categorised as overweight or obese (Oldewage & Egal, 2017).

Fourthly, consumers are looking to balance plant and animal products as a protein source in their diets. A phenomenon that we see mainly in developed countries. The inclusion of plant proteins in these consumers' diets, as an alternative to animal proteins, is usually either for health reasons or concerns about the impact of livestock production on the environment. Soy products generally have a longer shelf life, are cheaper to handle and store, and are about 50% more environmentally friendly than its protein equivalents (Myburgh, 2020).

Although soy-based products have grown in popularity globally[4], more specifically in the western world, the consumption levels of soy-based products in South Africa remain low despite its many applications and benefits. However, some scholars believe that "further research and consumer education on soya may be the key to unlocking more opportunities for the soya bean industry within the South African consumer market." (Muller et al., 2018).

The South African soybean value chain

The South African soybean value chain involves several key players, and several processes, to move the soybean from seed to feed or from seed to food. What makes the soybean value chain even more complex is that it also feeds into many other value chains such as livestock value chains, food value chains and textile and industrial value chains. Figure 3 below illustrates this complex value chain.

[4] Soy food products amounted to 38.7 billion USD globally in 2018, with an expected value of 53.1 billion USD in 2024 (Statista, 2021). It is expected that the increasing preference for plant-based proteins will augment the global demand for soy-based food products in the near future (Myburgh, 2020).

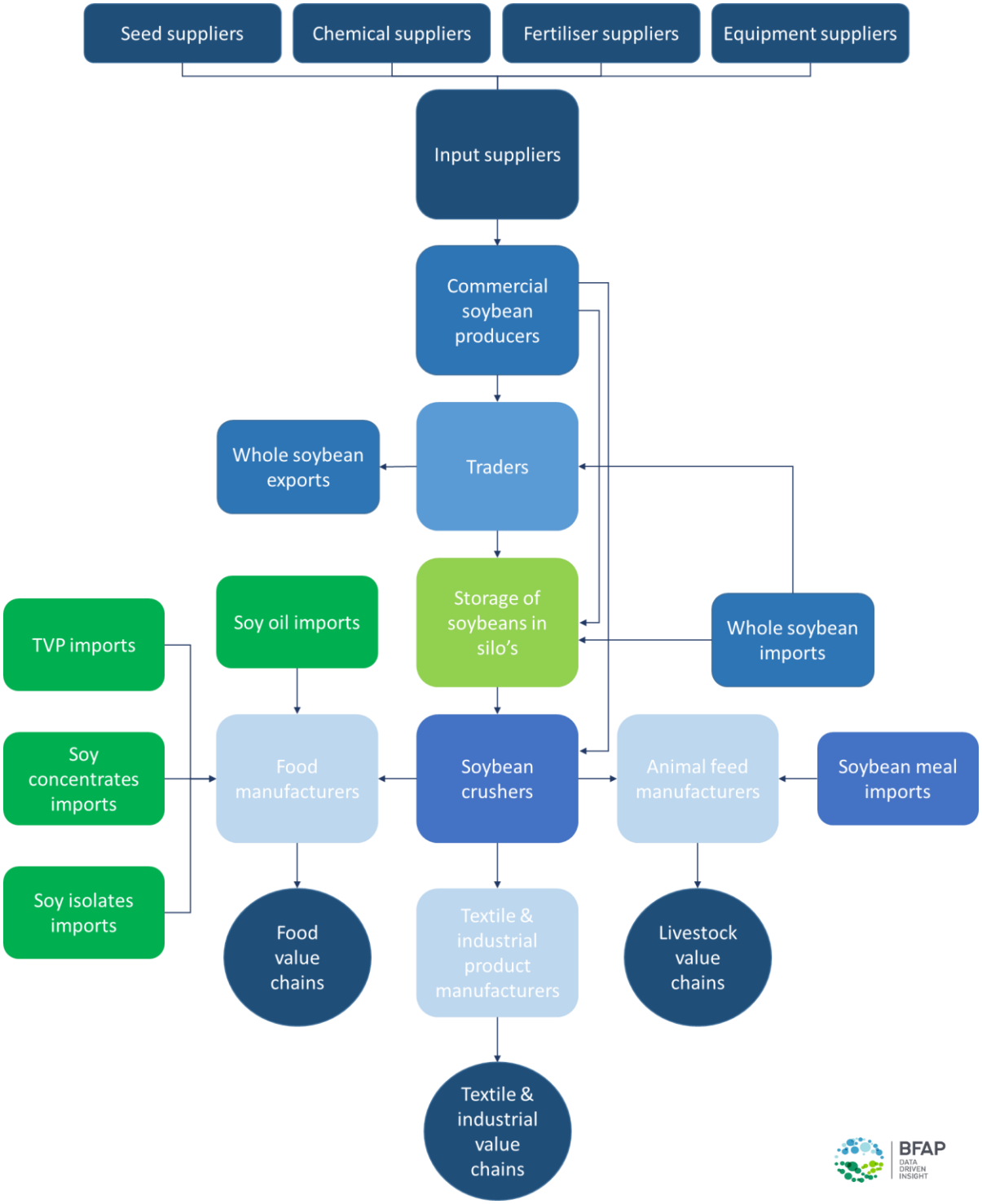

Figure 3: Soybean value chain
Source: Adapted from the NAMC (2011); DAFF (2014); Industry interviews

The remainder of this section briefly explains the main value chain nodes, production, processing, trade and final products destined for food, animal feed and textile and industrial products. This sets the scene for more detailed evaluations of the three critical nodes in the market for human consumption namely; consumption of soy-based

food products, processing of soybeans into products fit for human consumption and imports of soy proteins used in specifically the food value chain.

Soybean production

Most of the soybeans produced in South Africa are produced by commercial farmers and are mainly GMO soybeans. Less than 1% of the soybeans produced in South Africa are non-GMO. South Africa produced approximately 226 000 tons of soybeans, on average between 1998 and 2008, and since then, area planted to soybeans has increased to produce an average of 910 000 tons of soybeans between 2009 and 2020 (Figure 4).

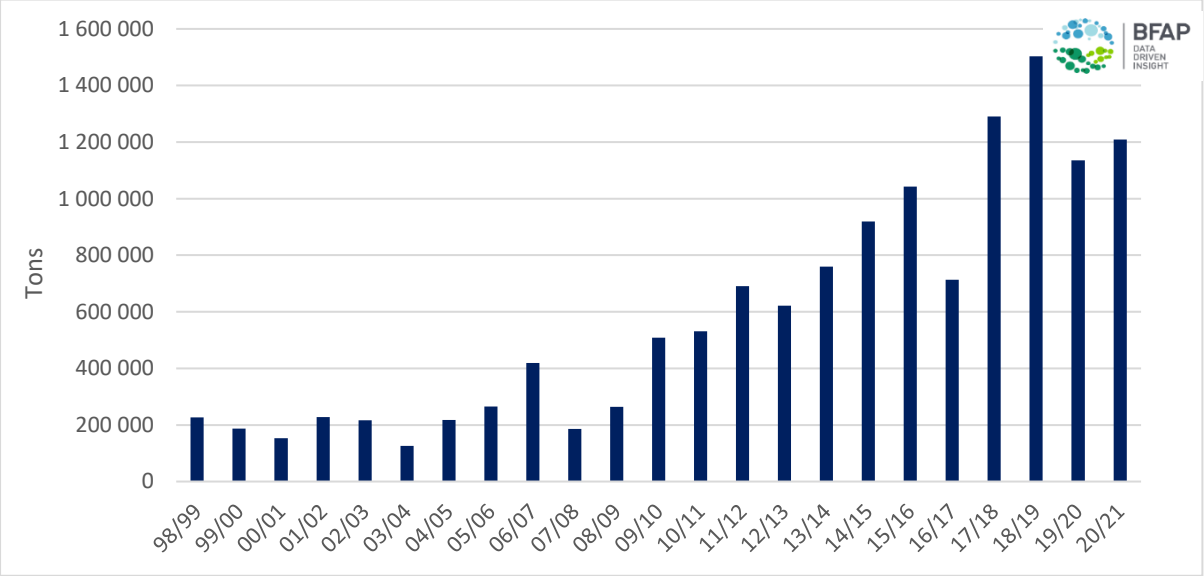

Figure 4: Soybean production in South Africa (1998 to 2020)
Source: SAGIS (2021a)

Over the last decade, South Africa has made significant investments in the domestic soybean crushing capacity. These investments mainly aim to stimulate domestic soybean production to displace imported soybeans and soybean products such as soybean meal. These investments led to increases in the crushing capacity to about 2.2 million tons. As a result of these investments, soybean production showed a steady increase and surpassed the 1-million-ton mark in 2015/16.

Soybean processing

According to the latest BFAP estimates the largest crushing plants are COFCO in Standerton (29%), followed by Wilmar SA in Randfontein (15%), RussellStone Protein

in Bronkhorstspruit (11%), Willowton Group in Isando (9%), Free State Oils in Villiers (9%), Nedan Oil in Potgietersrus (8%), and Majesty Oil Mills in Krugersdorp (7%).

Figure 5 illustrates the rapid growth in South Africa's crushing capacity over the last decade due to the investments made in pursuing the governmental import replacement strategy. In 2019 soybean crushing reached an all-time high of 1 484 692 tons. In 2020 South Africa crushed a total of 1 230 399 tons compared to 406 900 tons 10 years ago; a 202% increase over 10 years.

The biggest crushing plants producing soy products for the human food market, according to industry discussions, are Nedan Oil (60% market share) and Majesty Oil Mills (40% market share), together they crush and process 90% of the soybeans destined for the human market. The remaining 10% are shared by smaller crushing plants such as Free State Oils, Elanga Oil (Meyerton), and others.

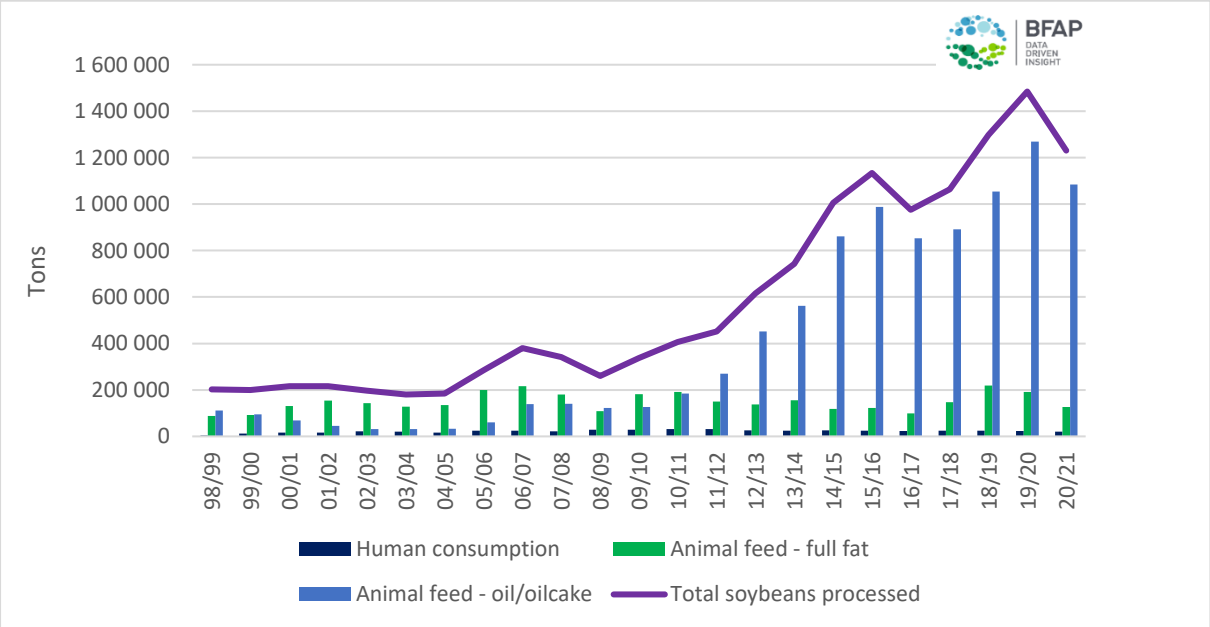

Figure 5: Soybean processing South Africa (1998 to 2020)
Source: SAGIS (2021a)

Soybean trade

Despite the increasing soybean production levels, South Africa still imports soybeans to satisfy oilcake demand from the animal feeds sector. This growth in oilcake demand was driven by increases in the demand for high protein food, specifically meats, within the growing middle class.

Figure 6 below illustrates soybean trade from 1998 to 2020. Most imports come from South America. In 2020, 88.9% of the soybeans came from Brazil, followed by Zambia (6.7%), Mozambique (2.6%) and Malawi (2.1%). In total South Africa imported 62 063 tons of soybeans. Since 1998 South Africa has only exported small amounts of soybeans with the most beans exported between 2009 and 2012. Soybeans are exported to neighbouring countries. In 2020, 63.1% of our soybeans went to Botswana, followed by Mozambique (34.8%), Lesotho (1.1%), Eswatini (0.8%) and Zimbabwe (0.2%).

Aside from whole soybeans, South Africa, at times, also imported soybean oil cake for the animal feeds market which falls beyond the scope of this report. TVPs, soy protein concentrates, and soy protein isolates, mainly destined for the food market, are also imported and discussed in much more detail in this report's subsequent sections.

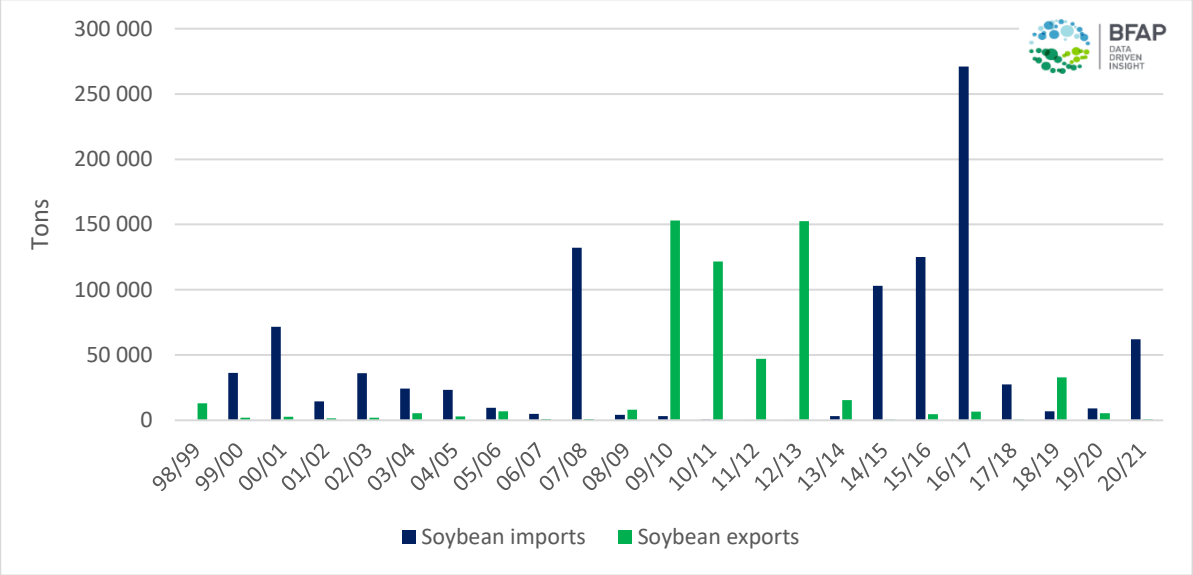

Figure 6: Trade of whole soybeans from 1998 to 2020
Source: SAGIS (2021a)

Soybean final products

Only about 1.6% of soybeans crushed in South Africa are destined for the human market either as white flakes or as TVPs to be used in food value chains (Figure 7). The remaining 98.4% feeds into animal feed value chains as full-fat soybean meal (10.3%) and soybean oil/oilcake (88.1%). Although the market for animal feeds falls outside this report's scope, the remainder of the report unpacks the derived soy products used for human consumption in South Africa in detail.

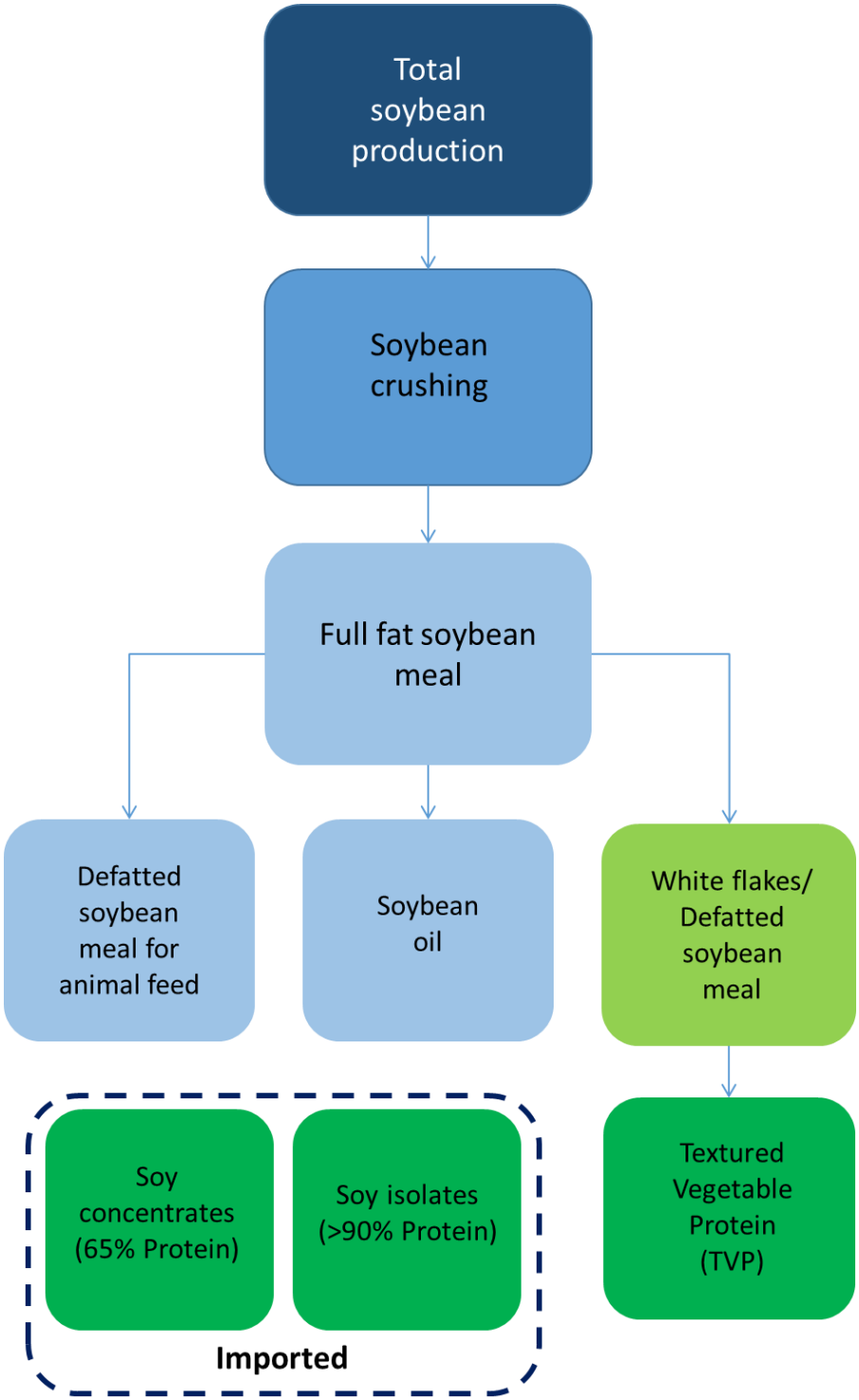

Figure 7: Main products from soybean crushing
Source: Industry interviews

One ton of soybeans yield 180kg oil, 630kg white flakes, or just over 500kg TVP according to industry discussions. In January 2021, industry experts reported the price of white flakes as between R8.50 and R10/kg, the price of TVPs at R35/kg, the price of soy concentrates at R48/kg and the price of isolates at R50/kg.

According to industry experts, several buyers in food value chains use white flakes and TVPs as inputs in food products. The biggest role players are Crown National, Deli Spice and Bluff Meats. Other companies also use soy derivates such as full-fat soybean meal, isolates and concentrates. These products are imported either because the market demands non-GMO products or because the specific soy product is not produced in South Africa. Food manufacturers that use concentrates and isolates include many processed meat manufacturing companies like Eskort, Tiger Brands, RCL foods and others that produce processed meat such as polonies, viennas, and burger patties. Apart from food manufacturers, isolates and concentrates are also used by companies such as Faithful to Nature, and Health Connection that produces health products such as protein shakes and health bars. Isolates and concentrates are also used in malnutrition packs such as those produced by Diva Nutritional products. Companies such as Pioneer Foods use full fat soybean meal to be included in products such as breakfast cereals.

Consumption of soy-based products

There are five major market groups for soy-based food products; those consumers that (i) limit certain animal products because of religious or dietary restrictions, (ii) look for a healthier alternative to meat, (iii) purchase soy-based snack products to supplement their diets, (iv) look for cheaper protein sources, (v) live in impoverished countries and demand protein-rich foods that remain stable under poor conditions and have a long shelf life, and (vi) those unaware that they are consuming food products fortified or supplemented with soy-based products. Therefore, it is, crucial to consider and exploit the potential within these markets to support and grow the soy for human consumption market within South Africa. Local and international food manufacturers are already making a strong effort to exploit the potential by bringing soy-based foods or foods with soy as an ingredient to the consumer (Van der Merwe et al. (2013).

The strongest demand for soy food products come from Asia Pacific (40% of the food market in 2017) specifically countries like China, Indonesia, and India. China is also the largest manufacturer and importer of soy food products. The largest importer of soybeans as raw material (mainly from Brazil and the USA) for food manufacturing, is Europe, with Germany having the largest number of production facilities. Germany followed by France was also the largest consumers of soy food products in Europe.

The USA is one of the major producers of soybeans and close to 50% of the beans are domestically processed into oil and milk for human consumption (Hexa Research, 2019). The product offering of soy food products has increased significantly, with the USA and Europe, showing growth rates in product offerings of more than 80% in recent years (Myburgh, 2020).

Some of the popular soy products include soy milk, yoghurt, and tofu. Some of the popular soy containing products include meat replacements, energy bars, protein-enriched cereals, bread, and other baked goods (Hea & Chen, 2017; Oldewage & Egal, 2017). Table 3 summarises some of the commonly consumed soy-based products in the global market.

Table 3: Commonly consumed soy foods

Non-fermented soy foods	Soy milk	• An off-white emulsion containing the water-soluble proteins and carbohydrates, and most of the oil of the soybeans.
	Tofu	• A white protein curd precipitated from soy milk by a calcium salt or, concentrated seawater. • Cottage cheese-like product formed into a cake. • Lower in calories compared to cheese or meat because of its higher protein/fat ratio.
	Soy sprouts	• Germinated soybeans in dark yellow cotyledons with white sprouts.
	Soy film	• A creamy, yellowish protein-lipid film formed from the surface of boiling soy drink. • It is presented in sticks or flakes.
	Edamame	• Immature green soybeans that are high in protein and fibre.
	Roasted soybeans	• Dry roasted soybeans, seasoned or non-seasoned.
Fermented soy foods	Miso	• Heated water extract of soybeans after grinding and filtration.
	Tempeh	• Cooked and dehulled soybeans fermented with a fungus. • Has a meat-like texture and mushroom-like flavour. • Becoming popular in the United States and other parts of the Western world
	Soy sauce	• It is extracted from a fermented mixture of soybeans and wheat.
	Natto	• Soybeans fermented with predominantly bacteria. • It has a slimy appearance, sweet taste and characteristic aroma.

Products derived from the oil fraction	Soybean oil	• Natural oil extracted from whole soybeans. • Most widely used oil in many parts of the world - sold as either pure soybean oil or as vegetable oil ingredient.
	Lecithin	• It is extracted from crude soybean oil through the refining process. • A natural emulsifier, lubricant, animal feed, pharmaceuticals, paints, and other industrial applications.
	Biodiesel	• Soy biodiesel is a fuel alternative produced from soybean oil used in diesel engines as an alternative fuel.
Products derived from the meal fraction	Soybean meal	• It is used as a protein source in animal feed.
	Defatted soybean flours and grits	• It is used in products for human consumption. • The basis for a variety of soy protein products including soy flour, soy concentrates and soy isolates.
	Protein concentrates	• Soy protein concentrate made from defatted soy flakes through a chemical extrusion process.
	Extrusion-textured soybean protein	• Defatted soybean flour with a specific moisture content is subjected to high shearing forces at high temperature in an extruder. • Product with a peculiar laminar structure is obtained. • After hydration, this product presents an elastic and chewy texture like meat.
	Textured soy protein	• It is made from defatted soy flour. • Sold in a dried, granular form and used as a meat extender or analogue and can be added to a meal to increase its protein content. • Texture like ground beef or other meat products. • Must be rehydrated with boiling water before use.
	Soy fibre (okara, soy bran, soy isolate fibre)	• Excellent sources of high-quality dietary fibre in both food and feed. • Okara is a pulp fibre by-product of soymilk, with a taste comparable to coconut milk. • Soy bran is made from soybean hulls and can be refined for use in food. • Soy isolate fibre is soy protein isolate in a fibrous form.

Source: UNCTAD (2016); Van der Merwe et al. (2013)

In South Africa, however, only a tiny percentage of soybeans are processed for human consumption[5] with most of the beans being processed for animal feed (SAGIS,

[5] Four soy products are frequently included in food products in South Africa: wet TVP and dry TVP (approximately 50% protein), soy protein concentrate (60% protein), and soy protein isolate (>90% protein).

2021a). The product offering of soy food products in South Africa is also small compared to the rest of the world and focus on consumers with lower disposable incomes. In South Africa, the main soy product consumed remain flavoured soy mince made from TVP. Other soy products such as soy concentrates are added to processed meats such as polony, viennas, and hamburger patties to ensure adequate protein levels. These soy products are also added to butcher meat such as mince and sausages as meat extenders to improve protein levels while improving the consumption experience (Myburgh, 2020).

South African consumers' relatively weak demand for soy-based products is mainly due to soy products' application in feeding programmes, uncertainty about the preparation of soy products (specifically TVP products such as soy mince) and the perceived lower quality of these products which constraints expansion (Van der Merwe et al., 2013). According to Muller et al. (2018), growth in the South African consumer market may benefit from consumer education on soy-based products.

Despite these negative sentiments, Van der Merwe et al. (2013), Muller et al. (2018), and others believe that soybean demand for the human market is increasing and shows potential for growth in the future. Potential that is already evident in the increase in the high-value soy-based product offering in the fresh, frozen and dairy aisles of retail stores. These offerings are driven by the growing popularity of vegetarianism and flexitarianism[6] following campaigns such as "Meatless Mondays", and the perceived negative impact that meat consumption has on the environment.

In January 2021, we visited several major supermarkets (Pick 'n Pay, Checkers, Spar and Woolworths) in Pretoria to identify and understand the soy for human consumption market. The observations made were then discussed with industry experts to deepen the understanding of the market and identify potential areas of growth. Our observations and discussions revealed the following.

The "fresh products" such as plant-based mince, nuggets and patties (made from wet TVP) displayed in fridges in either the meat section or the vegetable section of stores are produced in Europe, specifically the Netherlands, and imported. Moreover, these

[6] A style of eating that promotes mostly plant-based foods but allows moderate intake of meat and other animal products (Healthline, 2021).

products often contain pea protein as one of the main ingredients and not soy protein. According to industry experts, the fresh plant-based protein market is still tiny in South Africa and does not justify an investment by local food manufacturers to produce these plant-based products. The wealthy consumer demanding these plant-based products is also willing to pay the imported product's premium price. The main reason why these plant-based products contain pea protein and not soy protein is because pea protein is more palatable than soy protein as it does have a 'beany' taste often associated with products containing soy proteins. The industry experts highlighted three main reasons why it would not be feasible to replace these imported plant-based products with a local offering; (i) there is a significant risk of rejection by the consumer when pea protein is replaced by soy protein due to the difference in taste, (ii) the market for these products is too small to warrant the technological investment, (iii) the production of wet TVP comes at a higher cost due to the higher perishability of the product.

The frozen soy products section on retail shelves is dominated by the Fry Family Food Co (Fry's). The frozen soy products we find on retail shelves such as patties, nuggets, sausages and mince, are produced in South Africa and contain imported soy products (mainly concentrates) from Argentina, China or European countries. Industry experts explained that South Africa produces less than 1% of non-GMO soybeans while many food manufacturers prefer GMO free products, particularly those that export some of their final products. Moreover, to further process white flakes into concentrates would require a significant capital investment, something that the crushers are not considering now.

The dairy aisle, mainly stocked with soymilk, tells the same story with European products dominating the shelf space. Discussions with industry experts revealed that non-GMO soybeans with a white helium, a bean not grown in South Africa, are preferred for soymilk production.

Following these observations and discussions, it seems like the soy product market in South Africa with the highest potential is the market that produces products for the low-income consumer, particularly for products containing TVPs. Compared to other soy-based products produced in South Africa, these products make up the most significant share of the soy-based product basket.

To stimulate the consumption of soy-based food products among South Africans, the NAMC proposed the following already in 2011:

- Promote the health benefits of soy in diets as an alternative protein.
- Link with health practitioners and nutritionists to promote health benefits of including soy-based products in diets among consumers.
- Promote investment in processing technologies feasible for smallholder farmers in rural areas to promote soybean production and consumption in rural areas.
- Focus on research and development to improve the taste of soy products through, for example, improved cultivars.

These suggestions were made when South Africa was importing 90% of its soybean meal, on average, to meet local demand, mostly to satisfy the demands of the animal feeds market. Since then, local soybean processing capacity increased significantly, creating the potential to process higher volumes of soybeans for both the animal and human consumption. Although the local soybean crushers could largely displace imports for the animal feed market, soybean processing for human consumption remained low despite industry efforts.

The soybean industry experienced an initial increase in soybeans processed for human consumption after the expansion in crushing capacity, followed by a decline from 31 000 tons in 2011 to 20 052 tons in 2020 (Figure 8). Overall, the percentage of soybeans processed for animal feeds far outstrips the percentage of soybeans processed for human consumption. The percentage share of soybeans processed for human consumption decreased from 10.91% in 2008 to 1.63% in 2020. The apparent sharp decrease in the percentage of soybeans used for human consumption as a share of total utilisation was driven by the slight decrease in tonnages demanded for human consumption and the sharp increase in volumes crushed for the animal feeds market.

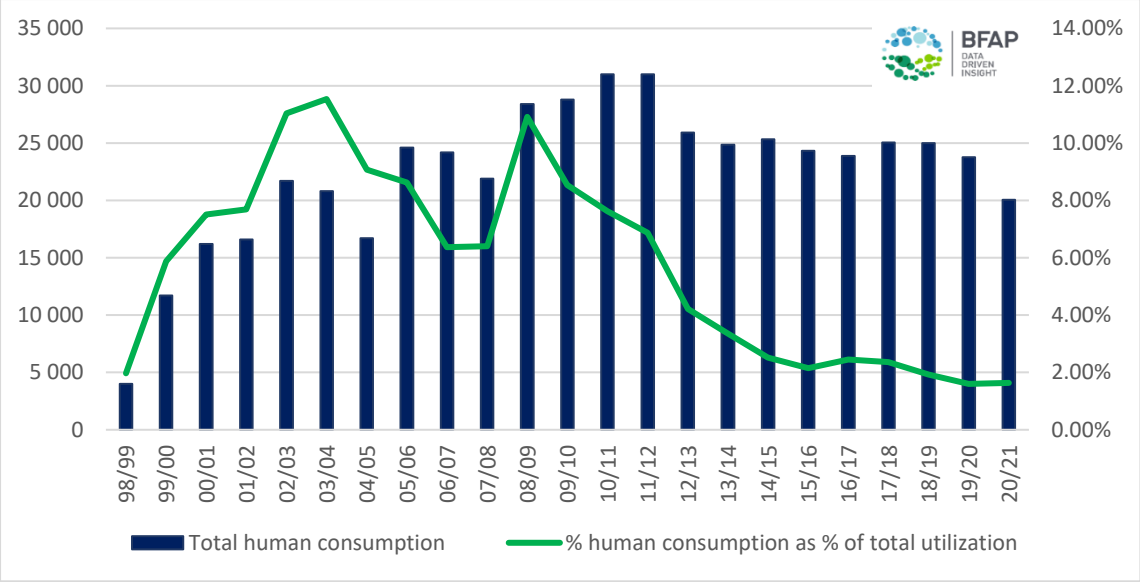

Figure 8: Human consumption of soybeans
Source: SAGIS (2021a)

Figure 9 below illustrates the volumes of soy-derived products manufactured for the human market between 2017/2018 and 2020/2021, specifically soybean flours and meals, and textured vegetable protein. The value for 2020/2021 excludes January to March but the expectation is that the final 2020/21 value will be close to the 2019/2020 value.

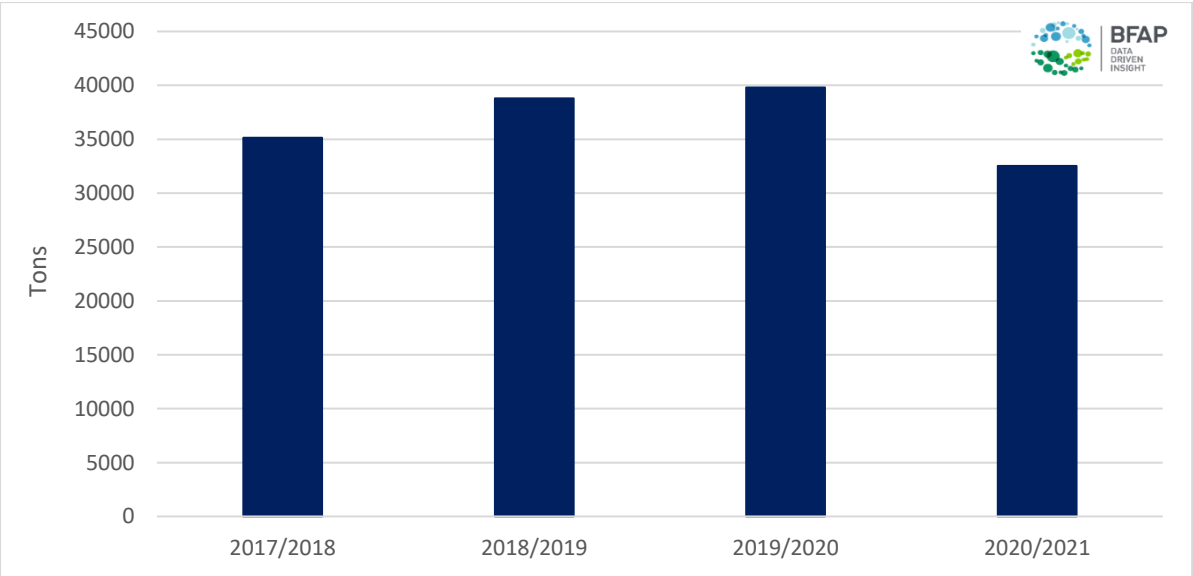

Figure 9: Soybean Flours and Meals / Textured Vegetable Protein manufactured (2017/2018 – 2020/2021)
Source: SAGIS (2021b)

Soy protein has been coined ‘mystery meat’ in the 1970s, a title soy protein has still not shed completely (Riaz, 2001). Since then, the industry has been working hard to

produce higher quality and more attractive meat analogues to market these products as new, high-quality products and not just inexpensive meat alternatives (Berk, 1992). “So far, this strategy seems to be successful” (Berk, 1992), especially in the developed world. Because of technological advancements, the food industry can create realistic analogues that equal their meat counterparts regarding texture, flavour and satiety (Riaz, 2001). As a result, North America and Europe have seen rapid growth in the market for TVPs used in meat analogues (Riaz, 2001). Although this strategy gained success in many parts of the western world, industry experts agree that a large part of the South African population, still considers meat analogues to be an inferior product and a cheaper alternative to meat.

Soybean crushing and manufacturing for the human market

The increasing pressure on food manufacturers to produce healthier and more affordable products with a higher protein content is expected to support growth in the soybean market for human consumption by about 25% over the next two years (Myburgh, 2020). Discussions with industry experts support this view. Many of the soybean crushers are seeing stronger demand for white flakes and TVP to be included in the production of processed meats and soy mince following the devastating effects of the COVID-19 pandemic on consumers’ disposable income in 2020. According to one soybean crusher and producer of TVPs, “consumers that were once able to purchase meat are now switching back to soy mince as a more affordable option.” Another soybean crusher reported a 20% increase in the demand for TVPs since August 2020.

Several companies produce or process soy-derived products for human consumption to be included in food products. These companies are split into three categories. Firstly, those that manufacture TVPs; usually soybean crushers or companies that purchase white flakes from crushers to produce TVPs. Secondly, those that produce soybean flours and meals (also white flakes). Thirdly, those that produce full-fat soybeans or use locally produced or imported full-fat soybeans in food manufacturing (Table 4).

Table 4: Processors/Manufacturers of soy-derived products for human consumption		
TVP manufacturers	**Soybean flours and meals**	**Full-fat soybeans**
Nedan Oil Mills	Impilo Products	Future Foods
Majesty Oil Mills	Irwing 615	CY Agriculture
Irwing 615	Nedan	Pioneer Foods
	Pro Rata Meulens	Oja Farms
	Somil	Chartwell
	Free State Oils	

Source: SAGIS (2021c)

The major soy products produced for the food industry from soybeans include textured vegetable protein (TVP), soy protein concentrates and soy protein isolates (Figure 7). TVP can be defined as "food products made from edible protein sources and characterised by having structural integrity and identifiable texture such that each unit will withstand hydration in cooking and other procedures used in preparing the food for consumption" (Featherstone, 2015). The primary use of textured vegetable protein (TVP) is as a meat extender in fresh or processed meat. As much as 30% of the meat can be replaced with hydrated TVP without sacrificing eating quality. Meat extenders are rehydrated to 60 to 65% moisture and blended with meats to reach a protein level of 20 to 30% (Riaz, 2001). TVP offers economic savings, and product improvement to increase the protein content, increasing the product's juiciness due to TVP's water-absorbing qualities and allowing for the use of higher-fat meats due to TVP's naturally lower saturated fat content. Mince extended with TVP has been used widely and successfully in school feeding programmes across the world. TVP's retortability also makes it popular to use in canned meats and other similar products. (Berk, 1992). TVP is also commonly used and marketed as meat analogues or 'imitation meat'. Although these products were mainly sought after by the vegetarian population, more and more health-conscious consumers consume meat analogues because of the health benefits of soy food products compared to other meat products. Texture and flavour remain the two biggest challenges when developing meat analogues (Riaz, 2001).

Soy protein concentrates are defatted soy meal without most of the oil and water-soluble sugars but with most of the protein (at least 70% on a moisture-free basis) and fibre of the original soybean. Soy protein isolates are defatted soy meal with most of the carbohydrates and oils removed, and contains more than 90% protein, on a

moisture-free basis (Berk, 1992). Soy concentrates, and soy isolates are not currently produced in South Africa but imported. According to industry experts, the equipment needed for chemical extrusion and isolation is not available in South Africa. The expansion into concentrates and isolates would require a significant capital investment. Moreover, the expected return on investments that the soybean crushers aim for is generally within five years. This return is not currently feasible for two main reasons. Firstly, the market for soy concentrates and isolates is relatively small, and the necessary returns would not be realised through local sales of these products. Secondly, although concentrates and isolates are used in high-value products such as health supplements, and breakfast cereals and bars, the high-value market makes up only about 10% of the total market for concentrates and isolates. The remaining 90% of these products are used in lower value products such as processed meats.

Figure 10 provides a detailed depiction of the soybean crushing process. Soybeans consist of 40% protein, 35% carbohydrates, 20% oil, and 5% ash (Muller et al., 2018; Van der Merwe et al., 2013). Raw soybeans are not suited for human consumption due to the protease compounds in the bean that inhibit digestibility. Once processed, the heat destroys the protease compounds, making the product safe to consume (Nortjé, 2020). The crushing process consists of four main steps; (i) drying and cleaning of the soybeans to remove dust and foreign matter, (ii) dehulling where soybeans pass through the first set of rollers to crack the beans to separate the beans from the hulls (either cold or warm dehulling), (iii) extrusion at high temperatures and high pressure to yield full-fat soy meal, and (iv) solvent extracting to separate the oil from the meal to produce soy oil and defatted soy oil cake that can be further processed into TVP. Further processing by way of chemical extrusion and isolation yield soy concentrates, and soy isolates, respectively.

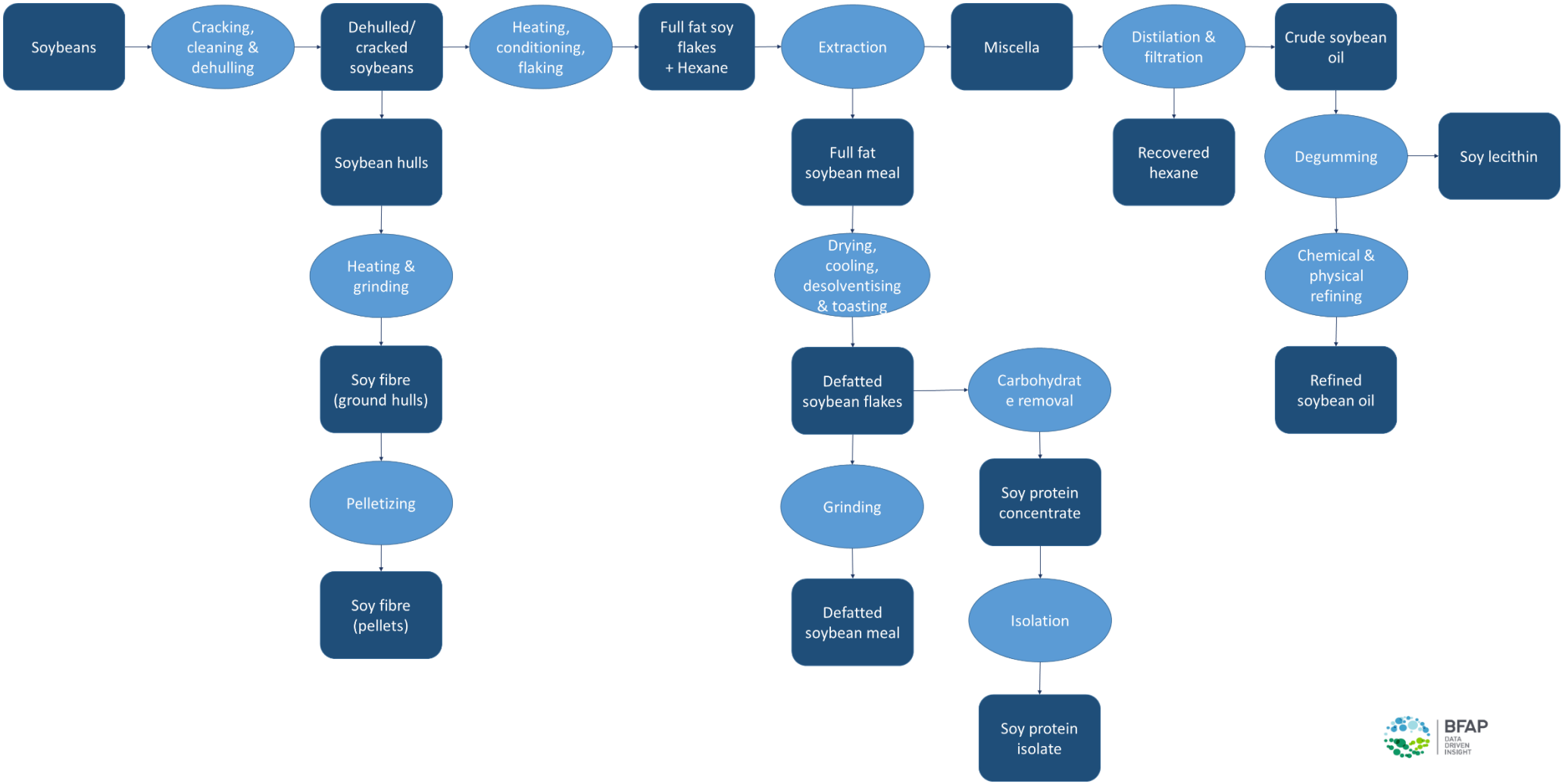

Figure 10: Soybean process map
Source: Willmar International (2021); Industry interviews

Van der Merwe et al. (2013) noted two main developments that can increase local, high-quality soy protein products. These are developing more economical processing technologies and improved soybean varieties to eliminate redundant, expensive processing steps to cut costs, and developing food-grade soybean varieties to improve the quality of locally produced soy protein.

The following soybean characteristics that need to be considered when producing soybeans for food was highlighted by Van der Merwe et al. in 2013. These food-grade varieties can support a reduction in processing costs, producing high-quality soy protein products demanded by food manufacturers, producing better tasting and less expensive soy-based food products that better satisfy consumer needs (Van der Merwe et al., 2018). Discussions with soybean crushers confirmed the characteristics listed below. However, some crushers noted that beans with a white helium are sometimes preferred to produce certain products.

- Large soybeans are preferred compared to smaller beans, with consistency in bean size critical.
- Beans need a clear hilum, a yellow, and thin but strong seed coat and a yellow cotyledon.
- In terms of its composition soybeans should ideally contain:
    - a high protein content (≥43%),
    - a high oil to protein ratio,
    - lower levels of the trypsin inhibitor to enhance protein digestibility,
    - lower activity of lipoxygenase to reduce the “beany” flavour during the oxidation process,
    - high sucrose levels
    - reduced flatulence causing raffinose and stachyose to fall below 1%, and
    - reduced polyunsaturated fatty acid content to improve oxidative stability.
- Although non-GMO beans are preferred to produce soy protein isolates, locally produced GMO soybeans are used to produce TVPs.

Trade of soy proteins for the human market

It may seem like the suggestions made by the NAMC in 2011 to promote the consumption of soy in diets were never fully implemented. However, the increasing soy concentrate imports suggest that higher volumes of soy-based products are

consumed domestically, despite the flat trend of soybeans crushed for human consumption over the last decade (Figure 8). This might be particularly true for products containing soy concentrates.

More than half of the soy products required for the human food market in South Africa are imported (Van der Merwe et al., 2013). According to industry experts, South Africa produces only full fat soy flour, white flakes and TVP. However, to supplement the food market's needs, South Africa imports some TVP. All the soy protein concentrates, and isolates used in food products are imported for the two reasons, as mentioned earlier. Firstly, the food value chain demands non-GMO concentrates and isolates, but South Africa produces less than 1% non-GMO soybeans. Secondly, the South African crushers do not have the required processing equipment to produce concentrates and isolates needed for food products.

Imports of derived soy products with a high concentration of protein has been steadily increasing over the past 10 years. Figure 11 and 12 summarises the movements in soy protein trade over the past three years in volumes and values. TVPs increased by 11.4% from 2018 to 2019 and then decreased by 0.5% from 2019 to reach 6 237 tons in 2020. Soy concentrates decreased by 7.8% from 2018 to 2019 and then increased by 21% from 2019 to reach 4 606 ton in 2020. Soy isolates contributed the largest proportion of imported soy proteins and showed little movements over the past couple of years, hovering around the 15 000 tons mark. In 2019, soy isolate imports increased by 3% from 2018, and in 2020 imports fell back by 2.3% to reach 15 045 tons. Although soy protein volumes imported show relatively small changes over the past three years, the rand's depreciation during 2020 led to significant changes in soy protein imports in value terms (Figure 9).

Most of the country's soy proteins originate from South America. Although South Africa produces a significant amount of TVPs, we also import some TVP from Argentina (63% of imports) followed by China (26%), Italy (9%), India (5%), the Netherlands (5%), and others (9%). As mentioned earlier, soy protein concentrates, and soy protein isolates are not produced domestically. Soy concentrates are mainly imported from Brazil (63%) and the USA (24%) with small amounts coming from the Netherlands (4%), China (3%) and others (2%). Soy isolates are mainly imported from China (93%)

with small amounts coming in from Brazil (3%) and other parts of the world (3%) (Trademap, 2021).

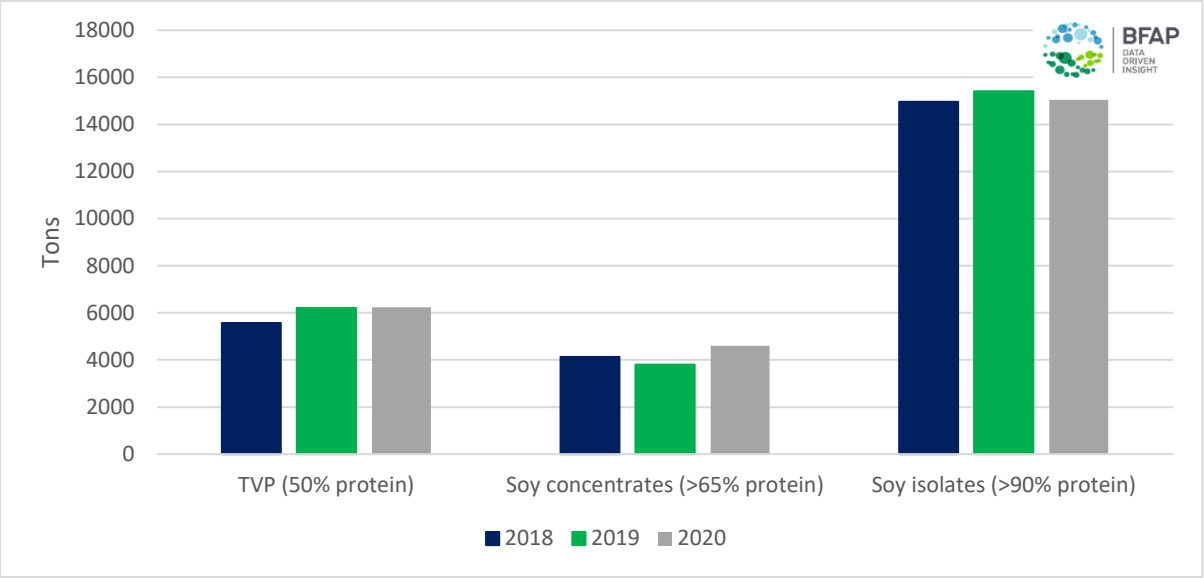

Figure 11: Soy protein imports (2018 – 2020)
Source: Trademap (2021)

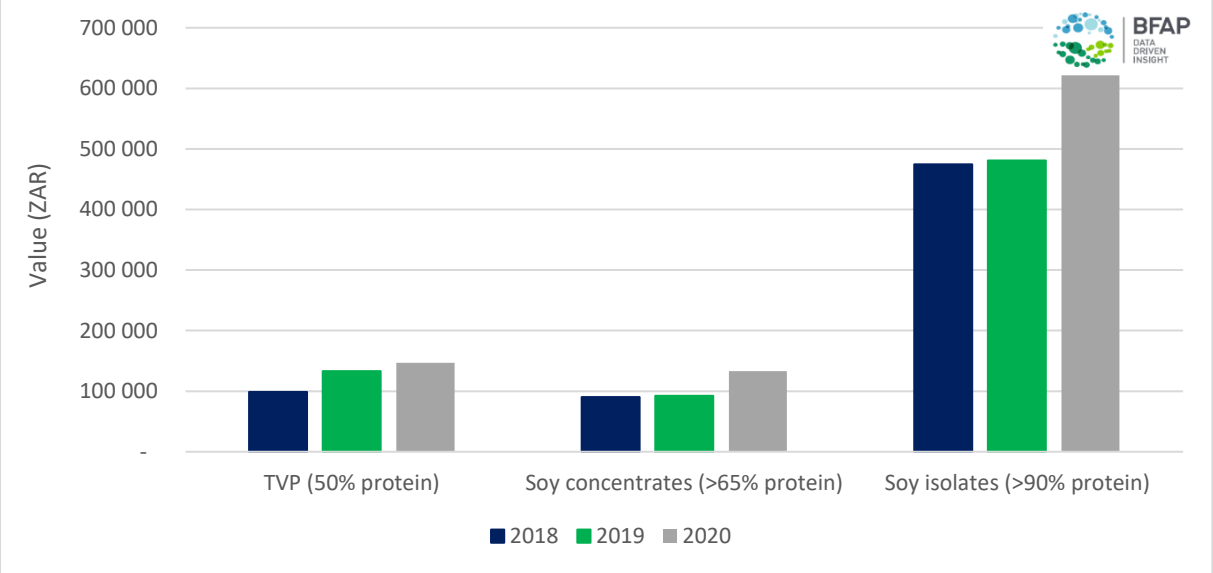

Figure 12: Soy protein export Rand value[7] (2018 – 2020)
Source: Trademap (2021)

[7] Nedbank Monthly Average Exchange rates – 2018, 2019, 2020 were used to calculate the ZAR values for Figure 9 and 10. https://www.nedbank.co.za/content/dam/nedbank/site-assets/AboutUs/Economics_Unit/Forecast_and_data/Daily_Rates/Monthly_Average_ Exchange_Rates.pdf

TVPs, soy protein concentrates, and soy protein isolates are also exported from South Africa (see Figure 12 for volumes and Figure 13 for values in USD). TVP exports decreased by 21.7% from 2018 to 2019 and increased by 77.8% from 2019 to reach 9 425 tons in 2020. Soy concentrates decreased by 48% from 2018 to 2019 and then increased by 4.9% from 2019 to reach 2 422 ton in 2020. Soy isolates decreased by 33.3% from 2018 to 2019 and increased by 68.6% to reach 118 tons in 2020.

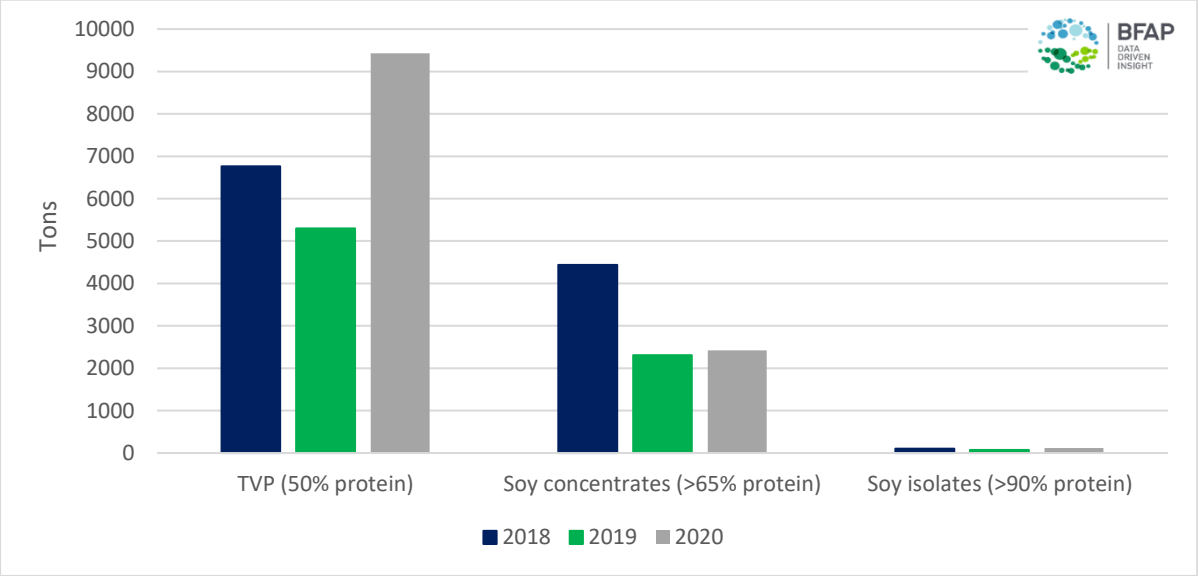

Figure 12: Soy protein export volume (2018 – 2020)
Source: Trademap (2021)

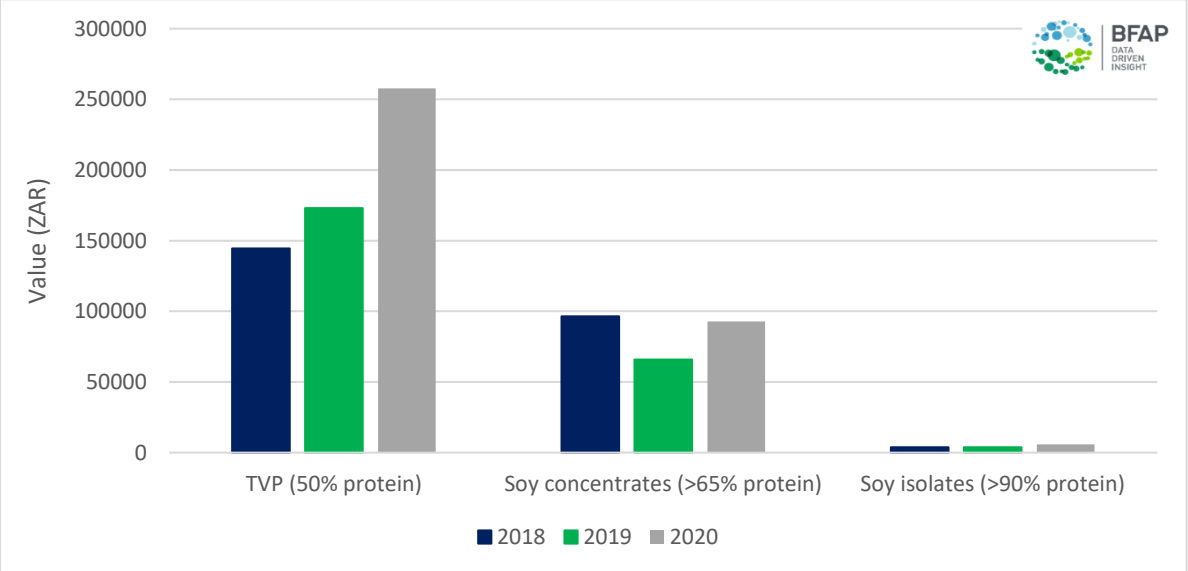

Figure 13: Soy protein export Rand value (2018 – 2020)
Source: Trademap (2021)

Most of South Africa's derived soy proteins are exported to the rest of Africa with South African TVP's biggest importer being Zimbabwe (56% of exports). Zambia and Saint

Helena import 8% each followed by Malawi (7%), Namibia (4%), Mozambique and Botswana (3% each), and Eswatini and the DRC (2% each). The remaining 7% is split between others in Africa and countries such as the UAE, the UK, the USA, China, France and others. According to industry experts, there is enormous potential to expand exports of TVPs to the African market. Figure 14 and 15 support these statements made by industry.

Figure 14 summarises the changes in the exports of TVPs to Africa. Between 2019 and 2020, South Africa exported 80% more TVPs to Africa. The most significant growth in TVP exports came from Zimbabwe (Figure 15). In 2020 South Africa exported 612% more TVPs to Zimbabwe compared to 2019. These figures indicate the enormous potential to expand the derived soy products for the human consumption market in South Africa by increasing exports to Africa.

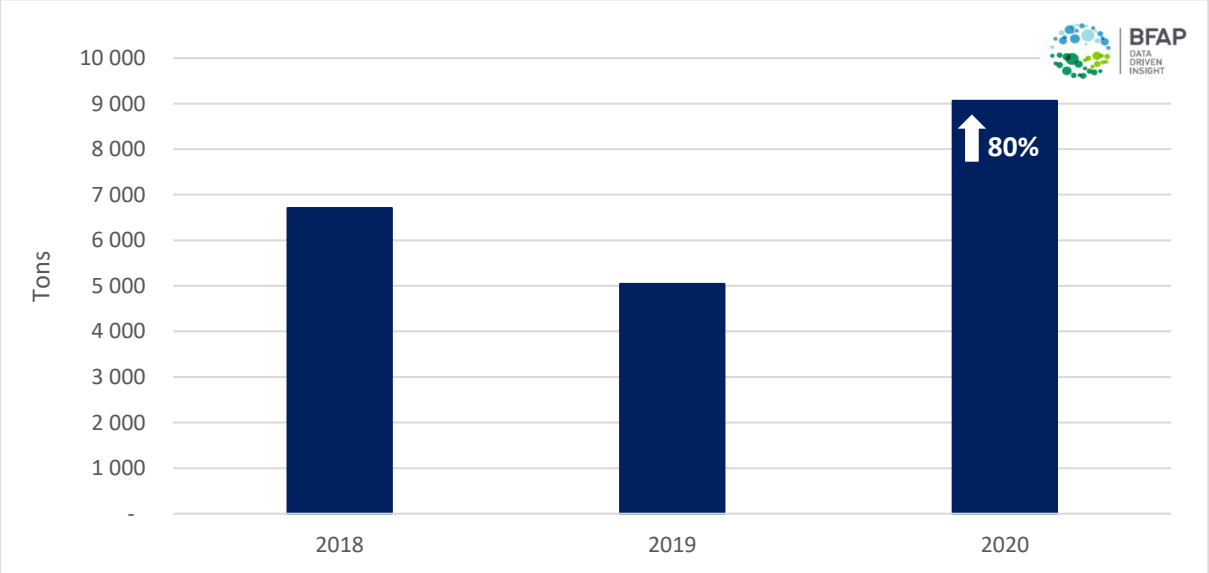

Figure 14: TVP exports to Africa (2018 – 2020)
Source: Trademap (2021)

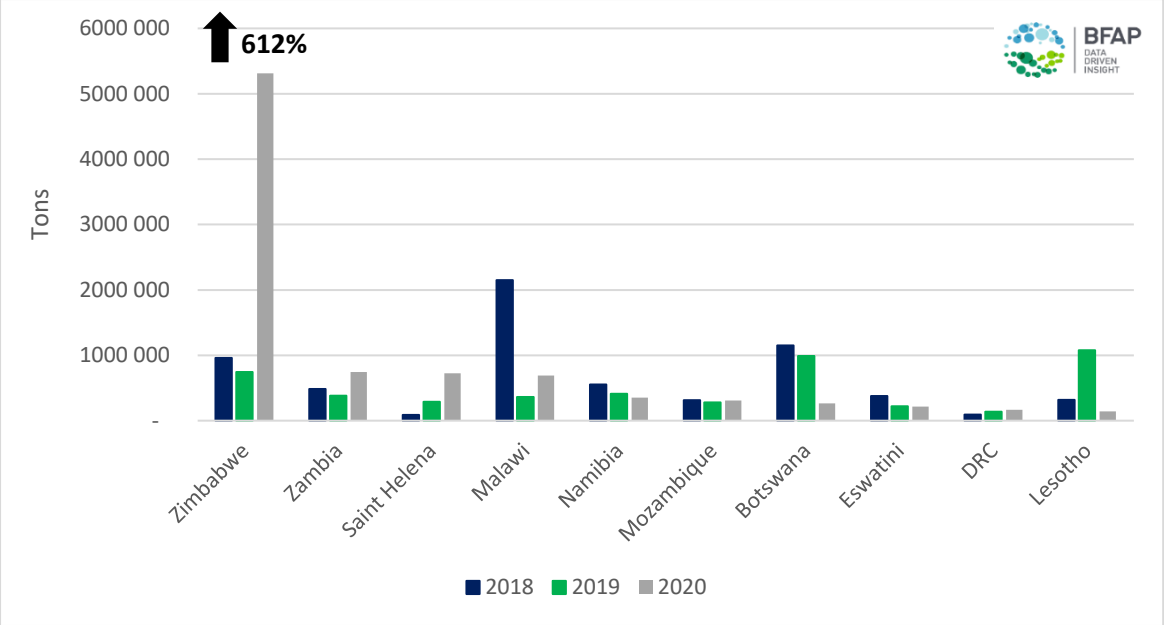

Figure 15: TVP exports to Africa by top 10 importing countries (2018 – 2020)
Source: Trademap (2021)

Since South Africa does not produce soy concentrates and isolates, some of these products are imported to be re-exported. Concentrates were mainly exported to Zimbabwe (35%), Namibia (18%), and Zambia (14%), Lesotho (9%), Malawi (8%), and Botswana (8%). The remaining 8% is split between mostly the other African countries. In 2020 all South Africa's exported soy isolates went to Africa. The biggest importers of isolates from South Africa were Malawi (32%), the DRC (19%), Botswana (17%), Zambia (11%), Kenya (7%) and others (14%) (Trademap, 2021).

Situation analysis for soybeans for human consumption

The situational analysis refers to an analysis of the broader environment in which the soybean value chain role players operate and consist of an external and internal analysis. An external analysis evaluates the general economy and the industries in which these supply chains operate. A good understanding of the external environment is critical. It directs strategic thinking and decision making to create new opportunities, such as exploring the potential to expand the market for soy products used for human consumption and overcome challenges. On the other hand, an internal analysis evaluates an industry's internal environment to assess its resources, capabilities, and competitive advantages. For this report, we focus on the competitive forces (external analysis) and the competitive capabilities (internal analysis) of the soybean industry to process soybeans for human consumption to inform strategic decision making.

Porter's five-forces model concentrates on five structural industry features that comprise the competitive environment, hence the industry's profitability. This report applies Porter's five-forces model to the South African soybean industry, focusing on the soy products for the human market. Table 5 summarises the relative impact of Porter's five forces. The remainder of the section unpacks each of these forces in more detail.

Table 5: Relative impact of Porter's five forces on the South Africa soybean industry for human consumption

Porter's Five Forces	Impact on the soybean industry for human consumption
Threat of new entrants	Low to Medium
Bargaining power of buyers*	High
Bargaining power of suppliers**	High
Threat of substitute products or service	Low
Rivalry among existing competitors	High

* Where buyers refer to the buyers of specifically TVPs
** Where the suppliers refer to soybean crushers and producers of specifically TVPs

Industry competitiveness – soybeans for human consumption

Porter's model provides a useful framework for analysing industry competition. The five forces model evaluates the following factors: the threat of new entrants, supplier bargaining power, buyer bargaining power, availability of substitutes, and the level of rivalry between organisations. Porter's five forces model is applied to a specific segment of the soybean industry, namely the soy for human consumption market, specifically the production of TVPs. The focus is on TVPs because the product mainly produced in South Africa for the human market is TVPs.

Threat of new entrants

The soybean crushing industry in South Africa is highly competitive, with high barriers to entry. The level of entry barriers can be determined by looking at the economies of scale, the market or cost advantage of current market players compared to new entrants, and the capital requirements (Olsen, 2011). High capital investments are required at the processing stage of the value chain. The two most prominent role players in the soy products for human consumption are Nedan Oil Mills and Majesty Oil Mills (90% of the total market). As the most prominent role players, they have both

a market and cost advantage over the smaller crushers. Nedan Oil Mills are also expanding their operations in the human market, giving them a further specialisation advantage. Regulations in terms of food safety and hygiene standards should also contribute to the high investments that reduce the threat of new entrants. The threat of new soybean crushers entering the soy for human consumption market is relatively low. However, the threat of existing crushers expanding their operations to also produce soy for the human market is relatively higher. As mentioned earlier, expanding into the human market supports crushing margins significantly.

Bargaining power of suppliers

According to Olsen (2011), suppliers generally have power when they are more concentrated than their buyers. They receive revenues from more than one industry, their buyers incur high switching costs, the product supplied is differentiated or no substitutes exist, and they can vertically integrate. The two biggest soybean crushers for the human market, Nedan Oil Mills and Majesty Oil Mills receive revenues from animal feed and food value chains. Although many alternatives for TVPs exist in the form of animal proteins, legumes, canned fish, eggs, and dairy products, TVPs remain the cheapest protein alternative, and not many substitutes can compete on price per gram of protein. The buyers of TVPs (Crown National, Deli Spice and Bluff Meats, among others), however, do not incur high switching cost and, therefore, often switch between Nedan Oil Mills and Majesty Oil Mills. The bargaining power of these suppliers is, therefore, medium to high.

Bargaining power of buyers

Generally, the higher the number of buyers of a product, the higher the competition in the industry and the more reasonable the prices. Like supplier bargaining power, buyers have power when there are only a few buyers, products are standardised, and buyers can vertically integrate, even if it is only partially. The primary buyers of TVPs in South Africa are Crown National, Deli Spice and Bluff Meats. These buyers are known to often switch between the two main crushers for the human market: Nedan Oil Mills and Majesty Oil Mills. These companies' products are also standardised and of similar quality, which means competition is high between the two crushers to close sales. Compared to the bargaining power of suppliers, the bargaining power of the buyers is higher.

Substitute products

The availability of substitute products increases the rivalry between role players in an industry and increases the competitive pressure to win buyers over. Although there are no substitutes for TVPs at similar prices[8] rivalry between role players remains high as there are only a few local buyers of TVPs in South Africa. The competitive pressure supports continuous improvement in product quality and consumer satisfaction.

Rivalry among industry role players

An industry is unattractive if it already contains numerous, strong or aggressive competitors (Kotler and Keller, 2011). Rivalries naturally emerge between companies competing in the same market. These conditions will lead to frequent price wars, advertising battles, and new product introductions to make it expensive to compete. According to Porter (1980), the intensity of rivalry acts similarly to the threat of new entrants. “It determines the extent to which firms already in an industry will compete away the value they create for buyers among themselves, passing it on to buyers in lower prices or dissipating it in higher costs of competing” (Porter, 1980). Therefore, without product differentiation, or expansion to other markets to increase the number of buyers, rivalry in the market of soy for human consumption, specifically the production of TVPs will remain high.

SWOT analysis - soybeans for human consumption

The strengths, weaknesses (internal to the industry), opportunities and threats (external to the industry) of the South African soybean industry should also be considered as part of the situation analysis. The SWOT analysis is a useful framework to use when making strategic decisions to minimise threats, focus on strengths, deal with weaknesses and take advantage of available opportunities. Table 6 summarises the South African soybean industry’s SWOT analysis, focused on the processing of soybeans for human consumption.

[8] It is difficult for consumers to switch to alternative proteins as most of the alternatives are more expensive compared to TVP based products.

Table 6: SWOT analysis for the South African soybean industry for human consumption	
STRENGTHS	**WEAKNESSES**
Investments in crush capacity enabled the industry to increase the production of soy products for animal feed and human consumption.	High entry and exit barriers. The high cost of equipment to produce concentrates and isolates makes it challenging to enter the concentrate and isolates market. A rough investment estimate to produce concentrates and isolates according to one of the crushers is R100 million.
Investments in the crushing capacity stimulated the local production of soybeans which supports the crushing margin through the availability of more affordable local beans.	Undesirable “beany” taste of soy-based products that is difficult to eliminate.
Proximity to the growing African market. Our two biggest crushers are situated in the Northern parts of South Africa; Nedan Oil Mills (Mokopane) and Majesty Oil Mills (Krugersdorp).	Perceived lower quality of soy derivatives; specifically, soy-based meat alternatives.
	“Poor-man’s meat” stigma around soy-based meat alternatives.
	Some food manufacturers demand non-GMO soy derivates, but South Africa produces less than 1% non-GMO soybeans.
	Some food products such as soymilk are produced from white helium soybeans that are not produced in South Africa.
OPPORTUNITIES	**THREATS**
Expansion into the growing African market. South African exports to Africa increased by 80% in 2020, with Zimbabwe being the most significant growth driver.	During times of drought, the high cost of beans puts crushing margins under pressure, even when crushing for human consumption at higher output prices.
Improving the quality of soy derivates and educating the consumer on the benefits of using soy-based products opens further growth opportunities, even in middle-income consumer groups.	Electricity fluctuations and ‘load shedding’ increase the cost of crushing and increase product quality variability.
The growing population of environmentally conscious consumers opens opportunities to market soy-based products as more environmentally friendly than animal proteins.	The increasing global demand for products made from pea protein instead of soy protein can potentially spill over to South Africa. Pea-based products are ‘green label’ products as it contains no allergens.
Crushing soybeans for human consumption supports the crush margin. Some crushers indicated that the crush margins when producing for the human market, are three times better due to the higher prices realised for TVPs compared to soybean meal for animal feeds.	The relatively high cost of doing business in Africa. Time delays and other barriers that make cross border trade difficult. The high cost of transport (fuel and tolls), and poor road infrastructure makes exports to Africa relatively more expensive.

	Cheaper imports of soy-based products from China.

The South African soybean industry operates in a complex, dynamic, competitive and globalised environment. Survival and growth in this competitive environment, particularly in the soy product market for human consumption, requires a high level of skills and knowledge, entrepreneurial innovation, and the adoption of new technologies.

Concluding remarks

The main soy derivative products produced for the human food market are full-fat soybean meal, white flakes, TVPs, soy concentrates and soy isolates. In South Africa, we mainly produce white flakes and TVPs to be sold as final to food companies, used as inputs in food value chains or exported. The majority of the full-fat soybean meal, soy concentrates, and soy isolates needs in South Africa are met through imports. The main reason why food companies use imported full-fat soybean meal is that the market demands non-GMO soybeans, yet South Africa produces mainly GMO soybeans. The main reason soy concentrates and soy isolates are imported is that the South African soybean crushers do not have the equipment to further process white flakes into concentrates and isolates.

Despite the wide use of derived soy products in food products, and anecdotal evidence that suggests that the processing of soybeans for the human market could support the crush margin, the size of this market and potential for its growth in South Africa is not clear.

The report is based on secondary data, observations and discussions with industry experts, specifically soybean crushers, producers of soybean products, and importers of soy proteins to understand better the lay of the land in the derived soy industry to support strategic decision making.

Based on the research conducted for this report and discussions from industry experts, five key take-aways have been identified to inform strategic decisions.

First; the processed meat market, where polonies and viennas are the leading consumer products, does not seem viable for expanding the market for soy products for human consumption. Not only does South Africans consume relatively small

amounts of processed meats (12g per person per day according to FACS (2021)), but soy products included in these products are mainly imported soy concentrates and isolates. These products are currently not produced in South Africa but imported; soy concentrates mainly from Brazil and soy isolates mainly from China. Due to the economies of scale needed to warrant the close to R100 million investment in equipment, the production of soy concentrates, and isolates are currently not feasible in South Africa. Moreover, these products are usually produced with non-GMO soybeans. Investing in equipment to produce soy concentrates and isolates could be feasible if a big enough market exists in Africa, if the GMO product could compete with the non-GMO product and if the South African crushers can compete with Brazil China on quality.

Second; it seems like the butcher meats market where TVPs are added as extenders or absorbents to mince, 'braai wors' and hamburger patties could be a feasible option to grow the market for TVPs.

Third; venturing into the production of high-value products explicitly targeted at vegetarians and flexitarians such as plant-based mince, -patties, and -nuggets, to name a few is not a feasible option. These products make up a small share of the market, are either imported from Europe or contains imported soy concentrates and isolates and contains mostly pea protein and not soy protein. For the South African crusher to break into this market, it will have to make the necessary investments to produce soy concentrates and isolates. It will have to compete with pea protein that does not have the typical 'beany' taste and the non-GMO label.

Fourth, it seems like the low-value soy or soy-based product shows the most growth potential from the report's findings. The low-value products, specifically those containing TVPs such as soy mince, hold the most significant growth potential for the local soybean industry. Some of the crushers highlighted the importance of including soy-based products in school feeding programmes and social grants as an excellent but cheaper protein source to support food security.

Fifth, the rapid expansion in demand for TVPs in Africa, particularly in Zimbabwe, suggests that TVPs are already part of many African consumers' diets and could be exploited. Although the local market also shows room for expansion, South Africa only imported around 6 000 tons of TVPs per year over the past three years. Optimistically

speaking it would be possible for the local crushers to replace the 6 000 tons of imported TVPs if they are not imported for specific characteristics such as non-GMO. The most significant opportunity for growth, however, seems to be the African market.

Industry experts highlighted several challenges that hinder growth in the production of TVPs, to be included in food products, that require further action. These include research on the perceptions of soy-based products among consumers to try and market soy-based products in such a way as to remove the 'poor man's meat' label that these products have been burdened with for decades. Consumer education targeted at low- and middle-income consumers to explain the benefits of adding soy-based products to meals to bulk up meals and increase the protein content is needed. Consumer education on the health and environmental benefits of soy-based products is also needed to expand the target market and include middle and perhaps high-income consumers. Sensory research among low-, middle- and high-income consumers is likely to determine consumers' taste preferences and identify whether the 'beany' taste is a problem. Since school feeding programmes can significantly affect the market for TVPs, it is essential to understand school children's taste preferences also. Previous reports indicated that soy-based meals were often left untouched when included in school feeding programmes; sensory research could shed some light on why.

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