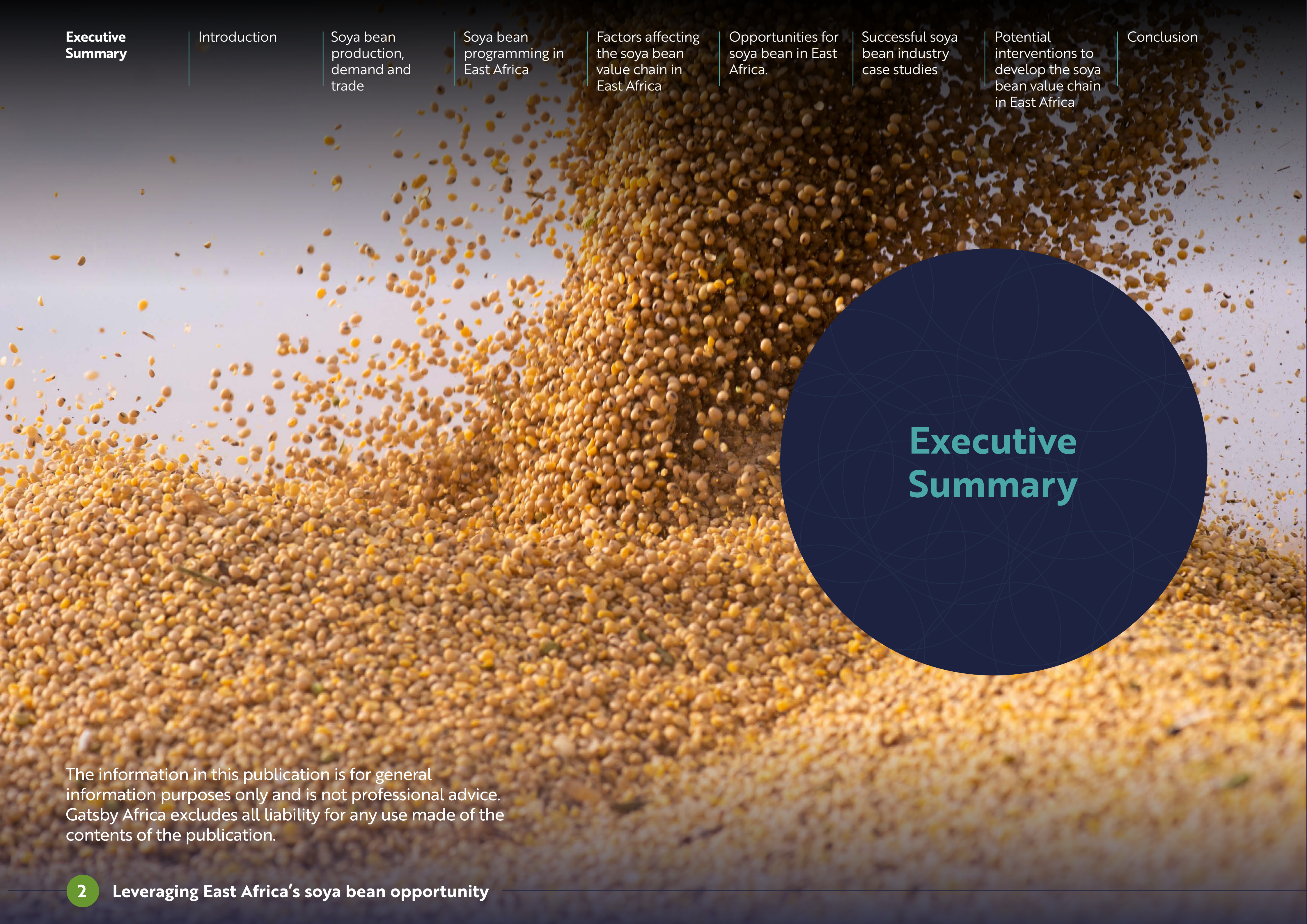
Gatsby Africa

Leveraging East Africa's soya bean opportunity

February 2024



Executive Summary

The soya bean value chain presents a significant opportunity for East Africa. Rapid population growth and rising demand for soya-based food and animal feed are fuelling a sharp increase in demand for a range of soya-related products across the region. Strong natural growing conditions mean that East African farmers are well placed to capitalise on this, and in doing so, raise farmer incomes, create jobs in processing, and enhance food and nutritional security (including through its contribution to the competitiveness of the livestock and aquaculture sectors). Crucially, soya bean can also enhance soil health through nitrogen fixation, thus contributing to broader agricultural resilience while simultaneously presenting a range of economic opportunities.

Despite this, regional production of soya bean remains low. With 90% of East Africa's soya bean production, Uganda dominates the market. However, East Africa remains largely dependent on imports, with Kenya, Tanzania and Uganda together importing USD 84 million or 129,000 metric tonnes (MT) of soya bean and soya-based products in 2022 (ITC, 2023). If farmers reached a target yield of 2.2 MT per ha (equivalent to 900 kg per acre), which research suggests is achievable, domestic production would be able to substitute imports, raising farmer incomes by at least USD 23.5 million per season.

Further export opportunities could substantially increase the crop's potential, both in terms of farmer incomes and across the value chain. Soya bean is the world's most important grain legume. Globally, 372 million MT were produced in 2021 (FAOSTAT, 2023), and demand and production are continuing to grow rapidly, with global trade in soya bean expected to reach USD 193 billion by 2028 (Ates, 2023).

However, East African productivity and profitability continue to limit the region's ability to capitalise on these opportunities. These are constrained by:

- **Weak value chain linkages that undermine farmer access to both input and output markets.**
  - **Lack of access to secure output markets** – inadequate aggregation, storage, transport and off-take arrangements affect farmers' access to output markets. For example, few processors in East Africa are willing to agree and honour off-take contracts with disparate farmers producing small volumes (which raises logistics costs), leaving farmers with unpredictable markets, often dependent on traders who may not operate consistently, and hold the bargaining power.

- **Lack of a secure output market also constrains farmers' access to inputs and services –** farmers are discouraged from consistently investing in raising productivity given market uncertainty, driving unpredictable demand for inputs and services. In turn, this unpredictable demand discourages inputs suppliers from producing and distributing quality inputs, and farmer service companies from expanding their coverage.

- **Limited access to quality seed and inoculants –** as above, due to unpredictable demand, companies produce limited amounts of certified seed and quality inoculants given the sensitivity and short shelf-life of soya bean seed and inoculants, hindering farmer access and productivity.

- **Poor agronomic practices –** only 3% of farmers across East Africa adopted at least three key good agriculture practices for soya bean production (e.g. use of certified seed, rhizobium inoculants and appropriate plant spacing) (Gatsby Africa, 2023) which continues to hinder productivity. Yields currently range from 647-741 kg/ha on average across Kenya, Tanzania and Uganda. Of the three, Kenya currently has the lowest yields.

- **High labour costs –** the labour intensity of soya bean production and the region's limited mechanisation are driving up labour costs. In Kenya for example, labour accounts for 41% of production costs for a typical soya bean grower (Gatsby Africa, 2023).

- **Cost competitiveness –** whilst soya bean meal/cake is an optimal animal feed input, its cost competitiveness is critical to East Africa livestock and fish producers. Currently, across the Southern and East Africa region, unit production costs for soya bean are lowest in Zambia and South Africa (and highest in Kenya). Alternative proteins such as sunflower, cottonseed and insect meal are also cheaper than soya bean meal/cake, making them increasingly attractive alternatives.

"Without the required services and a lack of market surety, farmers are less able and willing to invest in raising their productivity, remaining stuck in a low investment, low productivity, low output production cycle."

- **Price volatility –** driven by global commodity price volatility, over which the region has almost no influence, as a price-taker.

These issues have been compounded by constraints that apply across East African agriculture, such as limited access to finance for production, climatic and environmental changes, low soil fertility owing to poor historic agronomic practices, as well as poor post-harvest handling. Without the required services and a lack of market surety, farmers are less able and willing to invest in raising their productivity, remaining stuck in a low investment, low productivity, low output production cycle, limiting overall production potential.

Addressing constraints

By strengthening value chain linkages and market pull, to ensure that farmers have an assured market for their produce, an eco-system of services can develop, attracting a range of commercially viable private businesses working across the value chain to drive productivity and production gains in key growing areas. Providing farmers with guaranteed off-take arrangements should create the demand for distribution of specialised inputs such as inoculants and improved seed varieties.

Incentivising investment into competitive processing operations and downstream product development for human foodstuffs and animal products, could further strengthen the market pull for productivity and production increases, and drive the growth of local and regional markets.

Scaling regional production in order to create sufficient volumes to attract world-class processing investments has the potential to play a critical role in overcoming these challenges. Drawing on the successes seen in Malawi and Zambia in recent years, we estimate that in Tanzania this tipping point sits at approximately 50,000 MT of soya bean production.

"Drawing on Malawi and Zambia's recent successes, we estimate that in Tanzania the tipping point for production to attract large-scale processing investments is approximately 50,000 MT of soya bean production."

However, this far exceeds current production levels. To realise this opportunity, governments (and development partners) could play a critical role in enabling this jump to 50,000 MT or more. Although there are multiple avenues for transformation, our research suggests that three actions could be most effective:

- **Facilitating a stronger market pull and hence greater market access for all farmers:** Grants or tax breaks to firms developing soya-based food and/or animal and fish feed products, and substantial incentives for investors in intensive and semi-intensive livestock farming, would also play an important role in achieving this.
- **Providing targeted incentives for businesses delivering specific sector services:** For instance, supporting businesses producing and distributing inoculants or improved seed, providing information on good agricultural practices and other services such as mechanised land preparation, harvesting and threshing, to farmers. Incentivising businesses in these areas will enable farmers to optimise their investments to raise their yields and maximise returns, boosting regional competitiveness, and attracting further investment. Incentives could take the form, for example, of (i) voucher schemes to raise demand for these products, with a few years of commitment up front, (ii) multi-year tax breaks for firms producing quality inoculants and seed locally, (iii) support with distribution networks e.g. for storage warehousing in district centres.
- **A stable policy environment:** Reassuring businesses operating in the soya bean sub-sector that there will be stable government decision-making, demonstrating a credible commitment to open soya bean and soya product trade policies, maintaining targeted investment promotion incentives, and securing effective sector regulation in licencing and market oversight.

"Governments (and development partners) could play a critical role in enabling this jump to production of 50,000 MT or more."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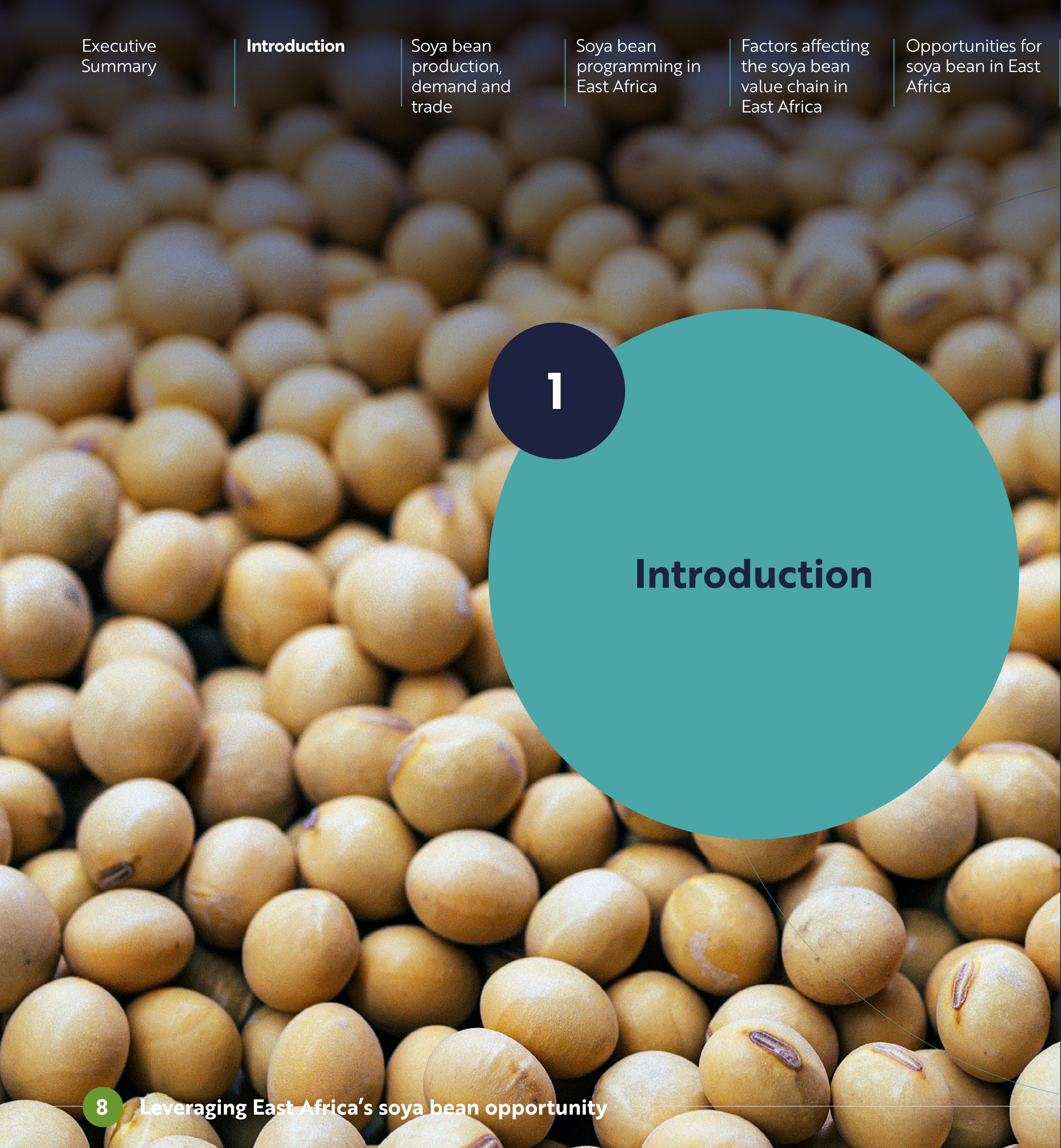


1 Introduction

Soya bean is presently the world's most important grain legume in terms of total production, international trade, and income (FAO, 2014). It has been cultivated for its high oil and protein content accounting for ~18% and ~35-40% respectively (Pingxu et al., 2022), and for its ability to increase soil fertility through biological Nitrogen fixation. Compared to cereals, it is also more tolerant to pests and diseases and maintains better quality in storage (Giller et al., 2011). The crop tolerates diverse climatic conditions and different types of soil, making it a versatile crop. Figure 1 illustrates a significant area of sub-Saharan Africa that is suitable for soya bean production.

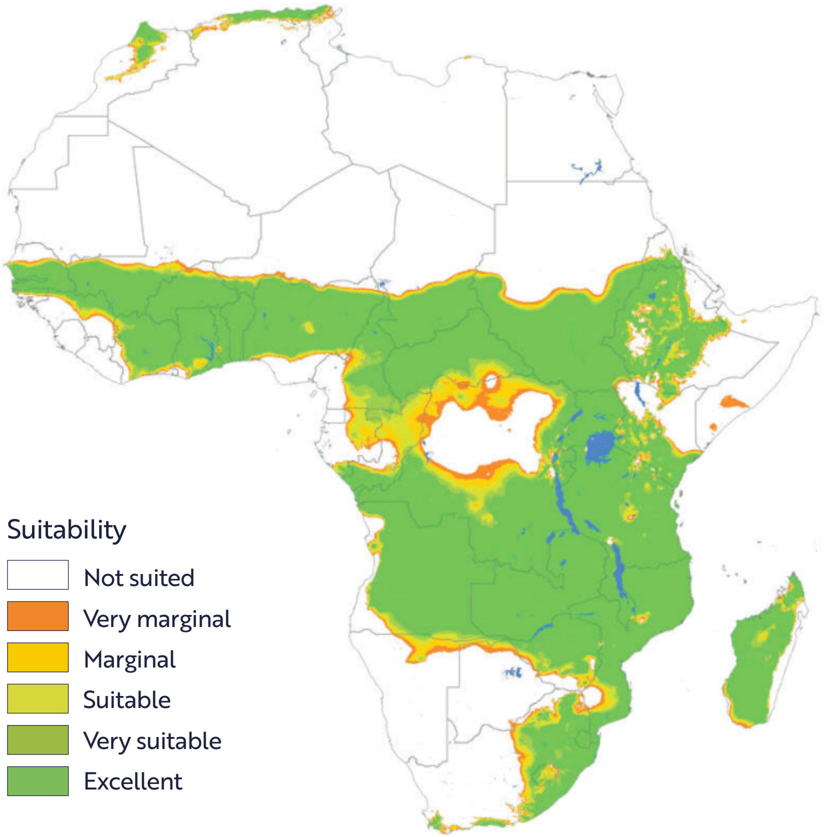
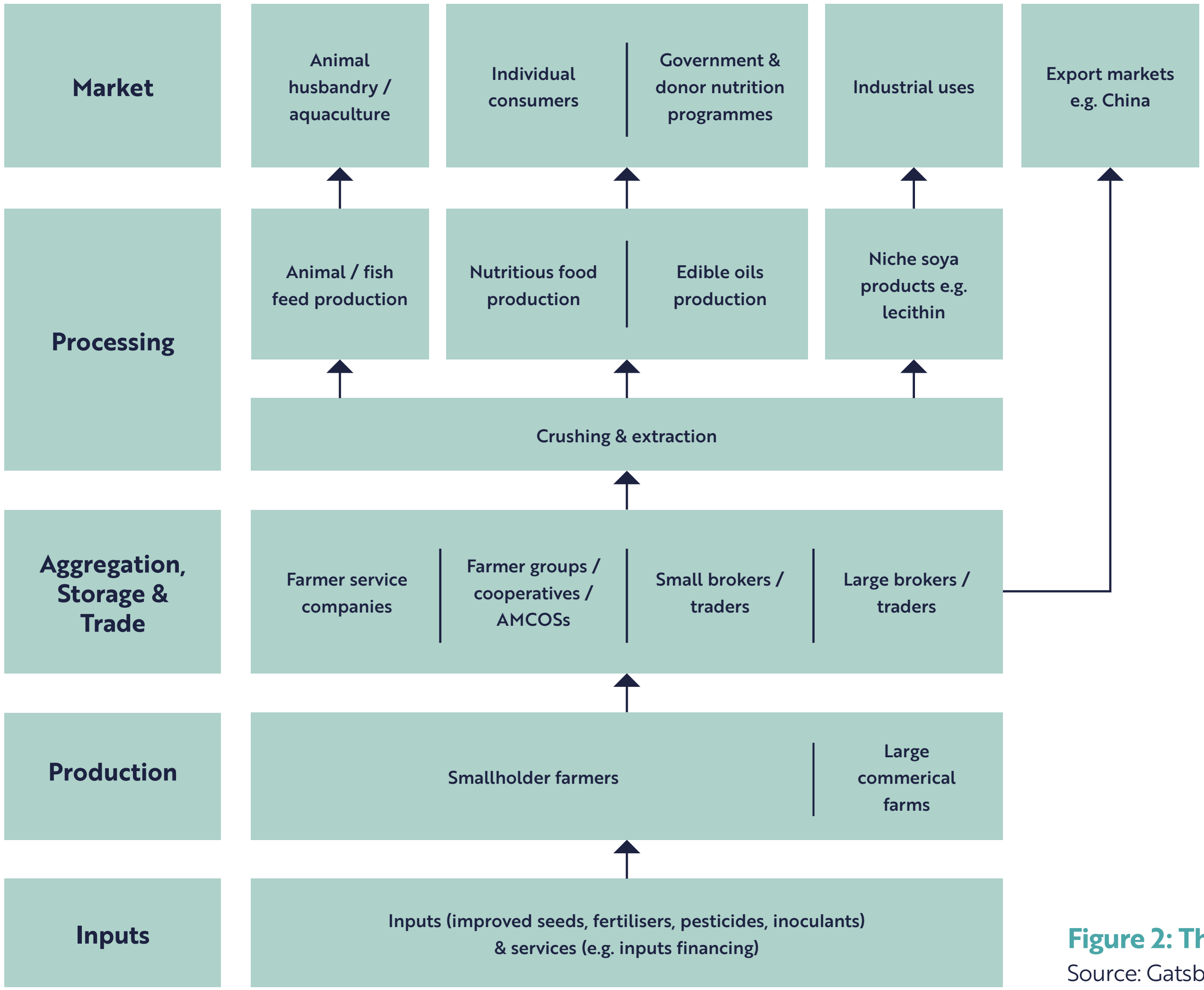


Figure 1: Soya bean suitability map Africa
Source: Tukamuhabwa P. M., 2010

"The crop tolerates diverse climatic conditions and different types of soil, making it a versatile crop."

The soya bean value chain is best regarded as a protein value chain that involves the production of soya bean, processed soya protein-based products, animal feed (meal/cake) contributing to meat and fish production for human consumption, and oil as a co-product (Singh, 2022). While there are an array of additional co/by-products such as soya gums and lecithin, these are relatively niche products. Soya is also produced as a biofuel (Soya ethanol) in contexts like the US, Argentina and Brazil, with relevant policy support, though there remain significant environmental concerns about the use of soya for energy (USDA, 2020) and (Glaucia et al., 2023). Figure 2 summarizes the key nodes in the East African soya bean value chain.



The economic viability of soya production relies on the commercial utilisation of both its meal and oil, though approximately 85% of soya bean produce is intended for animal feed production (IISD, 2020). Figure 3 illustrates the meal/cake and oil output from a processed soya grain.

Figure 2: The East African soya bean value chain
Source: Gatsby Africa, 2023

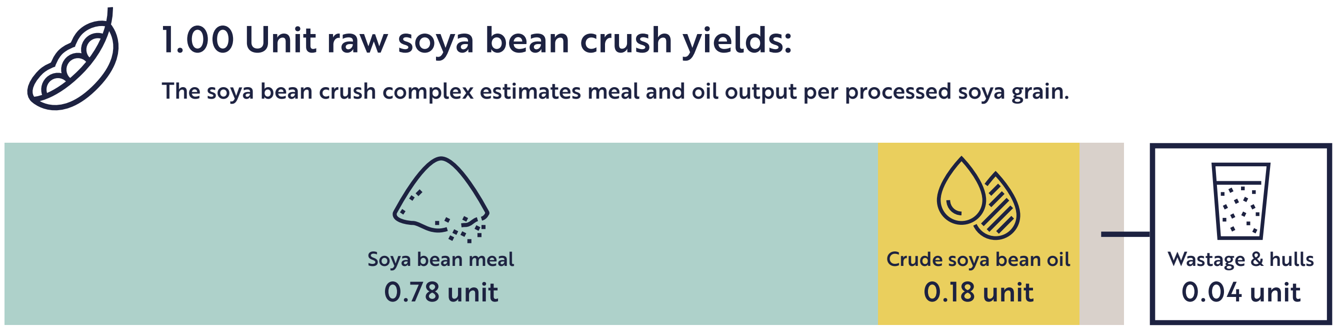


Figure 3: Soya bean crush complex
Source: TechnoServe, 2018

Africa remains a minor player in the global soya bean industry suppling less than 1% of the world's soya beans (Cornelius et al., 2019). Levels of production are low, as are yields (less than 1 MT per ha across the majority of soya bean producing countries in Africa) and growth rates in yield. Worldwide production of soya bean has grown at a compound annual growth rate (CAGR) of 4.7% since 1961, while African production is rising at a rate of 6.8% per year (USDA, 2022). Though both world and Africa's growth in production result mostly from an increase in soya bean area planted and not from yield (Cornelius et al., 2019). Whilst African production is rising faster than the world growth rate, that increase originates from a very low base.

Forecasts portend a continent where domestic demand for soya bean will continue to outstrip domestic production in the medium term, and imports will remain an important feature for meeting Africa's soya bean, soya bean meal, and soya bean oil needs (Cornelius et al., 2019). According to (Ministry of Agriculture and Livestock Development, 2023), soya bean production presents a great opportunity for improving the livelihoods of smallholders, through employment and enhanced household incomes. Implementation of the proposed strategy is expected to generate 500,000 direct and 1 million indirect jobs by 2027. It is expected to save the country USD 10 million in foreign exchange annually from 2023, while contributing up to KES 100 billion to GDP by 2027 (Ministry of Agriculture and Livestock Development, 2023).

Soya bean grows well with limited (nitrogen-based) fertilisers because it fixes nitrogen (N) in the soil which boosts the production of associated cereals through crop rotation, with shorter seasons it generates regular income, and its market value and demand are relatively high (Chianu et al., 2009).

Having identified soya bean as a high potential crop for East Africa, in terms of its contribution to farmer incomes, food and nutritional security, processing and sustainability, Gatsby Africa conducted research into the potential for development of the soya bean value chain across East Africa, in 2022-23. As well as literature reviews, analysis, and other key informant interviews, this included purposive sampling of 195 soya bean farmers across Kenya, Uganda and Tanzania. Purposive sampling focussed on the major production areas of each of the three countries as follows:

195 soya bean farmers across Kenya, Uganda and Tanzania participated in our soya bean farmer survey

Kenya (Migori)	Tanzania (Ruvuma)	Uganda (Lira)
59	57	79

Table 1: Soya bean farmer survey
Source: Gatsby Africa, 2023

2 Soya bean production, demand and trade

2.1 Global

2.1.1 Global soya bean production

Empirical data shows almost continuous growth in total soya bean production, area harvested and average yield. Since 1961, the world's soya bean production increased by 13.8 times, the average yield has more than doubled, and the global area planted to soya bean grew by 5.4 times – to almost 129.5 million ha in 2021. The reasons for the extraordinary growth in global soya bean production appear to be a combination of two major forces:

- extensification (the expansion of soya bean area);
- intensification (the increase in average yields due to genetic improvements and improved production techniques) (De Maria, 2020).

Figure 4 shows the evolution and composition of the global soya bean harvested area, soya bean production, and soya bean yields.

Global soya bean production is forecast to reach a record 410.6 million MT, up 40.2 million MT from 2022/23, assuming an increase in planted area and trend yield (USDA, 2022). Record soya bean crops are forecast for major producers, Brazil and the United States, as well as a normal crop in Argentina after a drought year (USDA, 2023). Global production of soya bean is dominated by a few key producing countries.

The USA, Brazil, and Argentina produce over 80% of the world's soya bean output (IISD, 2020). In 2019, Brazil became the world's largest soya bean producer, surpassing the USA for the first time (Colussi et al., 2021). Asia (excluding China) and Africa, together account for only 5% of global soya bean production with Africa accounting for less than 1% (Cornelius et al., 2019).

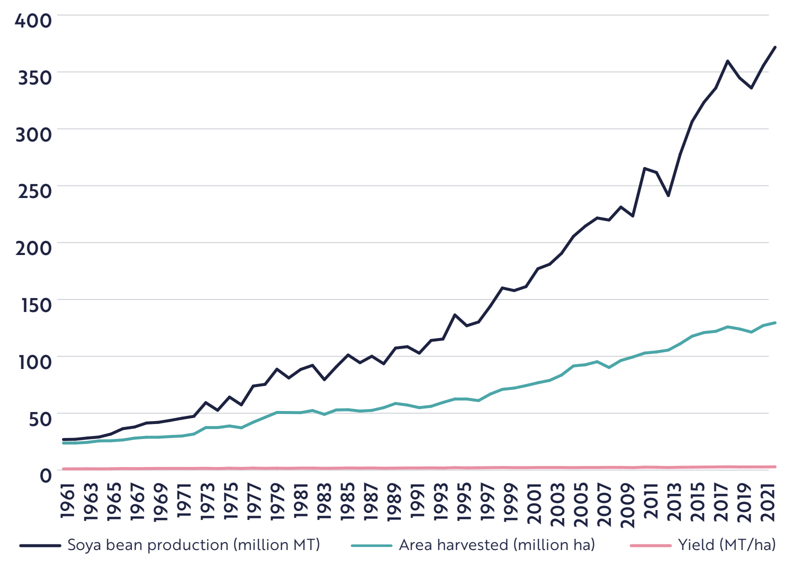


Figure 4: Global soya bean harvested area, production, and yields, 1961-2021
Source: FAOSTAT, 2023

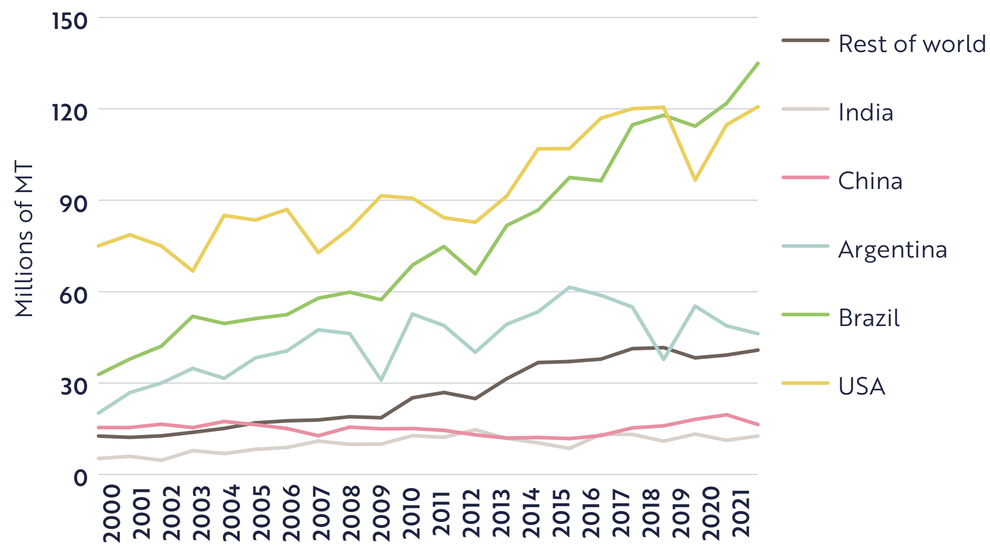


Figure 5: Soya bean production by major producers, 2000-2021
Source: FAOSTAT, 2023

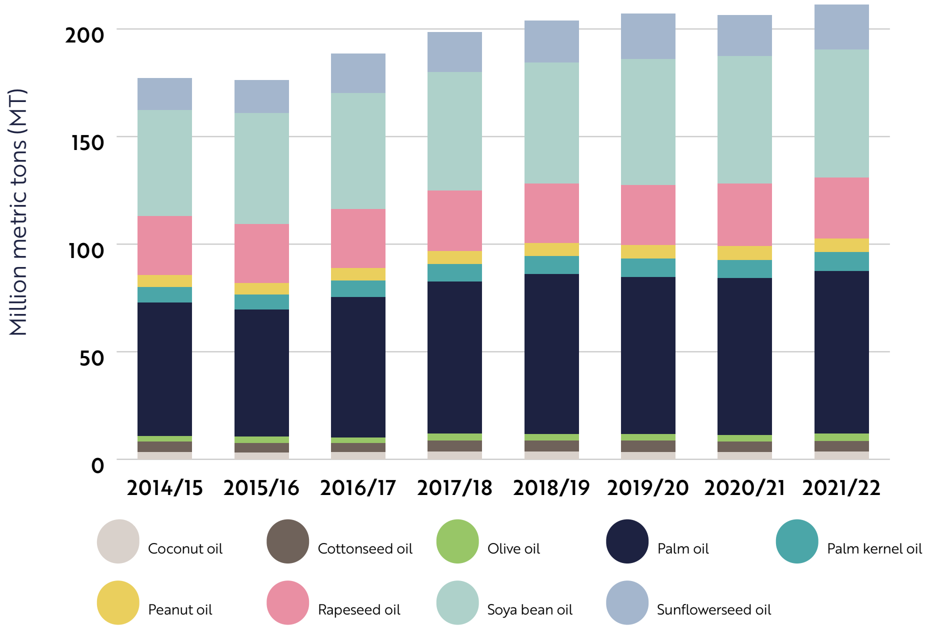


Figure 6: World vegetable oil production, 2014/15-2021/22
Source: USDA, 2023

Figure 5 indicates the evolution and composition of soya bean production by major producers.

As a major end product for soya bean, global vegetable oil production is broken down as follows, with soya bean being the second most important crop after palm oil (36%), accounting for 28% of global vegetable oil production (USDA, 2023).

Soya beans are the fastest growing broad acre crop in the world in terms of hectares under cultivation. Most of the expansion involves land use changes in developing regions of the world, including in Africa (Masuda and Goldsmith, 2012). This implies that population growth may further constrain land available for soya bean production, which will lead to further concentration of soya bean production among countries with the greatest ability to raise productivity (production per hectare).

2.1.2 Global soya bean demand

The Global Soya bean Market Outlook reported a global soya bean consumption value of USD 151.4 billion in 2022. Consumption is expected to grow at a CAGR of 4.1% from 2023-2028 to reach a value of USD 192.68 billion by 2028 (Ates, 2023). It is estimated that global raw soya bean consumption was 363.7 million MT in 2021/22 (USDA, 2022)– accessed 2023).

Soya bean demand has been on a steady rise and was estimated to exceed supply by over 40 million MT in 2022. This trend is projected to continue. This global supply gap has led to price increases, with a 62% increase in global soya bean prices since 2000 (Mondesir, 2020). However, USDA (USDA, 2023) projects that soya bean prices (like corn), will fall to USD 0.4 per kg in 2023/24, down USD 1.00 from the recent 2022/23 peak, and will stabilize at USD 3.7 per kg through 2032/33.

The exceptional growth in global production mirrors consumption patterns for soya bean (De Maria, 2020). The demand for soya beans is closely tied to global meat consumption and is fuelled by Asia (IISD, 2020). Domestic soya bean consumption data from the Foreign Agriculture Service of the USDA shows that the five largest consumers – namely China, the USA, Argentina, Brazil, and the EU – consumed about 80% of the soya bean globally produced in 2021 (De Maria, 2020).

"Demand for soya beans is projected to continue to grow due."

As discussed, demand for soya beans is projected to continue to grow due to a variety of factors. The consumption of meat, fish and soya-based food products is on the rise, while the population is forecast to grow, and policymakers in certain countries are supportive of biodiesel as a fuel alternative (FAO, 2017), (USDA, 2020) and (Glaucia et al., 2023).

Projected growth in global meat and fish consumption is expected to be driven by rising incomes and the growing middle class in emerging economies, whereby income-based shifts to greater protein consumption will drive demand for soya cake as a preferred input into animal and fish feed (FAO, 2020).

Roughly 70% of all protein animal feed comes from soya bean meal. Currently, 65% of soya bean trade is in the cake for poultry and animal feed, and it is projected that by 2032 soya bean will constitute more than 72% of global animal feed inputs due to its increasing international production (USDA, 2022). Projected increases in trade below are based on the following assumptions:

- Chicken production is projected to grow steadily as the broiler-to-feed price ratio rises and domestic demand and exports continue to rise.
- Beef production will rise 8% per annum due to expanding inventories, a higher beef cattle-corn price ratio, and slaughter weight (USDA, 2023).
- Pork production will increase by 11.9% per annum as the hog-feed ratio, slaughter weights, and pig inventories all show an upward trend (USDA, 2023).

As illustrated in Figure 7 below, as well as oilcake, soya is a key input into vegetable oil, accounting for 29% of world consumption, after palm oil (at 35%). Global use of soya bean oil is projected to increase by 21% between 2023/24 and 2032/33, whilst import demand for soya bean meal is projected to increase by 12% over the same period (USDA, 2023).

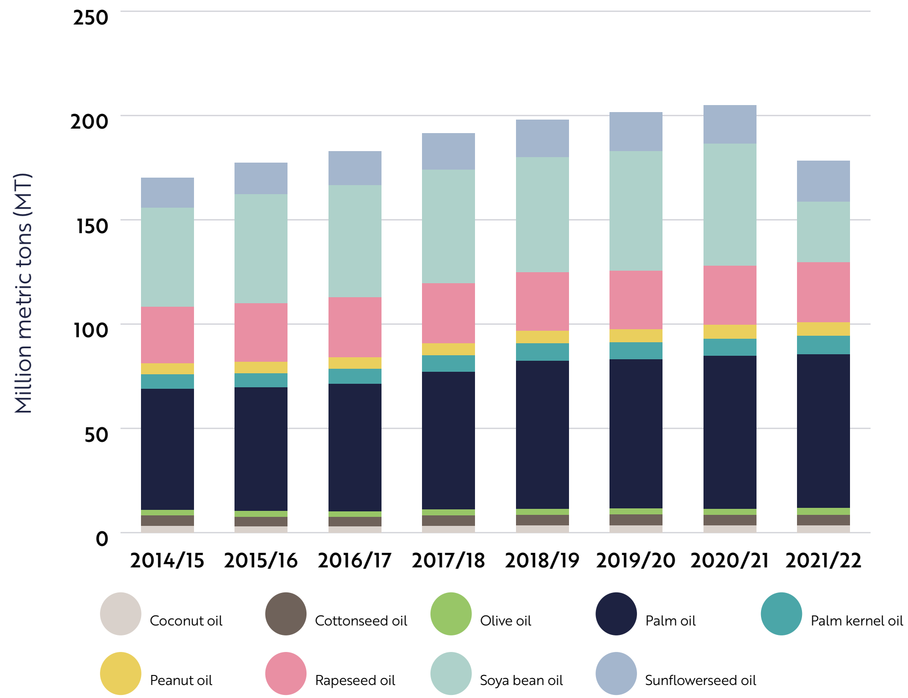
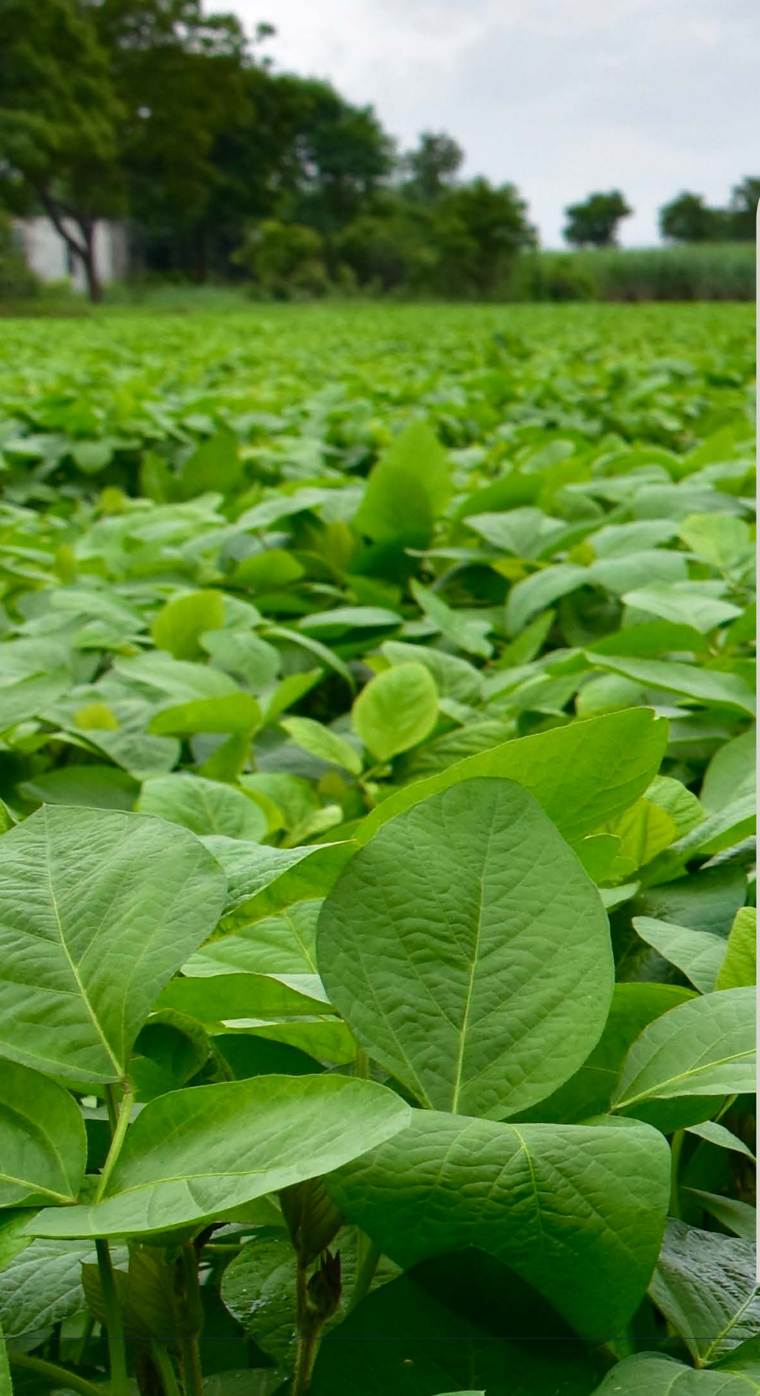


Figure 7: World vegetable oil consumption, 2014/15-2021/22
Source: USDA, 2023



China as a Demand Driver

China is a major player in the consumption of soya bean. In 1999, domestically, China used less than half of the soya bean consumed in the USA, despite having 4.5 times the US population at that time. In 2009 China's soya bean consumption surpassed that of the USA, making China the largest soya bean-consuming country in the world. China consumes about 60% of the world's soya bean (Rabobank, 2023. De Maria, 2020).

The two driving forces behind the rising demand for soya bean are the rise in livestock production and the switch to commercial animal feeds. China's meat production capacity depends on modernizing livestock and feed manufacturing industries as well as securing feed grains and oilseed crops.

As a means of strengthening its processing sector, China re-imposed a 13% value-added tax, effective July 1999, for soya bean meal imports, to encourage imports of whole soya beans and incentivize processing and investment therein (Tuan et al., 2004). Imported soya beans serve as the raw material for more than two-thirds of China's soya bean meal, partially because of the government's support to promote domestic crushing, feed, and food manufacturing (Goldsmith et al., 2012). In addition, China's traditional food self-sufficiency policy places greater importance on local production of staple cereals such as rice, wheat and maize rather than industrial crops like soya beans. Thus, local crushing of largely imported soya beans, as opposed to imported soya bean meal or the expansion of domestic soya bean production, is expected to meet future soya bean meal demand in China. China has thus become the major market for raw soya bean globally.

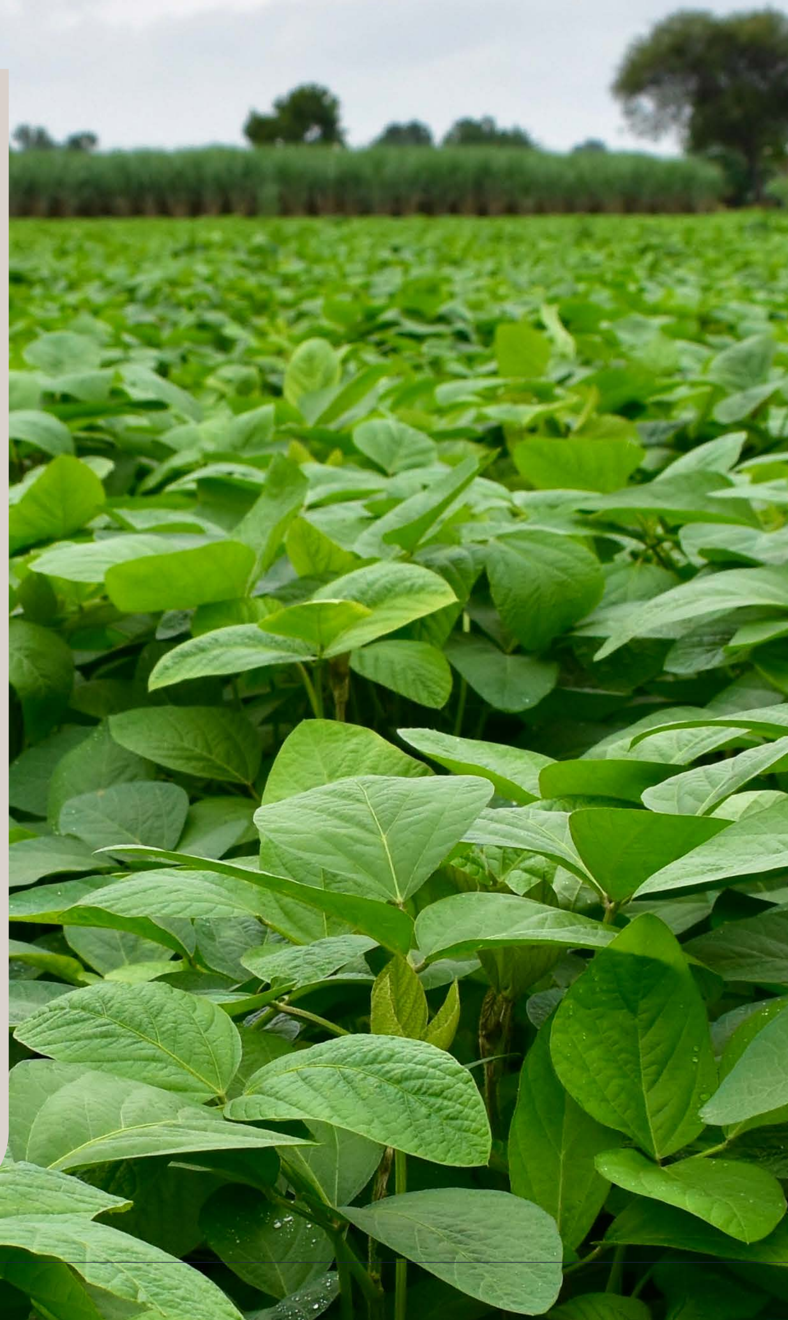
However, in response to higher USA tariffs on Chinese exports, China placed a 25% tariff on USA soya beans in July 2018. This resulted in a decrease in US soya bean imports into China in 2018 (from USD 12.2 billion in 2017 to USD 3.1 billion in 2018 (Hergt, 2020) and an increase in imports from other producing countries such as Brazil, but at higher premiums. Concurrently, USA soya bean shipments to the European Union scaled in 2018, albeit at a higher discount, benefiting the EU crushing industry. In 2019, China authorised tariff-free soya bean imports from the United States, once again increasing soya bean flows to China from the USA (IDH, 2020).

China's Ministry of Agriculture and Rural Affairs issued guidelines in 2021 to reduce the use of soya bean meal in animal feed, due to heavy import dependence (particularly from the US and Brazil) (S&P (S&P Global, 2023), as well as promoting higher domestic production of soya bean (USDA, USDA Oil Crops Outlook: January 2023). As a result, China's soya bean imports are expected to start declining by 2030 (Rabobank, 2023).

China recently signed a bilateral trade agreement with Tanzania for the import of soya bean. Despite limited current soya bean exports from Tanzania, future exports to China have the potential to earn the country up to USD 1 billion. Tanzania is a non-GMO producing country, and premiums paid for non-GMO soya were estimated at USD 69 per MT in 2022 (US Soybean Export Council, 2022).

"Tanzania is among the 19 authorized importers [to China] across the world and the third in Africa which is a huge opportunity to the country considering that soybeans could be grown in many regions such as Songwe, Mbeya, Ruvuma, Iringa, Kagera, Mwanza, Shinyanga, Singida, Dodoma, Tabora and Katavi."

Ambassador Kariuki, The Citizen, Tanzania, 24th October 2021[1]



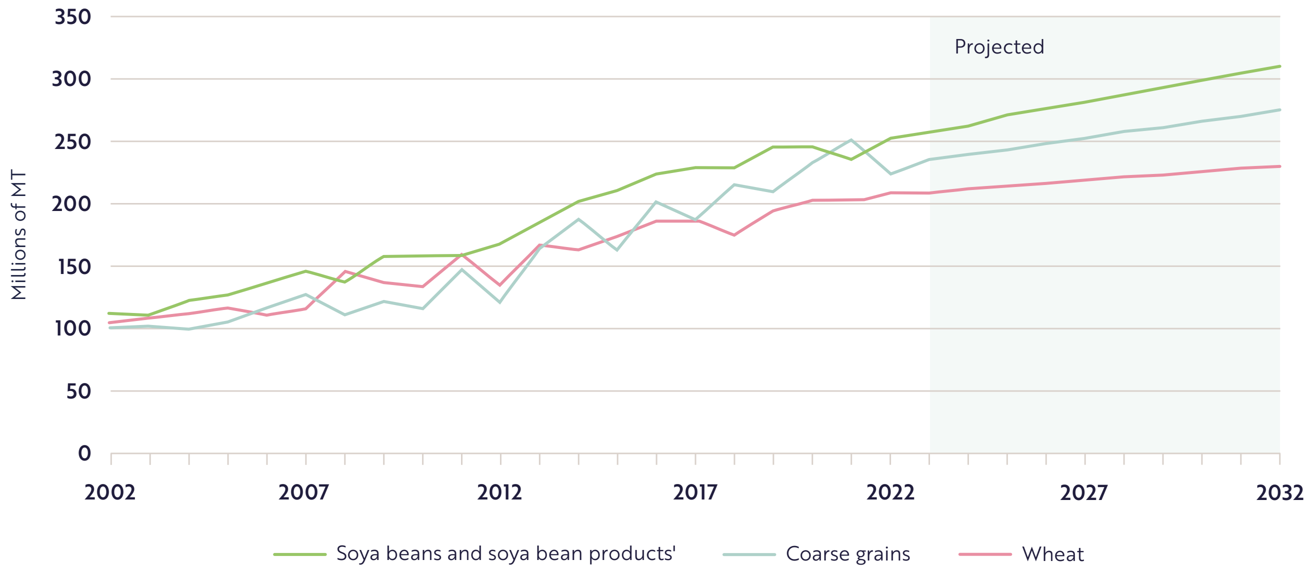
2.2.3 Global soya bean trade

Trade in raw soya beans can be largely captured by a small number of inter-country flows: most of the global trade in soya beans can be considered a flow from the US, Brazil, and Argentina to China and the EU, where they are processed. Global trade flows are highly consolidated due to the highly concentrated nature of production, which presents challenges to the entry of prospective new soya bean producers.

The largest importing countries in 2020 were China (102 million MT; USD 38.8 billion), Mexico (5.8 million MT; USD 2.2 billion), EU (15.1 million MT; USD 5.7 billion) of which Netherlands accounted for (5.6 million MT; USD 2.1 billion) (Resource Trade. Earth, 2023). China is the biggest importer from all three major producers, accounting for approximately half of the US and Brazil's exports and almost 80% of Argentina's exports (USDA, 2020).

The largest exporting countries in 2020, by weight and value, were Brazil (85.4 million MT; USD 31.3 billion), the United States (59.2 million MT; USD 23.7 billion), and Argentina (7.8 million MT; USD 2.9 billion) (Resource Trade. Earth, 2023). Brazil remains the key supplier to the EU – 54% in 2020, though environmental concerns about related deforestation in Brazil are impacting this market for Brazilian soya (Jorge and Jan, 2022).

Overall export volumes are growing faster than production, as the market is undergoing a transition. A gradual global decoupling of soya bean production from soya bean processing is taking place. Leading producers such as Brazil, Argentina, and the US, are shipping larger quantities of raw soya beans to China and, to a lesser extent, the EU and smaller markets in Asia and Egypt where processing then takes place. As shown in Figure 8, soya bean exports are expected to rise 8% over the projection period (2022/23-2032/33) (USDA, 2023).



[1]Total of soya beans, soya bean meal, and soya bean oil.
Source: USDA, Interagency Agricultural Projection Committee, October 2022.

Figure 8: Global trade in wheat, coarse grains, soya beans and soya bean products, 2002-2032
Source: USDA, Interagency Agricultural Projection Committee, October 2022

Figure 8 above clearly shows that the volume of trade in soya beans and their products has surpassed that of wheat and coarse grains to become the most traded commodity, and soya beans account for over 10 percent of the value of agricultural trade (USDA, 2019).

Global soya bean import demand growth, led by China, is mainly fulfilled by increased exports from Brazil (USDA, Agricultural Projections to 2032, 2023).

2.2 Africa

2.2.1 African soya bean production

Total African soya bean production was estimated at 4.7 million MT in 2021 (FAOSTAT, 2023). The top 10 largest producing countries in Africa produced 94% of the continent's soya bean (FAOSTAT, 2023). South Africa, Nigeria, Zambia, Benin and Malawi were the top five soya bean producers on the African continent in 2021 (see Figure 9) (FAOSTAT, 2023):

- South Africa's production was 1.9 million MT, which accounted for 41% of the African continent's production.
- Nigeria's production was 980,000 MT, which is 21% of the continent's production.
- Zambia's production was 411,000 MT, which is 9% of the continent's production.
- Benin's production was 291,000 MT, which is 6% of the continent's production.
- Malawi production was 220,000 MT, which is 4% of the continent's production.

Forecasts indicate that additional supply from these leading producers by 2030 would only reach 18 million bushels 705,882 MT; less than 0.15% of current global production. Africa, in the context of global soya bean production still produces much less than other continents (Cornelius et al., 2019).

The global average yield is 2.76 MT per hectare, while African producers' average yields are less than half, at 1.26 MT per hectare. According to one source, Egypt, using irrigation, leads all of Africa in terms of average soya bean yield at over 3 MT per hectare, while Ethiopia and Zambia, the number two and three yield leaders average 2.2 and 1.8 MT per hectare, respectively. South Africa averages 1.7 MT per hectare. And the rest of the continent (15 of the 24 African countries for which data exists) produces less than 1 MT per hectare (Cornelius et al., 2019). Expert interviews suggest that these figures may be overestimates.

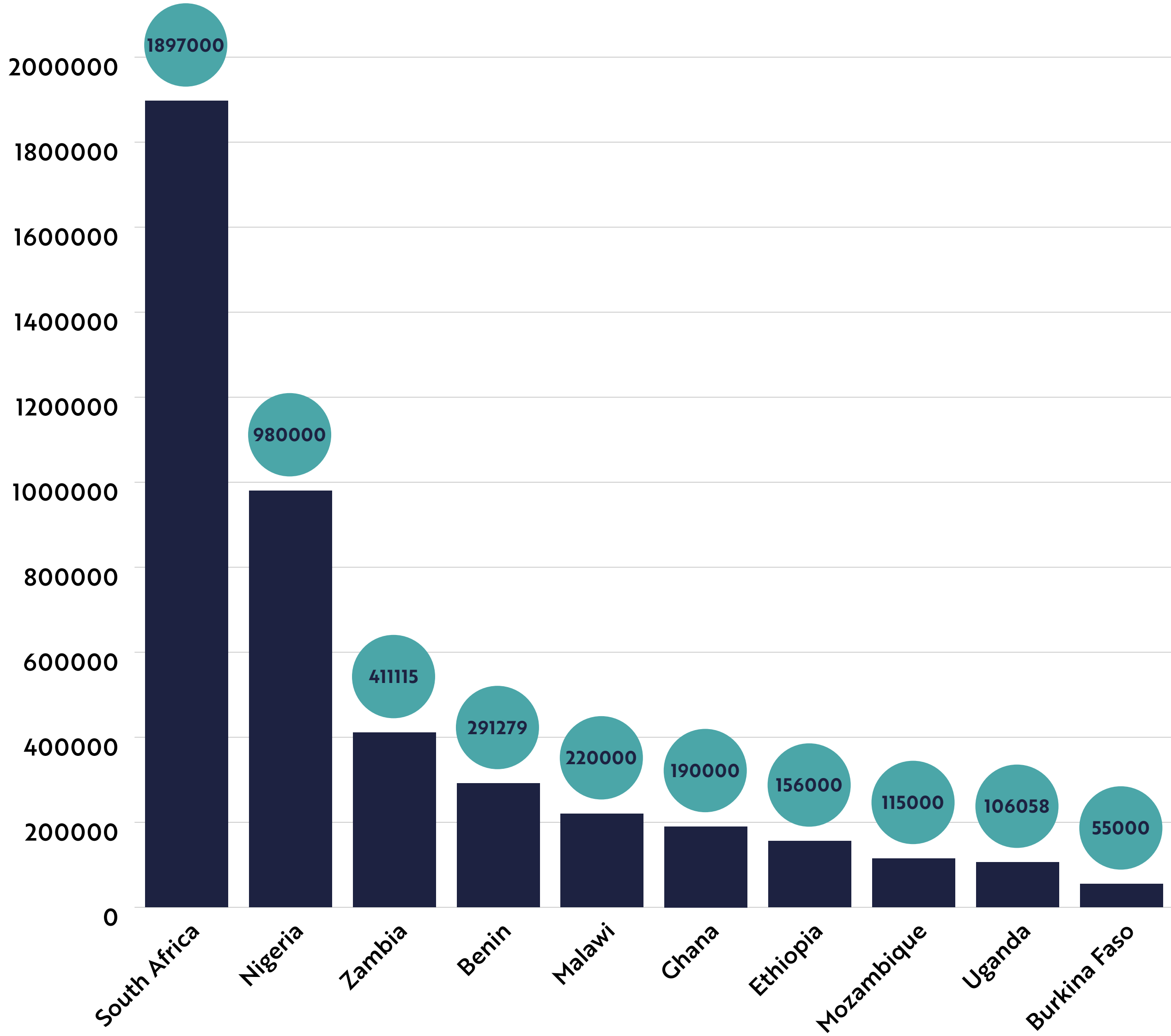


Figure 9: Africa's soya bean production by country, 2021 (MT)
Source: FAOSTAT, 2023

Regarding production growth, Angola has the highest Compound Annual Growth Rate (CAGR) for soya bean yield at 5.3% per year. Cameroon and Cote d'Ivoire follow at 4.92% and 2.88%, respectively. These three countries, though achieving relatively high annual growth rates in yield, are advancing from a low base producing less than 1.4 million bushels/37,940 MT combined. On the other hand, South Africa, Nigeria, and Zambia, the region's leaders in terms of total production achieve CAGRs of 2.6%, 1.8%, and 1.3% respectively, thus still maintaining low productivity growth (Cornelius et al., 2019).

2.2.2 Africa soya bean demand

Africa is estimated to import soya products (beans, oil, flour, sauce and soya meal) worth approximately USD 6.79 billion annually, of which it imports USD 3.5 billion worth of raw soya beans. In volume terms, raw soya bean imports into Africa currently stand at 2.2 million MT (ITC, 2023). Furthermore, according to World Bank estimates, the Sub-Saharan African population increased by 76% between 2000 and 2021 to 1.2 billion people, whilst the global population grew by 28% over the same period (World Bank, 2023). Food demand is expected to increase between 59% to 98% by 2050 (Schierhorn, 2016), implying a significant increase in soya bean demand.

Africa's soya bean imports, USD millions (2022)

Soya bean	Soya bean oil	Soya bean flour	Soya bean oilcake and other residues	Other soya-based products
3,522m	2,247m	23m	985m	15m

Table 2: Africa's soya bean imports, 2022 (USD millions)
Source: ITC, 2023

2.3 East Africa

2.3.1 East Africa soya bean production

In East Africa, soya bean production is largest in Uganda followed by Tanzania and Kenya, as summarized in Table 3 below.

	Kenya (2022)	Tanzania (2019)	Uganda (2020)
Total area under soya bean production (ha)	7,424	11,176	225,000
Number of soya bean farmers	5,540	39,453	520,259
Production volumes (MT)	1,888	19,710	138,000

Table 3: Soya bean production in East Africa

Sources: Tanzania National Bureau of Statistics, 2021 / Uganda Bureau of Statistics, 2022 / Ministry of Agriculture and Livestock Development, 2023

Soya bean production in East Africa is concentrated in only a few regions, as shown in Figure 10:

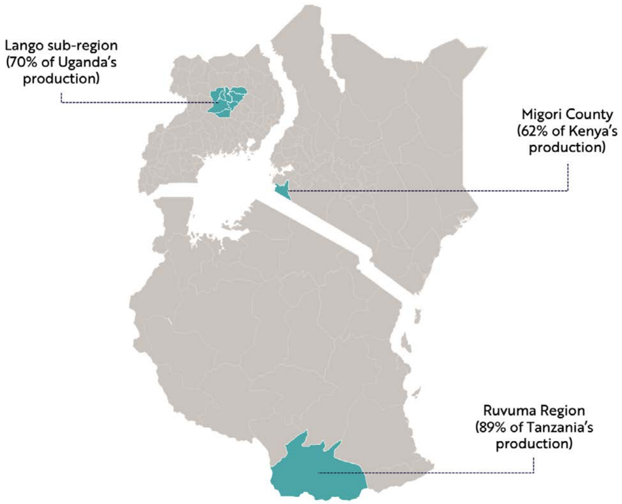


Figure 10: Major soya bean producing areas in East Africa

Sources: Tanzania National Bureau of Statistics, 2021 / Uganda Bureau of Statistics, 2022 / Ministry of Agriculture, Livestock, Fisheries and Co-operatives, 2022

Each of the three countries have two soya bean seasons in the year in most areas, with harvests as follows:

	First season	Second season
Kenya	March-April	October-November
Tanzania	January-February	July-August
Uganda	July-August	December-January

Table 4: Country crop calendars

Source: USDA, 2023

"The opportunity for farmers to diversify away from cotton production was a driver of the growth of soya bean, which has been able to leverage existing cooperative structures."

Dr Peter Ebanyat, Makerere University, October 2022.

In Kenya, as shown in Figure 11, Migori is the largest soya bean producer, followed by Bungoma, Kakamega, Meru, and Vihiga Counties. This highlights the concentration of soya bean production primarily in Western Kenya.

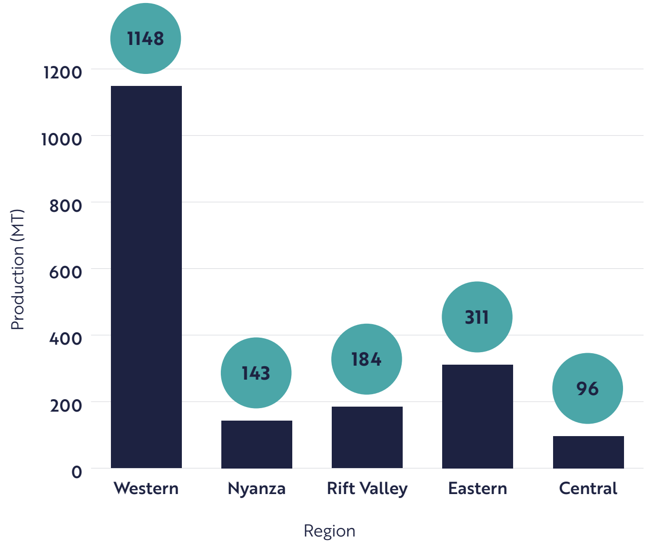
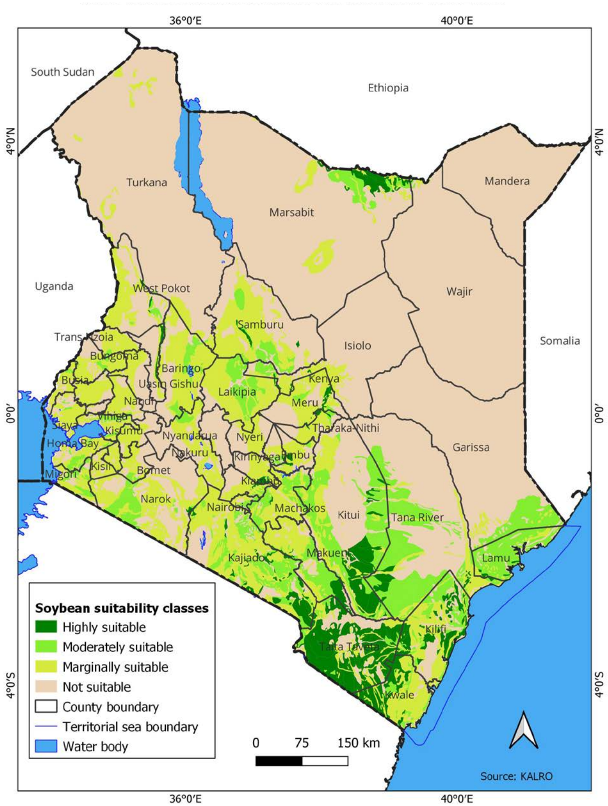


Figure 11: Regional soya bean production in Kenya, 2021 (MT)
Source: Ministry of Agriculture and Livestock Development, 2023

Yet, KALRO's soya bean crop suitability map indicates that the most suitable area of Kenya for soya bean production is in the Southern Counties of Taita Taveta, Kwale, Kajiado, Kitui and Tana River.



For Uganda, Figure 13 shows that soya bean production is largely concentrated in Northern and North-eastern regions with Lango and Acholi sub-regions being the largest producers of soya bean and Busoga, Bukedi, and Teso producing far smaller volumes. Multiple factors have driven the growth of the sector. NGO soya bean development efforts coupled with government goodwill to develop the Northern region of Uganda could explain the relative success of soya bean production in the region.

Figure 12: Land suitability for soya bean growing in Kenya
Source: KALRO, 2023

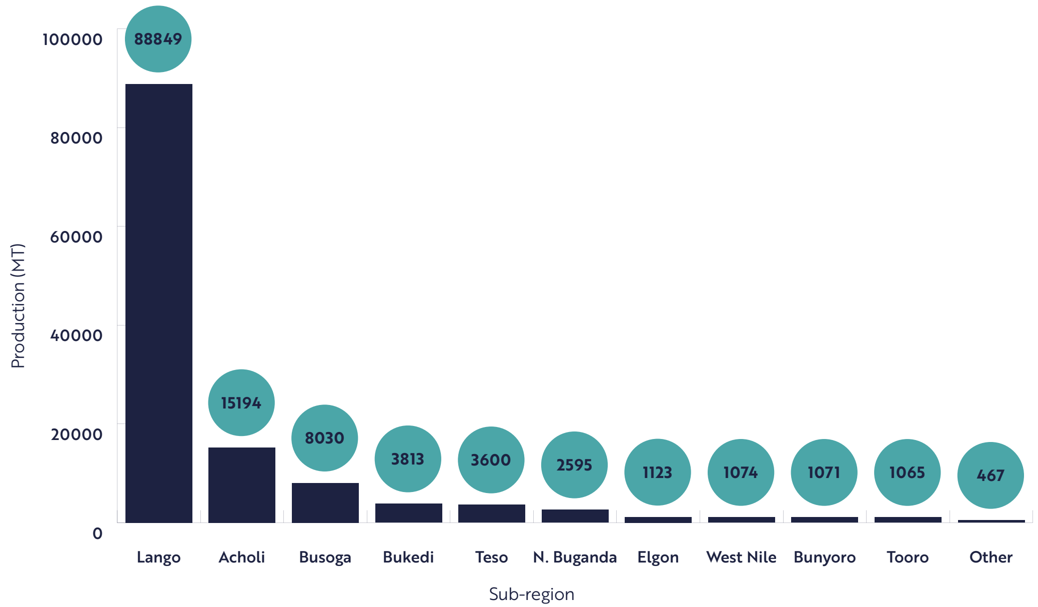


Figure 13: Major soya bean-producing sub-regions in Uganda, 2020 (MT)
Source: Uganda Bureau of Statistics, 2022

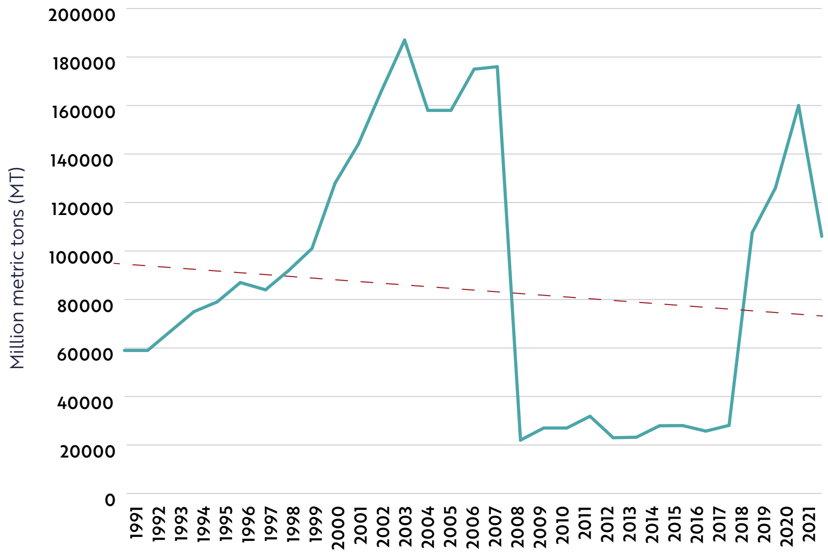


Figure 14: Ugandan soya bean production (MT)
Source: FAOSTAT, 2023

Whilst Uganda is the largest producer in East Africa, Figures 13 and 14 illustrate the volatility of Uganda's production.

For Tanzania, according to Figure 15, Ruvuma is the largest producer of soya beans, accounting for 89% of production. The large amounts of land available to farmers, relatively stronger government support, and existing cooperative (AMCOS) networks could explain the relatively high soya bean production in Ruvuma.

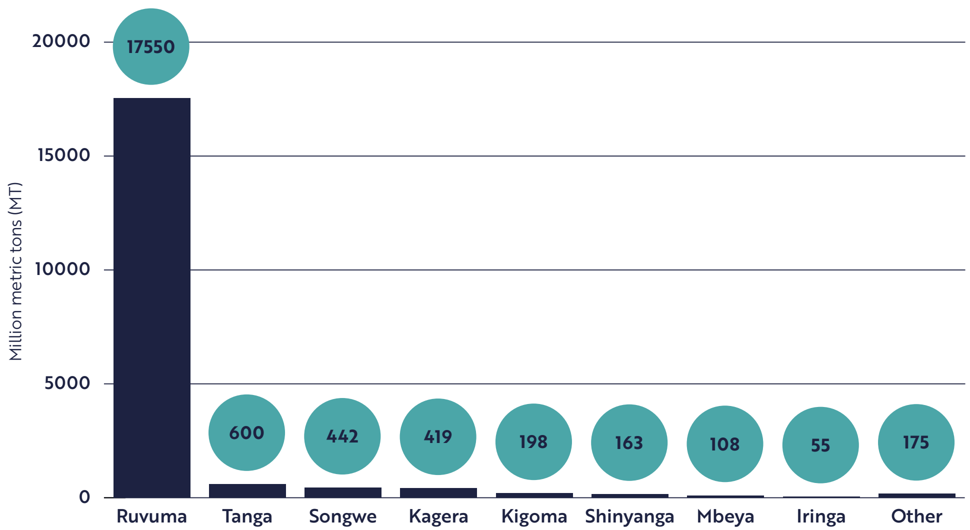


Figure 15: Regional soya bean production in Tanzania, 2019-20 (MT)
Source: Tanzania National Bureau of Statistics, 2021

2.3.2 East Africa soya bean demand

Soya bean demand is driven primarily by demand for edible oils and oilcake for animal feeds, with by-products and other processed products being secondary. The following table summarises demand estimates for these products, to which soya bean can contribute, where data is available.

As shown in Figure 21, significant and growing vegetable oil demand, currently met largely through imports, is dominated by palm oil due to its lower cost. Palm oil (mainly crude) accounts for 72% of all edible oil imports to the EAC (ITC, 2023). The Government of Kenya estimates that current annual demand for soya bean in Kenya varies between 150,000 and 200,000 MT whilst the annual domestic production stands at around 2,000 MT (Ministry of Agriculture and Livestock Development, 2023). Most of the demand is met through imports.

"The Government of Kenya estimates that current annual demand for soya bean in Kenya varies between 150,000 and 200,000 MT whilst the annual domestic production stands at around 2,000 MT (Ministry of Agriculture and Livestock Development, 2023)."

	Kenya	Tanzania	Uganda
Vegetable oil	759,000[2]	570,000[3]	410,000
Oilcake for animal feed	310,000[4]	Not known	23,000[5]

Table 5: Demand for products to which soya bean contributes (MT)
Sources: TIC, 2023 / Ministry of Agriculture and Livestock Development, 2023 / Larive, 2021 / Government of Uganda, 2023 / Shinyekwa, 2018

The combined demand for (commercial and non-commercial) animal and fish (aquaculture) feeds in Kenya was estimated at 797,700 MT in 2021 (Larive, 2021). It is estimated that this translates to approximately 310,000 MT of oilcake demand, to which soya bean oilcake contributes.

Human consumption of soya bean is marginal in most African countries, with Malawi and Nigeria as notable exceptions. A large untapped market of low-income consumers with latent demand for low-cost dietary protein could be addressed by soya bean processors.

2.3.3 East Africa soya bean trade

In East Africa, overall imports of soya bean and soya bean products are dominated by soya beans (64% in 2022) and soya bean cake (24% in 2022) for animal feed. Kenya, Tanzania and Uganda imported USD 45.3 million, USD 36.8 million, and USD 2 million respectively of soya bean products in 2022 (ITC, 2023), though Uganda is a net exporter. It is also possible that some of Uganda's production is actually unofficial trade from DRC (Giller, 2023). Imports are largely driven by the animal feed industry requiring soya bean oilcake/meal, some of which is processed in East Africa.

"The most traded soya bean product is oilcake which constitutes 86% of imports of soya bean products into the three countries (by volume)."

As illustrated in Figure 17, the most traded soya bean product is oilcake which constitutes 86% of imports of soya bean products into the three countries (by volume). Other traded products include soya beans, soya flour, soya oil, and soya sauce.

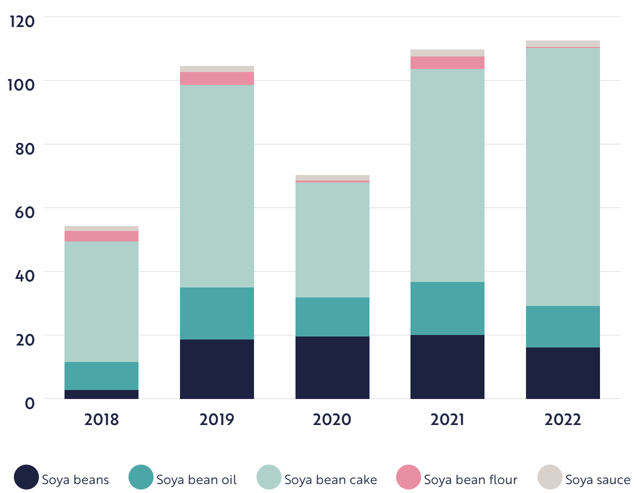


Figure 16: Total soya bean and soya product imports to EAC (USD millions)
Source: ITC, 2023

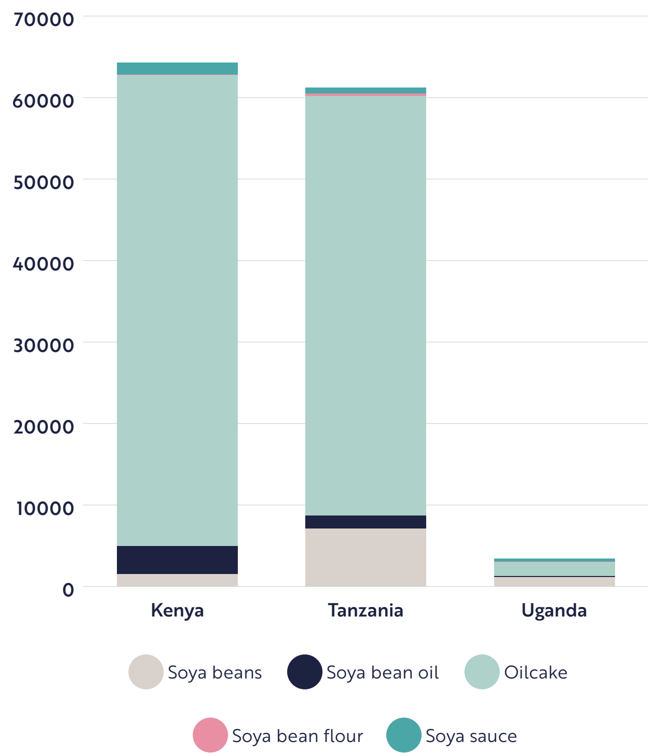


Figure 17: Total soya bean and soya bean product imports, 2022 (MT)
Source: ITC, 2023

Soya bean and soya product trade

Figure 18, which summarises imports of all soya bean and soya-based products into East Africa, highlights that exports from outside East and Southern Africa only came from the US and Ukraine (prior to the Russia-Ukraine conflict). This reflected 140,000 MT or USD 64.1m of trade.

Soya bean trade

Figure 19 shows the dominance of soya bean imports from Ukraine into Kenya prior to the Russia-Ukraine conflict in 2020. It also highlights regional soya bean from Malawi into Tanzania and Rwanda, and from Uganda into Tanzania. There was a total of USD 11m of soya bean imports into East Africa.

Figure 18: East African soya bean and soya product imports, 2020 (USD)

Source: https://resourcetrade.earth/

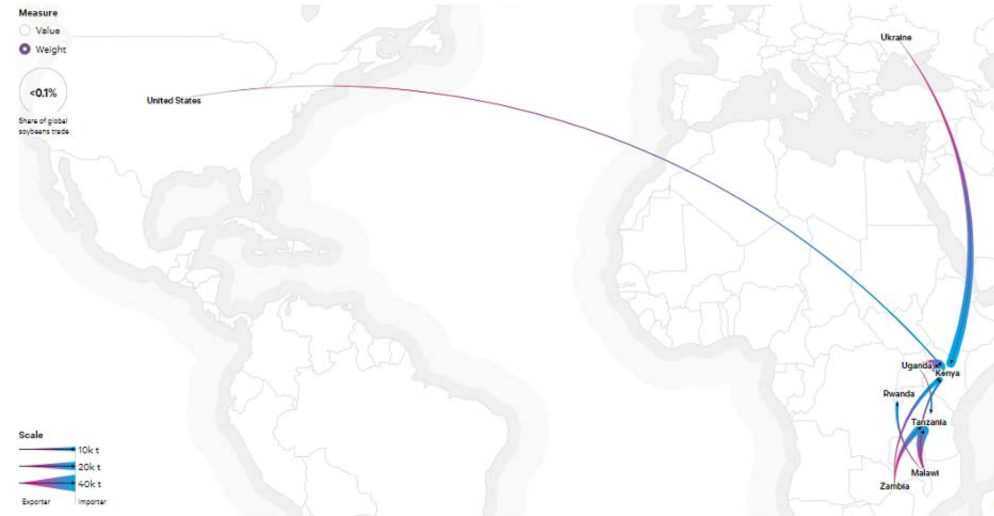
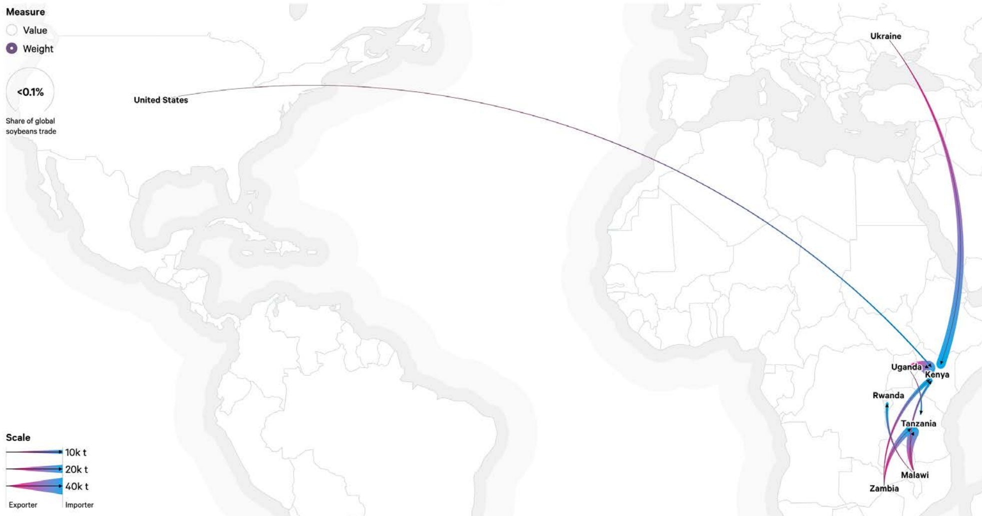


Figure 19: East African soya bean imports, 2020 (USD)

Source: https://resourcetrade.earth/



Edible oil trade

As illustrated in Figure 7, soya bean oil accounts for 29% of global edible oil consumption with palm oil as its greatest competitor (USDA, 2023). Figure 20 shows trade flows of USD 1.7 billion of oilseeds into East Africa, demonstrating the dominance of palm (USD 1.5 billion) almost entirely from Indonesia and Malaysia), which is also growing in value terms over time. Soya bean is the next most important oilseed crop, accounting for USD 64 million of imports, growing at 12% over the previous five years.

Figure 20: East African oilseed imports, 2020 (USD)
Source: https://resourcetrade.earth/

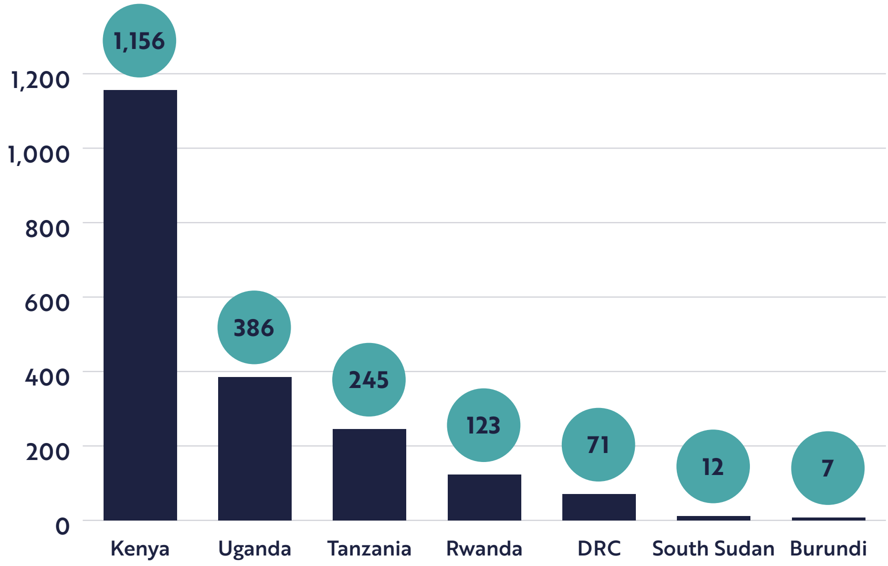


Figure 21: East African edible oil imports, 2022 (USD millions)
Source: ITC TradeMap, 2023

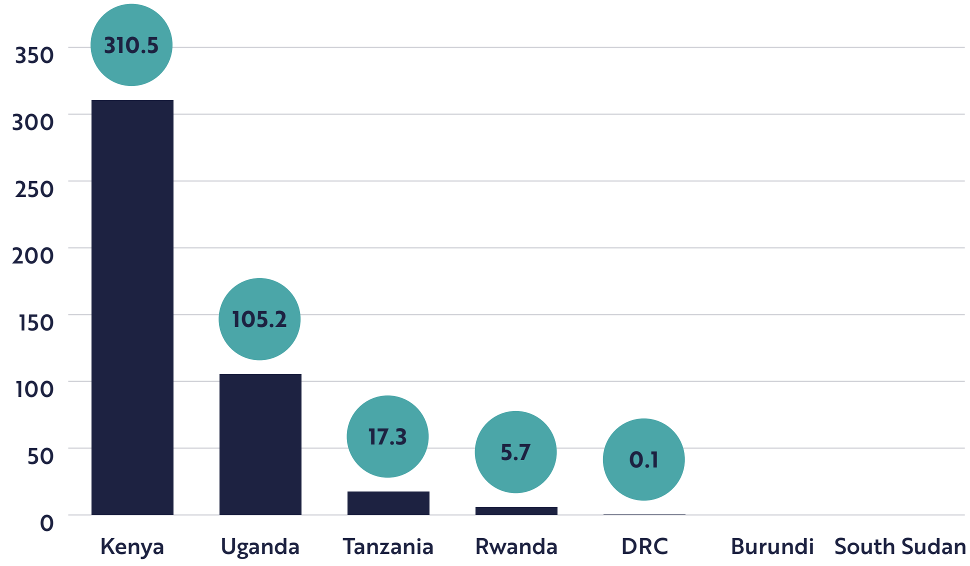


Figure 22: East African edible oil exports, 2022 (USD millions)
Source: ITC TradeMap, 2023

Figure 21 breaks down edible oil imports by country within the EAC. It is also important to note that whilst East Africa is a net importer of edible oils, there is considerable processing of imported crude oil within East Africa. 71% of the imports of palm oil into EAC are crude palm oil, which must be refined for final consumption. 89% of Kenya's USD 1,084 million of imported palm oil, is crude oil.

As shown in Figure 22, Kenya also dominates edible oil exports in East Africa, with USD 311m of exports, mainly to the EAC region, of which USD 191 million is palm oil. This indicates that a significant share of Kenya's imported crude palm oil is refined and re-exported to the wider region.

Soya bean oilcake trade

Figure 23 illustrates the dynamic regional trade in soya bean oilcake within East Africa, amounting to USD 39m, dominated by exports from Uganda into Kenya, followed by Malawi and Zambia into Tanzania.

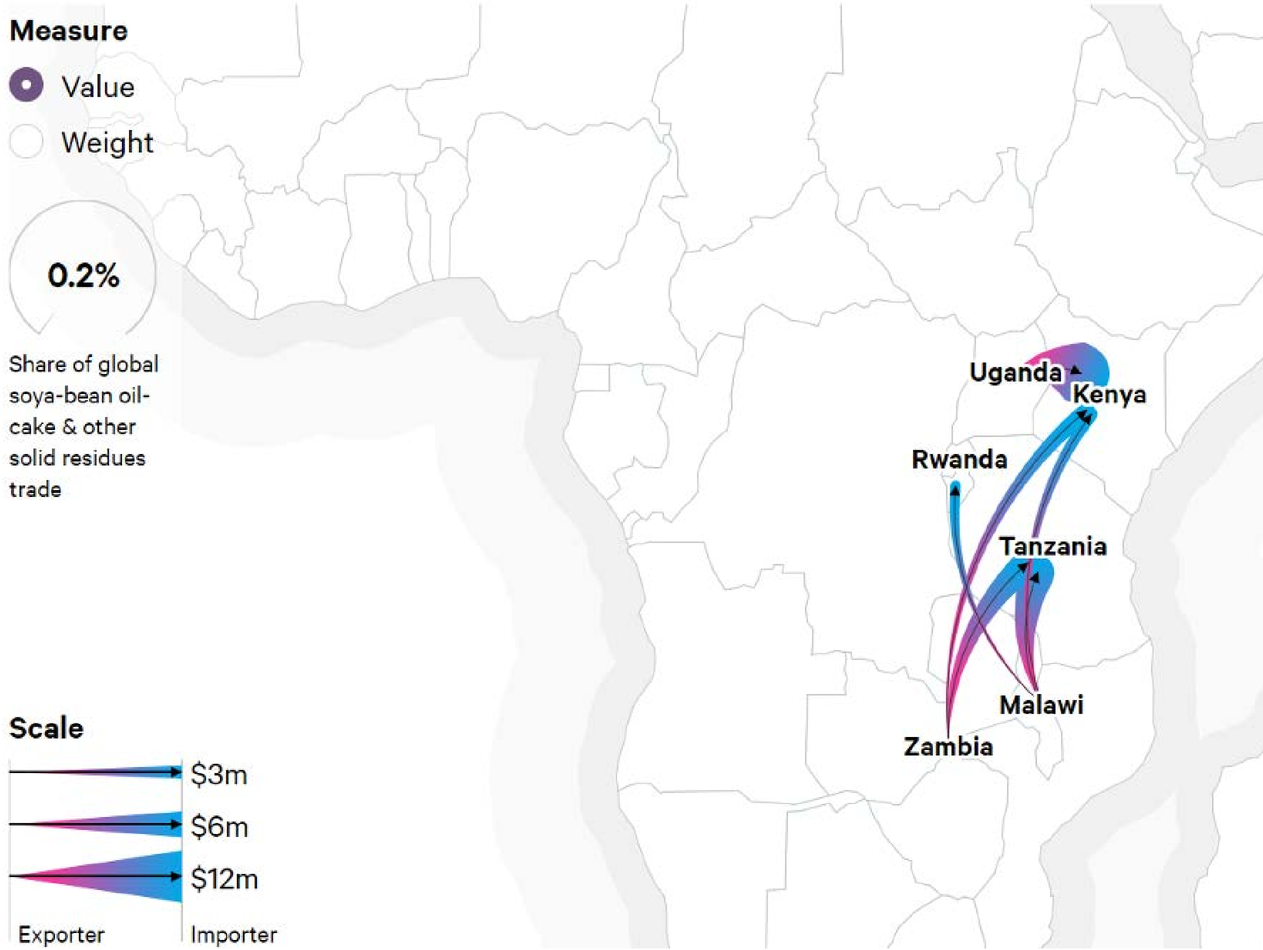


Figure 23: East African soya bean oilcake imports, 2020 (USD)
Source: https://resourcetrade.earth/

3

Soya bean programming in East Africa

Despite promotional efforts, the East Africa region remains small, accounting for less than 1% of global soya bean production.

3.1 Historical and current soya bean programmes in Kenya

Despite being introduced in the early 1900s by British colonialists, soya bean has never been hugely successful in Kenya, either under production by colonialist settlers or latterly by smallholders, owing to a lack of policy emphasis by successive governments, a lack of suitable varieties and subsequent lack of availability of seed, and the move away from promoting soya bean as a rotational crop with maize (Jackson, 2016).

The following development initiatives have promoted soya bean in recent years:

- **2011 to 2018**: the **Rural Outreach Program (ROP)32**[6], a regional Non-Governmental Organization, implemented two soil health projects in western Kenya funded by AGRA to scale up maize and soya bean production as well as promote value addition to their by-products for improved food security, nutrition, and incomes.
- In **2012**, **The Tropical Legumes II (TL II) project**[7], funded by the Bill & Melinda Gates Foundation, and jointly implemented by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), the International Center for Tropical Agriculture (CIAT) and the International Institute of Tropical Agriculture (IITA) in close collaboration with partners in the National Agricultural Research Systems of target countries in sub-Saharan Africa and South Asia. TL II aims to improve the livelihoods of smallholder farmers in drought-prone areas of the two regions through enhanced grain legumes productivity and production. This saw the release of several new seed varieties across various legumes.

- In **2012**, 2Scale[8], an inclusive agribusiness incubator, implemented by the International Fertiliser Development Center (IFDC), BoP Innovation Center (Bopinc) and SNV (and funded by the Ministry of Foreign Affairs of the Netherlands), was established with the aim of supporting clusters and businesses to develop products and markets for local consumers. As part of its soya and oil seeds industry focus, it supports the production of soya beans and soya-based including cooking oil for local markets. For example, it supported Equatorial Nuts Processors to produce fortified nutritious soya-based products and Pro-Soya Kenya Ltd to produce corn-soya blended flours (CSB) and related products. Both are sourcing from local smallholder producers, creating a reliable market for their produce.

- In **2020**, a partnership between CABI, Agriculture and Climate Risk Enterprise Ltd (ACRE Africa)[9], International Food Policy Research Institute (IFPRI) and Kilimo Trust (with funding from Innovate UK) aims to help 30,000 Kenyan farmers to improve their soya bean yields and sales through improved production and access to high-value markets. The project is focussing on tacking pests, and has developed an integrated suite of services, that includes new digital surveillance systems. Some of its activities include:
  - Training ~300 of ACRE Africa's Village Extension Service Providers (VESPs) on CABI's Plantwise plant doctor processes, focusing on soya bean pest management.
  - Extending and testing an innovative 'Picture-Based Insurance' tool as a means of accelerating uptake of pest insurance products in Kenya.
  - Validating pest models across rural and peri-urban locations.
  - Determining if models provide insurance providers with valuable data to inform 'basis risk' calculations, alerting them to the validity of forthcoming claims and examining the probability of longer-term B2B sustainability funding.

- **Since 2019**, the Syngenta Foundation for Sustainable Agriculture[10] has been supporting soya bean research trials across Kenya, in partnership with USAID under the Partnerships for Seed Technology Transfer in Africa (PASTTA)[11] program. They are partnering with KALRO, KEPHIS, other development initiatives such as the Soybean Innovation Lab as well as private sector partners such as AgVenture.

3.2 Historical and current soya bean programmes in Tanzania

Soya bean promotions in Tanzania date back to 1955, anchored on interest in expanding the use of soya beans for human foods. Soya beans were bought by the National Milling Corp and in 1973 tests were run in three villages making whole soya flour using a simple process developed at the USDA Northern Regional Research Center in the United States. By 1974, maize flour was being fortified with soya flour in porridges and wheat flour was fortified with soya flour in breads (Aoyagi, 2009).

The following development initiatives have promoted soya bean in recent years:

- **2007-10:** Care International implemented a three-year project in Iringa aimed at improving nutrition through soya bean fortification, homemade feed formulation and supply to the feed market.
- **2009-18:** The international Institute of Tropical Agriculture (IITA) in collaboration with Wageningen University and Research (WUR) implemented the **N2Africa programme**[12] which aimed to expand the planted area and enhance the yield of grain legumes in Africa, including in Kenya, Uganda and Tanzania (added in 2014), with the ultimate aim of improving incomes and food and nutritional security. It promoted soya bean cultivation in several countries with a focus on soil health through nitrogen fixation, promotion and adoption of better farming practices, as well as research and trials on soya bean seed varieties. N2Africa aligned key partners in the soya bean value chain to address input and output markets and reached 660,000 smallholder farmers (Wageningen University & Research, 2019) with improved legume technologies including seeds, rhizobium inoculant and legume fertilisers.
- **2012-19:** The Catholic Relief Service (CRS) - USDA funded **Soya ni Pesa project**[13] paved the way to commercial viability of the soya bean value chain in the SAGCOT region of Tanzania. Despite being a livelihood project, its private sector engagement attracted investment into developing seed systems, input delivery models, market engagement and financing mechanisms to commercialise the crop.
- **2015-18:** CABI, Farm Africa and IITA implemented the **Scaling-up Improved Legume Technologies in Tanzania (SILT) project**[14] – a food security and nutrition project that expanded the work of N2Africa helping develop and use innovative approaches including complimentary communication methods to scale-up improved legume technologies and establish sustainable input systems.

- **2017-present:** The **Farm to Market Alliance**[15] is currently operational in Tanzania (as well as Zambia, Kenya, and Rwanda) working through field level agreements with Nafaka Kilimo and Farm Africa. Its aim is to make markets work better for smallholder farmers by working through partnerships with off-takers, agri-related businesses, and service providers.

- In **2021,** the Tanzania Agricultural Development Bank (TADB) and Clinton Development Initiative (CDI) established a **3-year initiative**[16] supporting 2,900 CDI soya bean farmers and 29 agricultural marketing cooperative societies (AMCOSs) in Iringa Region to access inputs on loan and produce soya bean for feed and seeds markets. This built on an earlier three-year initiative led by the Clinton Development Initiative that organised input loans for village community banks and AMCOSs.

- **From 2022,** the Southern Agricultural Growth Corridor of Tanzania SAGCOT Centre Ltd is leading a **soya value chain partnership initiative**[17], the Tanzania Sustainable Soybean Initiative TSSI), in collaboration with a range of public and private sector partners including the Farm to Market Alliance (FtMA), International Institute of Tropical Agriculture (IITA), and ASPIRES Tanzania with financial support from The Royal Norwegian Embassy. It aims to enhance farmer incomes through boosting productivity, production and access to markets, as well as supporting animal feed production and the livestock industry. It aims to benefit 32,000 smallholder farmers and is operating in Morogoro, Iringa, Njombe, Ruvuma, Songwe, and Rukwa.

- **Currently,** Wageningen University and Research (WUR) is implementing the **Leg4Dev project**[18], a legume agroecological intensification programme promoting soya bean/maize rotations – and farmer learning, e.g. the 'Farmer MBA' app, which will interface well soya value chain partnership initiative outlined above.

These initiatives are complemented by the activities of other development programs, NGOs and Advocacy organisations including BRiTEN, RUDI, Farm Africa, Nafaka Kilimo, ACT and others, who are contributing to increasing productivity and facilitating access to markets, aid in reducing regulatory red tape, unblocking policy bottlenecks and awareness creation in consumption, utilisation, generating socio-economic impact. Likewise, research and development organisations including IITA, WUR, TARI, IFDC, AGRA, all have interest in developing and promoting improved technologies, uptake and adoption for improved production and yields. For further details of the lessons learned from several of the programmes above, please refer to (International Institute of Tropical Agriculture (IITA), 2023).

3.3 Historical and current soya bean programmes in Uganda

Soya bean was introduced into Uganda in 1908, though development of the crop was slow. The industry's recent growth is attributed to a combination of the availability of improved seed varieties, government investment in research and development, and private sector investment along the soya bean value chain (Makerere University, 2019).

Soya bean research and development efforts are led by The Makerere University Centre for Soya bean Improvement and Development (MAKCSID) since 2002. It is awarded delegated responsibility for soya bean research, development and promotion by the National Agricultural Research Organization (NARO). It focuses on practical plant breeding and seed technology and a key achievement has been to develop varieties with resistance to soya bean rust disease following a major outbreak of the disease in 1996. The introduction of the policy allowing for the multiplication of Quality Declared Seed (QDS) by Non-Governmental Organisations (NGOs) and Community-Based Organisations (CBOs) has helped to improve the supply of seed to farmers. It was estimated that around half of foundation seed from MAKCSID was taken up by NGOs and CBOs to produce QDS. In addition to training students, MAKCSID partnered with World Vision to do farmer training on soya bean production in several districts (Makerere University, 2019).

In addition, the following development initiatives have promoted soya bean in recent years:

- **2015-2022:** The Northern Uganda – Transforming the economy through climate smart agriculture (Nu-TEC) programme, implemented by Palladium and funded by FCDO, had a focus on improving commodity markets for oilseeds crops (sunflower, soya beans and sesame), agricultural inputs markets, storage and post-harvest handling and mechanisation. It included working with oilseed millers to enhance their grain supply, improve quality and enhance distribution channels for end products as well as supporting the development of local seed systems in Northern Uganda for soya beans (BEAM Exchange, 2022). Technical support on soya bean production was provided by the N2Africa project.

"The industry's recent growth in Uganda is attributed to a combination of the availability of improved seed varieties, government investment in research and development, and private sector investment along the soya bean value chain (Makerere University, 2019)."

- **2017-2023:** The Development Initiative of Northern Uganda (DINU) Programme is a multi-sectoral programme implemented by the Government of Uganda, and the National Agricultural Research Organisation (NARO) and supported by the EU in choli, Karamoja, Lango, Teso and West Nile. Under its Food Security, Nutrition and Livelihoods sector, it is supporting youth skilling in agri-business, training of local government in production and agricultural extension delivery, access to credit, quality enhancement, input and output market access, aggregation, market linkages and contractual arrangements. It focuses on the commercialisation of cassava, rice and soya bean as well as other crops from a food and nutritional security perspective. Activities are implemented by the International Institute of Tropical Agriculture (IITA), Kilimo Trust, Rikolto, Volunteer Efforts for Development Concerns (VEDCO) (Rikolto, 2020).

- **2018-2023:** The **Climate Smart Resilient Agribusiness for Tomorrow (CRAFT)**[19] project is implemented by SNV, Wageningen University & Research (WUR), Accelerating Impacts of CGIAR Climate Research for Africa (AICCRA), Agriterra, and Rabo Partnerships in Kenya, Uganda and Tanzania, funded by the Netherlands Ministry of Foreign Affairs. The project works with agribusiness SMEs to deliver inputs and services to smallholder farmers with an emphasis on climate resilient practices. In Uganda, it has focused primarily on soya bean (as well as sunflower and potato), where it partnered with Ugandan agribusinesses working in the soya bean value chain who helped secure seeds, raise adoption of good agricultural practices and procure grain (SNV, 2022).

4

Factors affecting the soya bean value chain in East Africa

Despite the potential of soya bean production in alleviating poverty, small-scale farmers face significant challenges producing soya bean in Africa. (Siamabele, 2019) highlights challenges faced by small-scale farmers ranging from inputs accessibility, rainfall dependence, climate change, declining soil fertility, and market access. Underinvestment may be driven at least in part by farmers having limited access to credit and other services to enhance their soya bean production.

4.1 Low Productivity

At yields close to 1.26 MT/ha on average across sub–Saharan Africa, compared to the global average of 2.76 MT/ha, production in sub–Saharan Africa is not competitive (Cornelius et al., 2019). According to farmer surveys conducted by Gatsby Africa in 2022-23, farmer-reported yields in Kenya, Tanzania, and Uganda are lower, as illustrated below. We recognise that farmer-reported yields have not been verified and may not be accurate. The Ugandan Bureau of Statistics notes that whilst yields were around 800 kg/ha in 2020, this had risen from around 600 kg/ha in 2019 (Uganda Bureau of Statistics, 2022). Ultimately, this limits the growth of overall production, farmer profitability, and the competitiveness of soya bean processing in sub–Saharan Africa.

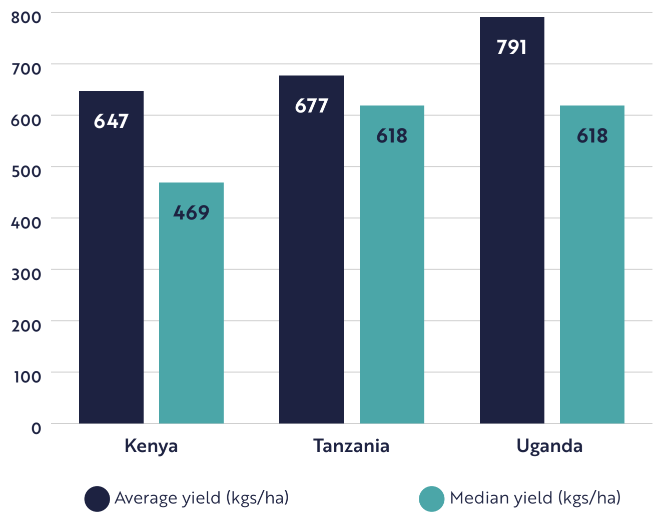


Figure 24: Soya bean yield, 2022 (kg per hectare)
Source: Gatsby Africa, 2023

Several issues contribute to these low yields, which are summarised below.

4.1.1 Seed systems constraints

Despite the strides made in seed innovation, accessibility remains low in East Africa. Despite the release of several high performing, improved seed varieties, their (commercialised) seed multiplication and distribution remains a major challenge. As above, Gatsby's farmer surveys found that 91%, 72% and 82% of the farmers in Tanzania, Kenya and Uganda respectively, depended on recycled soya bean seed (generally of local varieties) for their soya bean production. In some cases, farmers reported sourcing 'seed' from open-air grain markets. The major issue affecting their utilisation of improved seed was lack of access. Scaling up access through commercial multiplication and distribution would significantly increase soya bean productivity.

The lack of availability of sufficient improved seed is driven by the following factors:

- **Uncertain farmer demand** owing to lack of output market security and the ability of farmers to recycle seeds as soya bean is a self-pollinating crop.
- **Uncertainties about the ability of seed companies** to recoup returns from production of soya seed, owing to unpredictable demand driven by recycling of seed.
- The **sensitivity and limited shelf life of soya bean seed** (owing to its high oil content)
- **Resource constraints of agricultural research institutions** limit the volumes of foundation seed that they are able to produce for subsequent (commercial) multiplication.
- Varied **seed multiplication arrangements** across the region, all of which face capacity constraints.

The situation in each of the three countries is summarised as follows:

- In **Uganda**, basic seed[20] (Maksoy N1-N6 varieties) is produced by Makerere University and made available to a range of seed multipliers including formal seed companies such as Pearl Seeds, small agribusinesses and farmers groups or cooperatives. Formal seed companies produce certified seed whilst the other actors produce Quality Declared Seed (QDS). An estimated 18% of farmers are served with either certified or QDS seed in Uganda (interview with Prof. Phinehas Tukamuhabwa, Makerere University, 13th December 2022).
- In **Kenya**, the Kenya Agricultural and Livestock Research Organization (KALRO) has developed and/or released a number of varieties e.g. DPSB19[21] which had 85% market share of certified varieties (Syngenta Foundation, 2022), and SeedCo Kenya has two registered varieties (Salama and Saga) and is expanding local seed multiplication. Through Gatsby's recent research, it was observed that the biggest constraint among Kenyan soya bean producers was arguably access to quality and reliable improved seed.
- In **Tanzania**, the Tanzania Agricultural Research Institute (TARI) has developed several varieties (e.g. Uyole 1, Uyole 2). SeedCo has varieties that were registered for release with the help of the International Institute of Tropical Agriculture (IITA) under the N2Africa project, and they are exploring seed multiplication in Tanzania. The seed multiplication and availability problem was also observed in Gatsby's recent research with 93% of respondents utilising recycled seed in Tanzania.

The US-funded Soybean Innovation Lab[22] has conducted seed trials (with 388 varieties) across Sub-Saharan Africa, including 83 in Kenya, 70 in Uganda and 40 in Tanzania. This included seed products from organisations such as the International Institute of Tropical Agriculture (IITA), SeedCo, the Malawi Department of

Agricultural Research Service (DARS) and the Zimbabwe Crop Breeding Institute (CBI) (Soybean Innovation Lab). 15 new soya bean varieties have been introduced into markets including in Kenya, and 65 varieties in are the commercial pipeline, 22 of which have been nationally registered.

4.1.2 Poor agronomic practices

Farmers lack access to information on good/recommended agronomic practices, which impedes their adoption. For example, this includes plant population/plant spacing, use of quality seeds, inoculants, phosphorus ("P") fertilisers, and weeding (Siamabele, 2019), as well as harvest and post-harvest practices. For example, according to recent Gatsby's research, less than 8% of farmers across East Africa used inoculants (Gatsby Africa, 2023). Farmers' rationale included lack of knowledge about inoculants and inaccessibility.

Also, misinformation about the lack of need for fertilisers has greatly affected the use of fertilisers in soya bean production in Africa. In some cases, the knowledge that soya bean fixes nitrogen in the soil has been misconstrued to mean that soya bean does not require fertilisers or soil nutrient inputs. During Gatsby's recent research, as illustrated in Figure 25 below, it was observed that 84% of the farmers across Uganda, Kenya and Tanzania did not use fertilisers on soya bean. Farmers' reasons included lack of training and awareness and lack of access. This is likely to have been compounded in recent seasons by the high cost of fertilisers.

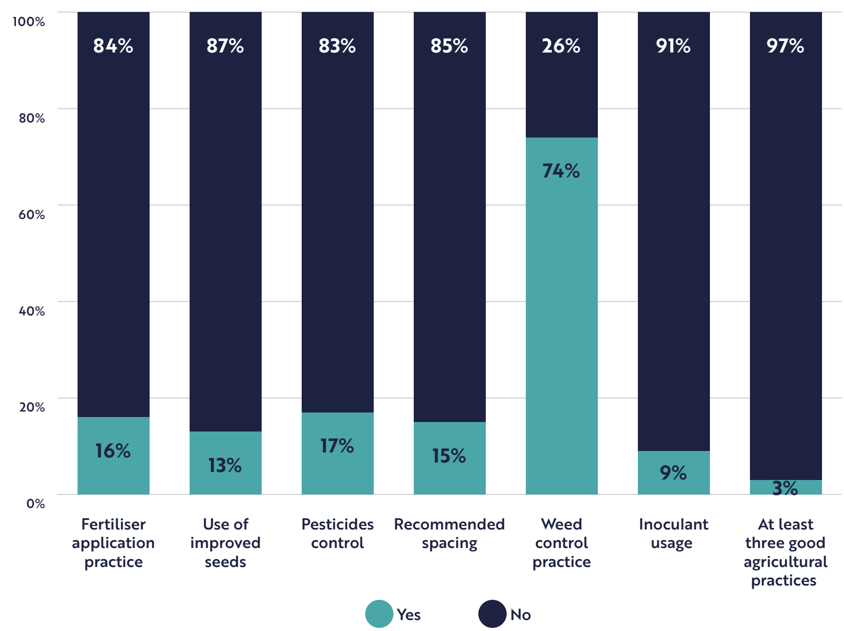


Figure 25: Adoption of good agricultural practices in East Africa
Source: Gatsby Africa, 2023

Also, regarding irrigation, farmers were more likely to use irrigation to support the production of more profitable crops. Thus, there was limited use of irrigation in soya bean production compared to highly profitable value chains like horticulture (Gatsby Africa, 2023).

4.1.3 High labour requirement for soya bean production

According to (Siamabele, 2021) soya bean is a relatively labour-intensive crop, especially at harvest. In Gatsby's recent research the significant labour requirement constituted 41% in Kenya, 33% in Tanzania and 18% in Uganda of total production cost for a representative farmer (see Figure 26). This is at least in part explained by low rates of mechanisation: 52% in Kenya, 4% in Tanzania and 15% in Uganda (Gatsby Africa, 2023). These labour (and/or mechanisation) requirements deter farmers with low incomes (and lack of family labour) from investing in soya bean production. With mechanised land preparation, threshing, and drying in soya bean production, labour costs would be reduced, lowering the total production cost (Musoni, 2013). Yet, the majority of soya bean producers in East Africa are smallholder farmers with low incomes, facing affordability constraints.

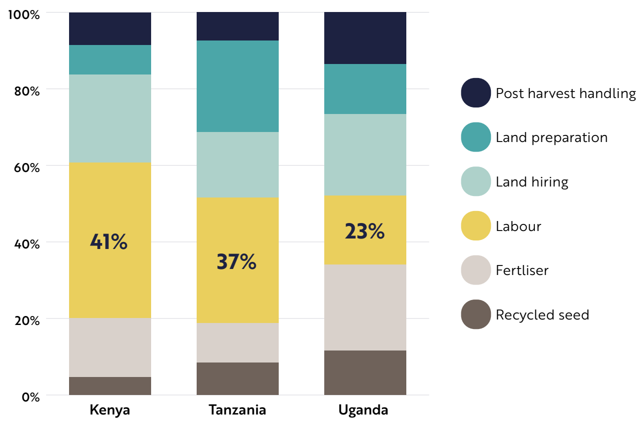


Figure 26: Soya bean production cost components (%) [23]
Source: Gatsby Africa, 2023

Figure 27 points to a rise in the cost of soya bean production and fluctuation in farmer returns, even in the case of highly mechanised production in the US. Figure 27 depicts the total cost of producing one acre of soya beans in the United States, which increased by 14 percent between 2012 and 2020.

At the same time, grower revenue – the returns a grower receives from producing an acre of soya beans – decreased by 14 percent (USDA, 2021).

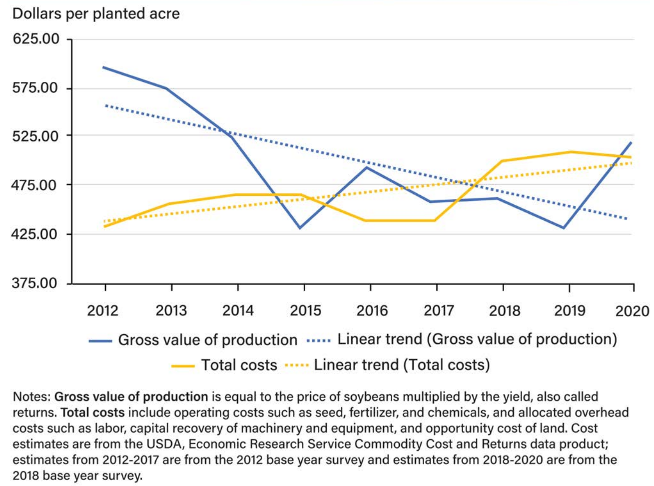


Figure 27: Costs and returns associated with soya bean production, 2012-2020 (US)
Source: USDA, 2021

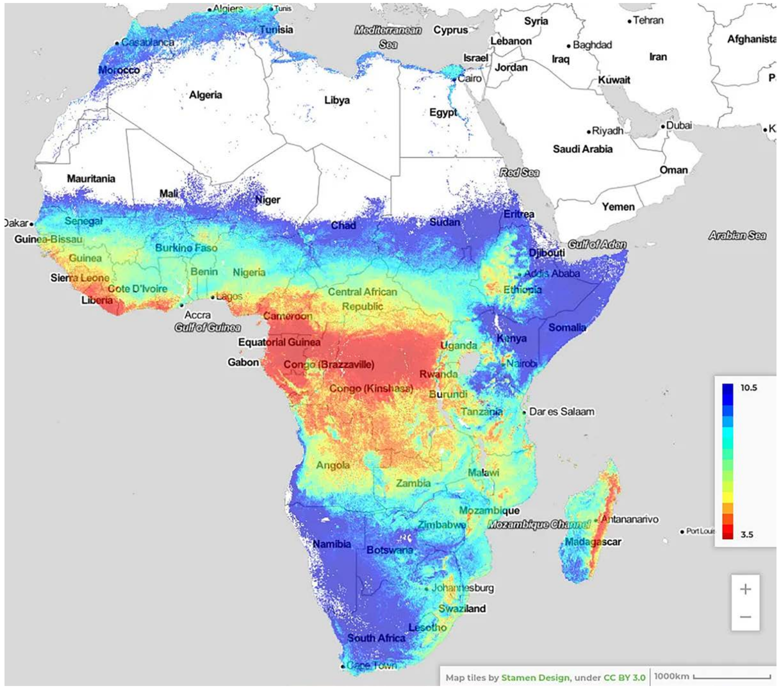


Figure 28: Soil fertility map for Africa
Source: Open Geo Hub, 2020

4.2 Soil fertility

Low soil fertility and inefficient management of soils in sub-Saharan Africa have been major challenges affecting productivity among smallholder farmers. As illustrated in Figure 28 below, lower soil fertility scores are observed particularly in Uganda, Western Kenya and Southern Tanzania (where pH levels are less than 6.5, indicating soil acidity).

Unfortunately, both underuse[24] of appropriate fertilisers and other poor agronomic practices have contributed to soil degradation, demonstrated by increasing soil acidity in several areas and low organic content in most areas (Stewart, 2020). Therefore, smallholder farmers may only realise their maximum potential if a more sustainable, targeted, affordable, and efficient integrated nutrient management system, compatible with their socioeconomic status, is practiced (Adekunle et al., 2017).

Various factors affect the use of fertilisers. For example, in addition to lack of awareness referred to above, a significant proportion of farmers believe that their land is fertile, and thus does not require fertilisers. Gatsby's recent research observed that more than 57% of farmers interviewed believed that their soils were fertile and did not thus require fertilisers. The high cost of fertilisers in recent years has been another strong deterrent.

4.3 Lack of access to finance

The significant contribution of the agricultural sector in terms of employment and Gross Domestic Product (GDP) is well acknowledged, while less than 1% of commercial lending in Africa goes to agriculture (African Development Bank, 2010). Meanwhile, the majority of lending to the sector goes to large-scale commercial farmers, leaving smallholder farmers most underserved. Lack of access to finance limits the adoption of good agricultural practices for soya bean production by small-scale farmers, including through limiting access to quality agricultural inputs and services (Dogbe, et al., 2013) (TechnoServe, 2018).

4.4 Cost competitiveness

Soya bean production cost in EAC

Drawing on data from Gatsby's farmer survey, Table 6 below summarises the production costs of a typical farmer, according to current common practices and average costs in each of the countries of interest. Where no costs are included, less than a third of farmers were adopting that practice in the given context. The table highlights that the cost of production is highest in Kenya and lowest in Uganda. As a result of cost, as well as price and productivity, it was observed that soya beans were the least profitable in Kenya and most profitable in Uganda.

Table 7, that draws on averages from secondary literature for comparison, suggests that the cost of production is higher in countries with low levels of production and low productivity, with Kenya registering the highest cost of production per ha/acre, and the highest unit cost of production. Various factors are likely contributing to lower costs in other contexts, such as lower cost of labour, seed varieties, agro-ecological conditions and widespread mechanisation. Though higher average productivity in other countries is likely to be the key driver of this phenomenon as will be discussed in later chapters.

	Kenya		Tanzania		Uganda	
	Per ha	Per acre	Per ha	Per acre	Per ha	Per acre
Seed cost (recycled)	26.7	10.8	34.6	14.0	46.9	19.0
Fertiliser cost	89.7	36.3	-	-	-	-
Inoculant cost	-	-	-	-	-	-
Herbicide cost	-	-	-	-	-	-
Pesticide cost	-	-	-	-	-	-
Labour cost	235.0	95.1	134.9	54.6	72.6	29.4
Land hiring cost	133.7	54.1	70.2	28.4	85.7	34.7
Land preparation cost	43.7	17.7	98.3	39.8	52.6	21.3
Post harvest handling cost	49.4	20.0	30.1	12.2	54.6	22.1
Total production cost	578	234	368	149	314	127

Table 6: Baseline average production cost (USD[25])
Source: Gatsby Africa, 2023

Country	Average cost of Production		Average yield		Average unit cost (USD per kg)
	USD/ha	USD/ acre	kg/ha	kg/acre	
Kenya	487	197	647	262	0.92
Malawi	341	138	1,001	405	0.84
Uganda	222	90	791	320	0.61
Tanzania	326	132	677	274	0.58
South Africa	393	159	2,360	955	0.41
Zambia	264	107	1,300	526	0.20

Table 7: Average production costs and yields (by country)

Sources: FAOSTAT, 2023 (yield) / Gatsby Africa, 2023 / Farmers Weekly South Africa, 2018 / USDA, 2023 / Agriculture in Zambia, 2021 / Business Malawi, 2023 / USAID Agrilinks, 2019

	Kenya	Tanzania	Uganda
Local production costs (USD)	329	133	173
Local yield (kg per ha)	647	677	791
Malawi Production costs (USD)	341		
Malawi yield (kg per ha)	1,001		
South Africa Production costs (USD)	393		
South Africa yield (kg per ha)	2,360		
Input cost efficiency (vs. Malawi)	1.5	0.6	0.6
Input cost efficiency (vs. South Africa)	3.0	1.2	1.3
Summary	Low	Medium	Medium

Table 8: Input cost efficiency

Sources: Gatsby Africa, 2023 / Farmers Weekly South Africa, 2018 / USAID Agrilinks, 2019

It is also helpful to consider input cost efficiency, which benchmarks local production cost vs. return (yield) i.e. the efficiency with which input (costs) are converted to outputs, with those of other countries. Using Malawi and South Africa as benchmarks, we find that Kenya has a low input cost efficiency ratio, and whilst Tanzania and Uganda's are lower than those of the benchmark countries, their input cost efficiency ratios are slight better.

Likewise, the relative trade advantage ratio (RTA) indicates whether or not there is a case for investing in the value chain to drive soya bean import substitution based on a country having a comparative advantage in the production of that product. The ratio is calculated as below:

$$\frac{\text{(local soya exports/local total exports)}}{\text{(world soya exports/world exports)}} - \frac{\text{(local soya imports/local total imports)}}{\text{(world soya imports/world imports)}}$$

The ratio indicates that both Tanzania and Uganda have potential for import substitution of soya beans owing to indicated comparative advantage (with a ratio of more than 1), though Kenya has a marginal/nil disadvantage (with a ratio of less than one).

Soya beans		
Kenya	Tanzania	Uganda
-0.01	1.2	0.5

Table 9: Relative Trade Advantage ratio (RTA) for soya bean

Source: ITC, 2023

Competition from alternative proteins

In East Africa, the range of key protein sources used for compound animal feed includes fish (e.g., Omena) meal, soya bean meal, insect meal, sunflower meal, cottonseed meal and canola (Bill and Melinda Gates Foundation, 2020). A comparison of cost demonstrates the cost competitiveness of alternative grain proteins. This demonstrates that whilst the preference for soya bean cake derives from its high protein content, alternatives such as cottonseed cake can compete on both price and protein content.

Substituting soya bean meal with alternative proteins such as black soldier fly larvae meal can reduce poultry feed production costs by up to 25%. Thus, making the black soldier fly larvae-based meal a viable potential alternative to soya-based animal feed, though its maximum production depends on the feedstock, which is not a constraint for soya bean production. Projections must therefore factor in emerging alternatives to soya bean.

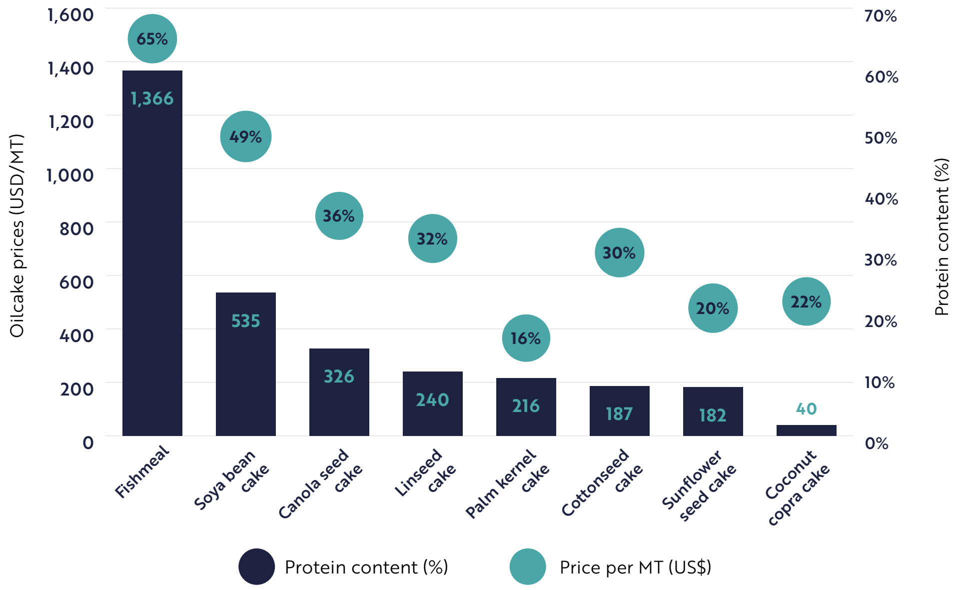


Figure 29: Oilcake prices vs. protein shares
Sources: IMF, 2023 / Singh R, 2022 / Fanatico, 2018

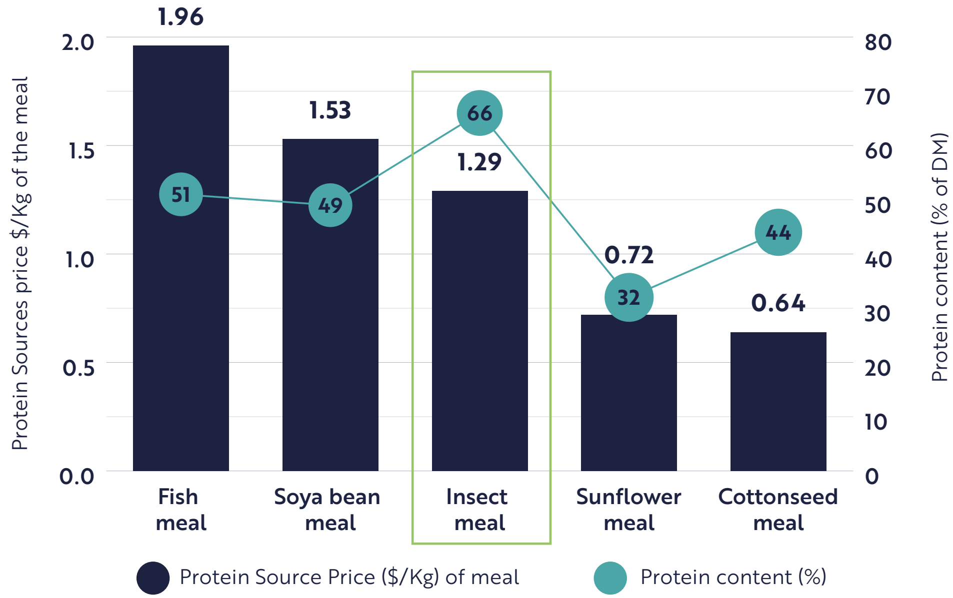


Figure 30: Alternative animal feed protein sources in Kenya
Source: Bill and Melinda Gates Foundation, 2020

Animal feed production cost in EAC

Additionally, to enhance the regional competitiveness of East Africa in animal, fish and poultry production, there is a need to reduce the cost of production, which is primarily driven by the cost of feed (which is directly impacted by soya bean production costs). It is therefore important that East Africa takes measures to reduce the cost of raw material inputs such as soya bean if it is to become competitive in the global livestock and aquaculture markets. Figure 31 illustrates that soya constitutes 28% of conventional poultry feed inputs.

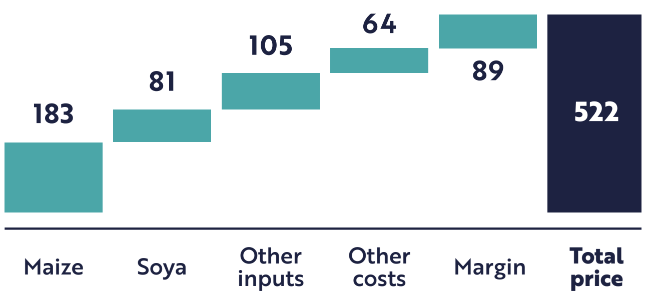


Figure 31: Price components of 1 MT of poultry feed under conventional formulation (USD)
Source: Bill and Melinda Gates Foundation, 2020

Competition from alternative edible oil crops

In addition to the relative cost competitiveness of palm oil as an edible oil; groundnuts, and sunflower seeds have higher oil recovery and do not need any special (solvent) extraction process, making them preferable for some edible oil processers compared to soya beans (Tinsley, 2009). Figure 32 summarises the comparative global costs of different edible oils.

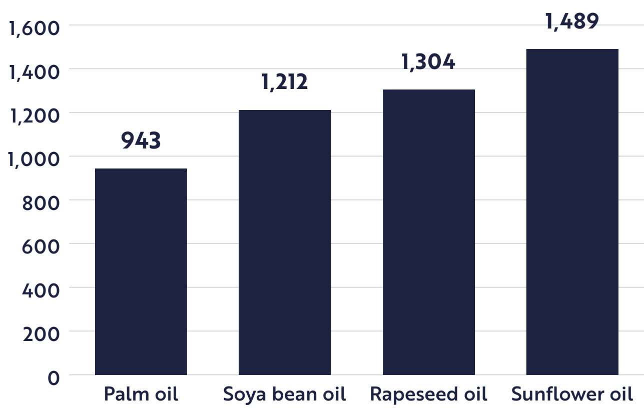


Figure 32: Global commodity market prices, 2020-2022 (USD/MT)
Source: IMF, 2023

Figure 33 summarises the average oil content of different oil crops, showing that once the copra has been separated from the coconut husk, it contains the highest oil content, followed by groundnut and sesame.

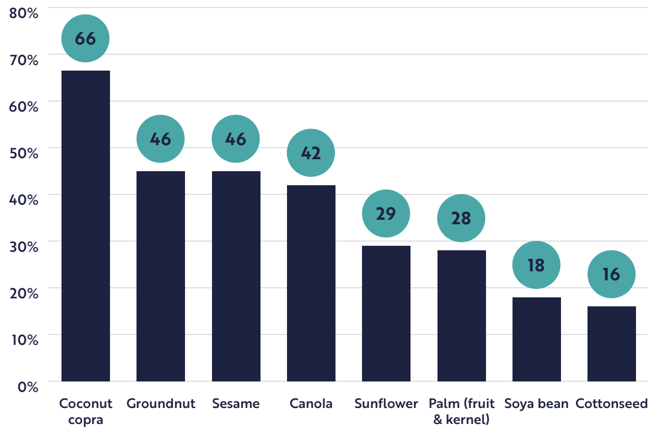


Figure 33: Oil crops by average oil content (%)
Sources: Britannica, 2023 / Agri Farming India, 2023 / Kenya Agriculture and Food Authority (AFA), 2023 / Ostbring, 2019 / de Oliveria Filho, 2021 / Palm Oil Extraction Machine, 2023 / UNCTAD, 2019 / Sharif, 2019)

4.5 Post-harvest handling

Soya bean, due its high oil and protein content is a delicate crop, one which requires tailored management and most importantly effective post-harvest handling (Mabehla, 2018). Threshing should be done carefully, as any kind of severe beating or trampling may damage the seed coat, thus reducing the viability of the crop and the quality of the harvest. After harvest, seeds need to be stored and kept for the next planting season. Seed moisture determines the length of seed storage life. At harvest, the moisture content of the seeds should be about 13% to 14% when harvesting with a thresher. If the crop is harvested when there is high moisture content, the longevity of the seed is reduced dramatically. For example, seeds with high moisture content can be more susceptible to fungus or other storage pests (Mabehla, 2018).

Ideal moisture storage rates (Mabehla, 2018)

- For short-term storage (6 to 8 months), moisture content should be reduced to approximately 12%. Seeds should be stored in a cloth or gunny bag.
- For long-term storage (1 to 2 years), moisture content should be reduced to below 7%. Seeds should be stored in a polythene bag.

However, most farmers still face challenges achieving optimum post-harvest handling. In the recently concluded Gatsby farmer surveys, it was observed that more than 61% of the soya bean farmers did not have effective post-harvest handling materials, and the majority threshed their soya bean manually which destroyed seed, whilst more than 88% of these households recycled these seeds.

4.6 Lack of access to secure output markets

Several projects and studies of the soya bean value chain have worked on the assumption that the soya bean bean market is available and ready to absorb supply. Yet, assuming that farmers have access to markets fails to recognise the disconnect between farmers and markets and fails to incentivise farmers to invest in increasing their yields (Dogbe, et al., 2013). A broad range of informants with experience in the sector highlighted this disconnect, with some citing aggregation challenges which increase the costs of local sourcing making it uncompetitive (it was estimated the minimum volumes for most processors would be 10-20 MT), the lack of enforceable off-take contracts and highlighting that soya bean production had declined in some areas because farmers had not been able to find buyers, and had subsequently stopped producing soya bean. When asked about their greatest challenges related to soya bean production in Migori County, Kenya, 41% of farmers cited lack of secure markets (Gatsby Africa, 2023).

4.7 Climate and environment

With most smallholder farmers in sub-Saharan Africa, especially in legume crops, depending on rainfall (and few using irrigation), climate change is causing a strain on agricultural production. Despite the various adaptation strategies adopted by many; yields under optimal management conditions are likely to decrease in SSA (Shiferaw, 2014). Climate change projections suggest that rainfall will become more variable, but that by 2030-40 the short rains (October to December) are likely to deliver more rainfall than the long rains (March to May) (Paul I. Palmer, 2023).

Experience in South America has also demonstrated the need for sustainable expansion of soya bean production. Soya bean production has been directly related to deforestation of the Amazon rainforest as well as impacts on biodiversity in other parts of Brazil, and to deforestation and loss of grasslands and rangelands in the Gran Chaco in Argentina (De Maria, 2020). In Tanzania, where there is greater land availability, for example, it will be important to ensure that any expansion in area planted to soya bean, is managed sustainably.

Likewise, the feed conversion ratio (the weight of feed per weight of animal or fish protein produced) contributes both to the carbon footprint of animal protein production, as well as to the cost of production of animal protein. Whilst soya bean has, for example, a lower feed conversion ratio for fish, than maize and maize gluten (Inayat, 2005), there are emerging alternatives that could enhance efficiency and reduce cost and carbon footprint by at least partially substituting for soya bean meal (Parrini, 2023).

4.8 Price volatility and variation

Global soya bean prices have experienced significant volatility in recent years, which has affected local price dynamics within East Africa. Figure 34 highlights the dramatic increase in prices of soya bean in Kenya in 2021, that had a direct impact on animal feed and animal protein costs (Njagi, 2022).

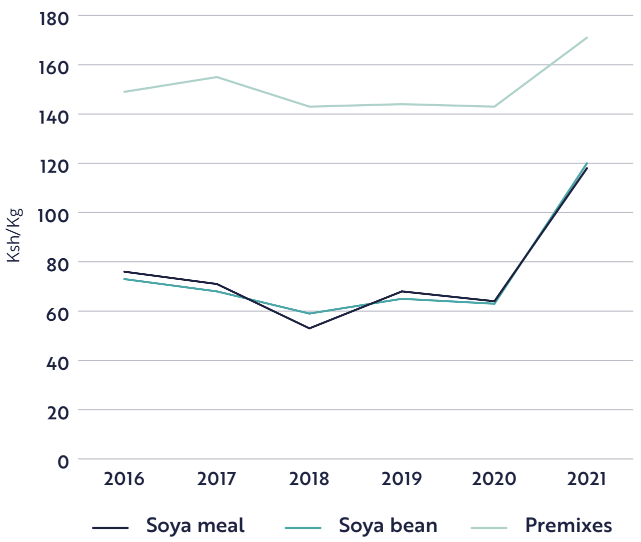


Figure 34: Trend in prices for raw materials
Source: AKEFEMA, 2021, from (Njagi, 2022)

It is also important to recognise the significant variation in price within the Eastern and Southern African region, which cannot be fully explained by differences in transportation costs between the different markets, with significant margins being captured by traders (Nsomba, 2022). For example, Figure 35 highlights the significantly higher prices of soya bean in Dar es Salaam until April 2023. It is not known what caused the sudden decline in prices after April 2023.

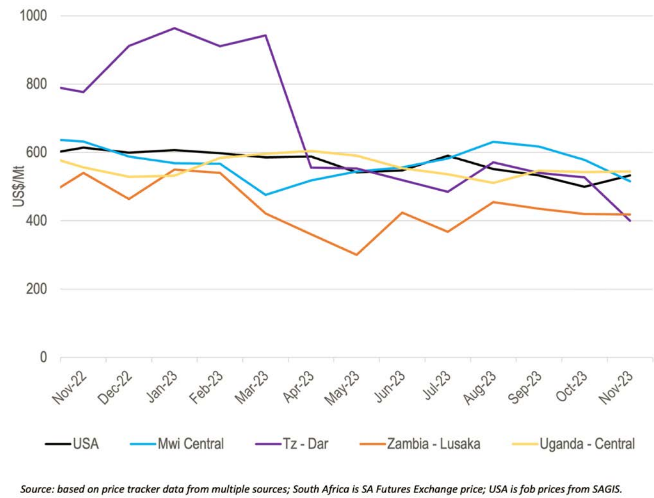


Figure 35: Soya bean prices by location (USD per MT)
Source: African Market Observatory (AMO), 2023

5 Opportunities for soya bean in East Africa

Across East Africa, there is high and growing demand for soya beans and soya-based products, creating opportunities for the region to increase both production and processing.

With combined imports of soya beans and soya bean products of USD 84.1 million into Kenya, Tanzania and Uganda in 2022, there may be an import substitution opportunity for African producers and processors, if they can compete on the price and quality of imports. It is likely that unit production costs will be reduced by improved practices (including use of quality inputs) driving up yields across the region, and by reducing labour costs particularly in Kenya.

Kenya, in particular, has excess secondary (refining) processing capacity for edible oils. The Kenya Association of Manufacturers stated that its 13 major producers have a combined processing capacity of approximately 2 million MT/year, over half of which is idle (Kenya Association of Manufacturers, 2023). There is an opportunity to quickly increase supply of raw material to use this existing capacity, which is likely to reduce costs by increasing throughput.

5.1 Raising farmer productivity and profitability

Ultimately, farmer net income or profitability will determine whether and how much soya bean is produced in East Africa, as over time, farmers will tend towards growing the crops that provide them with the highest returns. Profitability could be enhanced by (i) increasing yields, (ii) increasing prices, and/or (iii) reducing production costs. With relatively low production levels in East Africa, and soya bean being a globally traded commodity, East Africa is a price taker, so will not be able to influence price. Whilst it is possible to increase the share of the price accruing to the farmer, many government interventions in price are unlikely to be sustainable, and the greater contributions are likely to come from increasing yields and reducing production costs.

The typical East African farmer's production efficiency be improved to address the current situation of lower-than-average yields and higher-than-average production costs by support from nongovernmental agencies and research organizations (Foyer et al., 2018). This will increase Africa's competitiveness in the global oil seed trade market while contributing to the incomes of individual households.

As part of a scoping exercise to explore opportunities for agricultural sector development in East Africa, Gatsby Africa conducted soya bean farmer interviews using purposive sampling. In total, Gatsby surveyed 195 soya bean farmers across Kenya, Uganda, and Tanzania.

Average farmer outcomes

The following table summarises key aspects of soya bean production by country, on the basis of an average for the surveyed farmers. The average yield was found to be highest in Uganda (791 kg/ha or 320 kg/acre), followed by Tanzania (677 kg/ha or 274 kg/acre) and then Kenya (647 kg/ha or 262 kg/acre). Not only was the yield highest, but prices were also most favourable in Uganda.

On the other hand, Kenya's soya bean farmers faced the lowest prices and lowest yields, and the highest total cost of production, at USD 329 per ha (USD 133.21 per acre). As a result, Ugandan farmers had the highest, whilst Kenyan farmers had the lowest net profit per acre on average.

The significantly higher production costs in Kenya, driven primarily by higher labour costs, were checked in the following ways. Whilst it was not easy to triangulate wage rates with other data sources, the daily wage rate is below the official minimum wage of KES 374.64 in Kenya (Minimum Wage – Agricultural Industry, 2023):

- The average number of labour days for soya bean growers was 11 compared to an average of 19 across a broader range of crops covered by the survey in Kenya which included vegetables and other labour-intensive crops (42% lower).
- The average daily wage rate for soya bean growers was USD 2.82 for soya bean compared to an average of USD 2.20 for all other crops (28% higher).

It is, however, important to note that Kenya's Ministry of Agriculture and Livestock Development estimate a gross margin per ha of KES 25,770 (KES 10,429 per acre) assuming a yield of 1,890 kg per ha (765 kg per acre) (Kenya Ministry of Agriculture and Livestock Development, 2023).

Table 10: Average farmer outcomes

Source: Gatsby Africa, 2023

	Kenya		Tanzania		Uganda	
	Per ha	Per acre	Per ha	Per acre	Per ha	Per acre
Area under soya bean	0.4	1	0.8	2	1.2	3
Yield per unit area (kg)	647	262	677	274	791	320
Average price per kg (USD)	0.43		0.47		0.51	
Gross income per unit area (USD)	279	113	321	130	378	153
Cost of production (USD)	329	133	133	54	173	70
Net income per unit area (USD)	-49	-20	188	76	205	83

Positive deviants

We analysed the top 20% of soya bean farmers in Kenya based on their profitability, to understand what was driving their outcomes. As set out in the table below, these farmers were earning an average net income of USD 440 per ha (USD 178 per acre), 190% higher than the overall average. Income from crops was the primary source of income for all of these farmers, and for 82%, soya bean was their most profitable crop.

In terms of their characteristics:

- 64% had some secondary education or more.
- 82% were in the 36-60 age group.
- 73% had over 5 household members.

In terms of their behaviour and decision-making:

- 90% of farmers cultivated up to 7.4ha (3 acres) and 70% of these ('small') farmers hired at least some land for this cultivation.
- 46% of these farmers received extension information from a private farmer service company (compared to 18% from Government extension officers).
- 72% of these farmers did rotational cropping.
- 90% of them also grew maize.
- 100% of them used mechanised land preparation.
- 73% hired labour (compared to 80% for the wider surveyed population).
- All of them were members of an out-growers' scheme.
- 82% financed their soya bean production from their own income/savings.
- 36% used post-harvest handling equipment (compared to 37% for the wider surveyed population).

In terms of input usage/good agricultural practices:

- 46% used fertiliser (compared to 40% for the wider surveyed population).
- 27% used inoculants (compared to 20% for the wider surveyed population).
- 64% used improved seeds (compared to 27% for the wider surveyed population).
- 18% used pesticides (compared to 15% for the wider surveyed population).
- None used herbicides (compared to 5% for the wider surveyed population).
- 27% used recommended spacing (compared to 17% for the wider surveyed population).

	Ha	Acre
Area under soya bean	2.5	1
Yield (kg by area)	1,663	673
Average price per kg (USD)	0.42	
Gross income by area (USD)	689	279
Cost of production by area (USD)	250	101
Net income by area (USD)	440	178

Table 11: Soya bean farmer outcomes, top 20%, Kenya
Source: Gatsby Africa, 2023

Baseline scenario: Typical farmer

In addition to average and positive deviants from the survey, we modelled a current (baseline) 'typical' farmer and what they could realistically aspire to (target), in order to assess what would be an achievable level of productivity and therefore profitability.

The following table illustrates the experience of a 'typical', representative farmer making average investments and adopting commonly observed practices (see Table 5 above). We treat this as a baseline scenario for most farmers across East Africa. For example, of the 195 interviewed soya bean farmers, 169 (87%) used recycled seed, so we assume use of recycled seed as typical practice. On this basis, soya bean production is currently profitable only in Uganda (at USD 183 per ha / USD 74 per acre).

	Kenya		Tanzania		Uganda	
	Per ha	Per acre	Per ha	Per acre	Per ha	Per acre
Yield (kg/area)	647	262	677	274	791	320
Average selling price (USD per kg)	0.43		0.47		0.51	
Gross income by area (USD)	279	113	321	130	405	164
Production cost by area (USD)	484	196	326	132	222	90
Profit by area (USD)	-208	-84	-5	-2	183	74

Table 12: Baseline scenario (current typical farmer): recycled seeds only
Source: Gatsby Africa, 2023

	Kenya		Tanzania		Uganda	
	Per ha	Per acre	Per ha	Per acre	Per ha	Per acre
Yield (kg by area)	2,224	900	2,224	900	2,224	900
Average selling price (USD per kg)	0.43		0.47		0.51	
Gross income by area (USD)	956	387	1,055	427	1,142	462
Production cost by area (USD)	628	254	492	199	474	192
Profit by area (USD)	329	133	563	228	670	271

Table 13: Target scenario (feasible): improved seeds, fertiliser, and inoculant
Source: Gatsby Africa, 2023

Target scenario: Aspirational farmer

This feasible scenario expresses a situation where a farmer incurs additional cost on improved seed, fertiliser and inoculants (we prioritised this narrower set of good agricultural practices as those generally found to make the greatest contribution to increasing yields and profitability). Additionally, the target scenario assumed that the additional usage of quality inputs and adoption of recommended agricultural practices would enable farmers to achieve a target yield estimate of 2,224 kg/ha or 900 kg/acre. This follows trials in Kenya (KALRO, 2020).

As small global players, East African producers are price-takers and cannot influence price, so the prices per kg we held constant. Additionally, in this scenario, the total cost of production per ha was reported to be highest in Kenya (USD 628) and lowest in Uganda (USD 474). The biggest profitability gains could be made from small changes in practices in Uganda, followed by Tanzania, then Kenya.

The typical East African farmer's production efficiency can be significantly improved to address low yields and high production costs through support and innovation from governments, businesses, non-governmental organisations, and research organisations (Foyer et al., 2018). Aggregators and agro-processing companies can provide the required market and potentially additional support such as inputs on credit and extension services under contract arrangements. Investing in raising farmer productivity would increase Africa's competitiveness in global soya bean production and processing, while contributing to the incomes of individual households.

To validate the feasibility of these scenarios, we calculated a yield intensification index for each of the three countries. The yield intensification index is calculated as follows, and indicates the feasibility of the average farmer enhancing yields, based on the actual experience of the highest performing farmers in their areas:

$$1 - \frac{\textbf{(Average yield in sample)}}{\textbf{(Highest yield attainable by farmers)}}$$

The results indicate that there is high potential for yield intensification in all three countries.

	Kenya		Tanzania		Uganda	
	Per ha	Per acre	Per ha	Per acre	Per ha	Per acre
Average yield in sample	**647**	**262**	**677**	**274**	**791**	**320**
Highest attainable yield	**2,471**	**1,000**	**1,606**	**650**	**3,000**	**1,214**
Yield intensification index	**0.74**		**0.58**		**0.74**	

Table 14: Soya bean yield intensification index[26]
Source: Gatsby Africa, 2023

Regression analysis

To explore the opportunities to increase soya bean profitability, a multivariate regression analysis was conducted on profit, yield, and production cost against good agricultural practices (e.g. appropriate spacing, use of improved seed), farmers' behaviours (e.g. membership of out-grower scheme, hiring labour, marketing arrangement), and characteristics (e.g. age, gender). The purpose was to offer guidance on the best opportunities to boost both soya bean yield and profit in the EAC region. The results tables only focus on the significant variables unless the variables are considered critical good agronomic practices. The yield, cost, and profit variables were standardized per acre while GAP, farmers' characteristics, and behaviours were dummies.

The reported results in the tables below include good agricultural practices as well as farmers' behaviours and characteristics where the results were statistically significant.

The regression model is summarised as follows:

Profit = f (Revenue, cost)

Profit = (Revenue - cost)

- Revenue = f (Yield, price) = (yield*price).
- Cost = f (fertiliser cost, seed cost, mechanization cost, Labour cost, Inoculant cost, postharvest handling cost, land preparation cost, land hired cost).

Due to endogeneity bias, we conducted three multiple regressions with:

- Endogenous variables: Yield, Cost, and profit.
- Exogenous variables: Farmer behaviours, Good agricultural practices, and farmer characteristics.

Yield = $\beta 0$+ βi(good agricultural practices)+ βj(farmers behaviors)+ βk(farmers characteristics)+$\mu 1$

Profit = $\beta 0$+ βi(good agricultural practices)+ βj(farmers behaviors)+βk(farmers characteristics)+ $\mu 2$

Production cost = $\beta 0$+ βi(good agricultural practices)+ βj(farmers behaviors)+ βk(farmers characteristics)+ $\mu 3$

Regression 1: Yield Function – the estimation results of the effects of farmer characteristics, behaviours, and adoption of good agricultural practices on yield are shown in the table below:

Yield	Coefficient	p>|t|
Fertiliser application	-9.4066	0.755
Weed control practice	-4.2593	0.825
Recommended spacing practice	-9.7926	0.661
Pesticides application	27.7795	0.212
Use of improved planting materials (quality seed)	64.3076	0.039
Farmer group membership	47.4888	0.027
Acreage under soya - Non-out-grower scheme - Out-grower scheme	 -36.7285 -57.4008	 0.102 0.010
Adult household size	31.2599	0.095
Age	26.3954	0.069
Gender	35.9115	0.040
Education level	10.8506	0.027

As set out above, to influence yield, farmers combine several agronomic practices. The only practice that impacted yield in the regression analysis at a 5% level of significance[27] was the use of improved seeds which had a positive and significant effect on yield. This justifies the introduction and easy access to affordable improved seed varieties for soya bean farmers to boost yields.

Farmers' characteristics and behaviours also impacted yields, as follows:

- Farmers who belonged to a farmer group such as a cooperative, SACCO, or VSLA typically had higher yields. There was a positive and significant impact of farmer group membership on yield at a 10% level of significance. Whilst it is not possible to establish causality, more farmers that were members of groups accessed inputs on credit, mechanised services soil testing, herbicides, which could indicate better access to inputs and services.

- Soya bean is a labour-intensive crop thus the results indicated that having larger adult household sizes provided additional labour, thus a positive significant effect on yield at a 10% level of significance.

- Amongst the farmers who reported a yield of more than 593 kg/ha or 240 kg/acre, 59% had a male household head whereas 41% had a female household head (noting that in Uganda and Tanzania the majority of respondents were male, unlike in Kenya where they were female). Therefore, across the three countries higher yields are associated with a male household head. This is also explained by the finances and capital available to purchase quality inputs in the households. Of the 45 interviewed farmers who accessed inputs on credit, 62% of them were male while 38% were female.

- More educated farmers with at least some secondary education had a positive impact on yield at a 10% level of significance.

- The results also showed that no large-scale[28] farmers are in out-grower schemes, whereas 64% of small farmers belonged to an out-grower scheme. The effect of land size on out-grower scheme membership therefore showed a negative but significant coefficient. The interaction term developed between land cultivated and yield showed that whilst farmers had an average area of 0.8ha or 2 acres, the distribution of yield was found to decrease with land size increase, until 0.2ha or 0.5 acres when it starts to increase. This was reflected by the -0.5 coefficient in the regression (though not significant, and not shown here). Of farmers in out-grower schemes, there was higher adoption of good agricultural practices, with 55% adopted three or more good farming practices, suggesting better access to knowledge and/or inputs. The study concluded that the expansion of land available for growing soya by the farmers in the out-grower scheme would boost yield.

Regression 2: Profit function – regression analysis was used to estimate the influence of farmer characteristics, behaviours, and adoption of good agricultural practices on profit. The outcomes are displayed in the table below:

Profit	Coefficient	p>|t|
Fertiliser application	-38.7965	0.037
Use of improved planting materials (quality seed)	25.7213	0.173
Inputs on credit	-40.8714	0.003
Soil testing	61.5709	0.079
Out-grower scheme	-84.9883	0.002
Acreage under soya - Non-out-grower scheme - Out-grower scheme	 -0.1889 22.7545	 0.989 0.094
Amount sold per acre	0.1753	0.000
Education level	0.3600	0.720

As discussed above, farmers should combine several agronomic practices to positively influence not only yield but also profit.

- As was the case in the yield function above, low fertiliser use combined with low adoption of improved seed (and other important agronomic practices) explains the unexpected negative but significant coefficient on profit at a 10% level of significance, as the returns to using fertiliser in combination with recycled seed were very low.
- The use of improved seeds was found to influence profit positively but insignificantly. This can be explained by the low use of other inputs, preventing the benefits of improved seed from being realised.

Farmers' characteristics and behaviours also impacted yields, as follows:

- Farmers were resource-constrained as shown by the unexpected negative but significant coefficient of inputs on credit on profit at a 10% level of significance. Unfortunately we did not collect data on cost of credit, which may have explained the negative impact on profit.
- Soil testing was reported to have a positive significant influence on profit, as it gives greater clarity to the farmer on their soil status to inform their optimal use of inputs. Though only five surveyed farmers used oil testing, 80% were male and 40% were college/university educated. They also typically had higher adoption of other good agricultural practices e.g. 40% used improved seeds and 60% used fertilisers.
- Additionally, the farmers who did not belong to an out-grower scheme were found to be more profitable as indicated by the negative significant coefficient. Thus, we evaluated the characteristics of the farmers who got inputs on credit but were outside the out-grower scheme. We found that 55% of them practiced at least three of the good agricultural practices, 21% sourced extension services, 21% belonged to a farmer group, 30% practiced soya rotation with other crops between seasons, 38% used certified soya bean seeds, 33% controlled pests while 20% used fertilisers. Our conclusion is therefore that strengthening the 'offer' and effectiveness of the out-grower schemes could support higher levels of adoption of good agricultural practices, contributing to higher profits.
- The results also showed that more commercially oriented farmers tend to be more profitable as expressed by the positive and significant coefficient on share sold per acre, at a 5% level of significance.

Regression 3: Cost function – we estimated the effects of farmers' characteristics, behaviours, and adoption of good agricultural practices on production costs using regression analysis. The results are shown in the table below:

Production cost	Coefficient	p>|t|
Fertiliser application	14.930	0.071
Weed control practice	10.280	0.057
Use of improved planting materials (quality seed)	7.450	0.376
Pesticides application	0.212	0.972
Out-grower scheme	15.980	0.049
Labour hiring	25.310	0.000

- As expected, the cost of individual agricultural inputs had a positive effect on overall production cost. The results show a positive and significant coefficient of fertiliser application and weed control measures on production cost at a 10% level of significance. However, the use of certified seeds and pesticides application had a positive but insignificant coefficient on production cost per acre. The cost of improved seed appeared to be substantially underestimated in Kenya, which may explain the lack of a significant coefficient.
- A shift from non out-grower membership to out-grower membership would have a positive significant influence on total production cost at a 10% level of significance. This is likely to be due to farmers being encouraged to purchase an overall package of inputs, potentially at a higher cost, when they are part of an out-grower scheme.
- The results showed that soya is a labour-intensive crop thus having a positive and significant effect on the production cost at a 10% level of significance.

The regression analysis indicated the following key areas as offering the greatest potential for increased yield, reduced cost, and enhanced profitability:

- Farmers should adopt a combined set of good agricultural practices to optimize the benefits of each practice.
- Out-grower schemes need to deliver greater benefits to farmers, probably by enhancing information on good agricultural practices.
- Mechanisation could help to reduce the particularly high labour costs incurred in Kenya.

"Mechanisation could help to reduce the particularly high labour costs incurred in Kenya."

Soya bean viability for farmers relative to alternative crops

In addition to enhancing the profitability of soya bean from present to higher potential levels, it will need to compete with alternative crops (and be used in rotation with some, where those crops would see a yield uplift through nitrogen fixation). In the major soya bean producing areas in East Africa, according to Gatsby's farmer surveys, farmers were also growing the following crops, with associated profitability. This shows that soya bean is relatively more attractive for farmers, compared to alternative crops, in Lango District, Uganda and Ruvuma Region, Tanzania. In Migori County, Kenya, however, farmers were growing several more profitable crops. The benefit of growing soya bean that farmers in Migori County highlighted, however, was the greater frequency with which they were earning income. This means that farmers in Migori would need incentives to switch away from other crops.

Table 15: Relative crop profitability, by area

Source: Gatsby Africa, 2023

Location		Crop	Average net income (USD per acre)
Migori County, Kenya	1	Peas	636
	2	Tobacco	587
	3	Beans	156
	4	Groundnut	135
	5	Maize	111
	6	Pineapples	23
	7	Soya bean	-20
	8	Nyota beans	-289
Ruvuma Region, Tanzania	1	Sesame	80
	2	Soya bean	76
	3	Sunflower	70
	4	Maize	-180
Lango District, Uganda	1	Rice	666
	2	Soya bean	83
	3	Tomato	28
	4	Pigeon pea	19
	5	Beans	8
	6	Maize	60
	7	Sunflower	-104

5.2 Enhancing Soil Health

Soya bean offers several major advantages in sustainable cropping systems (Sinclair & Vadez, 2012) that include driving improvements in soil fertility, which is a foremost need in African farming systems; characterised by exhausted soils due to over cultivation (Vance & Graham, 2013). Soya bean absorbs atmospheric nitrogen (N_2) via symbiotic N_2 fixation and hence alleviates the need to apply large amounts of nitrogen-based fertiliser which is especially important in crop production in Africa where farmers' ability to purchase fertiliser can be prohibitive. Other key benefits are summarised as follows:

- The dense canopy of soya bean helps to conserve soil water moisture, protect the soil against recurrent erosion, and suppress weeds such as Striga in the soya bean field.

- The extensive root network of soya bean maintains the soil structure and promotes infiltration, which is crucial for the absorption of water and nutrients.
- The soya bean crop also disrupts the life cycle of several pests and diseases especially in cereals when grown as an intercrop (Pandey, 1987) and when rotated with cereals (Tukamuhabwa et al., 2019).
- Decaying soya bean root residues improve soil fertility (Siamabele, 2019).
- Also, the diverse rotational options which also enhance ecological pest control (Kabita et al., 2021).

Therefore, soya bean can be promoted as a rotational crop to improve the productivity of other crops being grown, such as maize (Tukamuhabwa & Obua, 2015). This has been described as "diversification through intensification" of production if soya bean is promoted as a rotational crop (Ken Giller, interview, October 2022).

For example, when rotated with maize, soya bean improves maize yields on average by 0.5 MT by adding nitrogen to the soil (Franke, 2018). It is important to note that the percentage increase depends on the baseline, whereby a low starting yield is likely to see a larger percentage increase. Assuming a 10 to 20% yield increase (compared to a 28% increase in the study referred to above), Gatsby calculated that for an average farmer in East Africa, growing maize after soya bean could raise their subsequent maize income by USD 46 to USD 144 per acre. It is, however, important to note that overall, rotating soya bean and maize on a continual basis only delivers continuous income gains in Uganda, likely due to the very low initial maize yields.

In Uganda, crop rotation of soya bean and maize delivers an overall income gain of USD 94 to USD 128 per acre per year. Whereas, in Kenya and Tanzania, overall farmers earn lesson from rotation. This analysis does not, however, capture the potential to reduce production costs through reduced fertiliser use, reduced costs of land preparation nor quantify the (cumulative) benefits of improved soil fertility.

Table 16: Crop rotation net income scenarios

Source: Gatsby Africa, 2023

		One year net income (USD per acre)		
Season 1 crop/season 2 crop	**Maize yield uplift**	**Kenya**	**Tanzania**	**Uganda**
Maize/maize	0%	865	657	421
Soya bean/maize	10%	638	603	515
Soya bean/maize	20%	710	649	549
		Difference: change in one year net income from switching away from monocropping		
Change from maize/maize to soya bean/maize	10%	-227	-55	94
	20%	-155	-9	128

5.3 Potential for Value Addition

Value can be added to soya beans through processing via the crushing process and transformation into edible oil for cooking, meal/oilcake for feed to support the livestock and aquaculture industries, high protein food products and other products such soaps and detergents. The key commercial value chains include:

<u>Edible oil:</u>

Current edible oil demand in East Africa is large and growing, with total imports of USD 1,999 million in 2022 (ITC, 2023). For example, as the largest importer of edible oils in the EAC, Kenya's total estimated demand for edible oils is 759,000 MT (Ministry of Agriculture and Livestock Development, 2023), whilst it imported 812,000 MT of edible oils in 2022 (ITC, 2023). 96% of Kenya's imports were palm oil, and of this, 90% was crude palm oil, (ITC, 2023) which is refined in Kenya, using its 2 million MT of edible oil processing capacity to produce refined oil for domestic and regional markets (Kenya Association of Manufacturers, 2023).

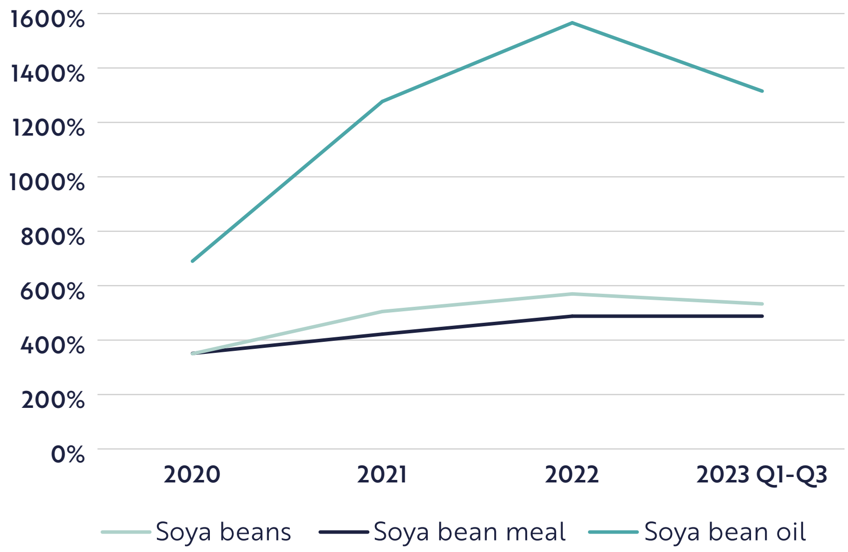


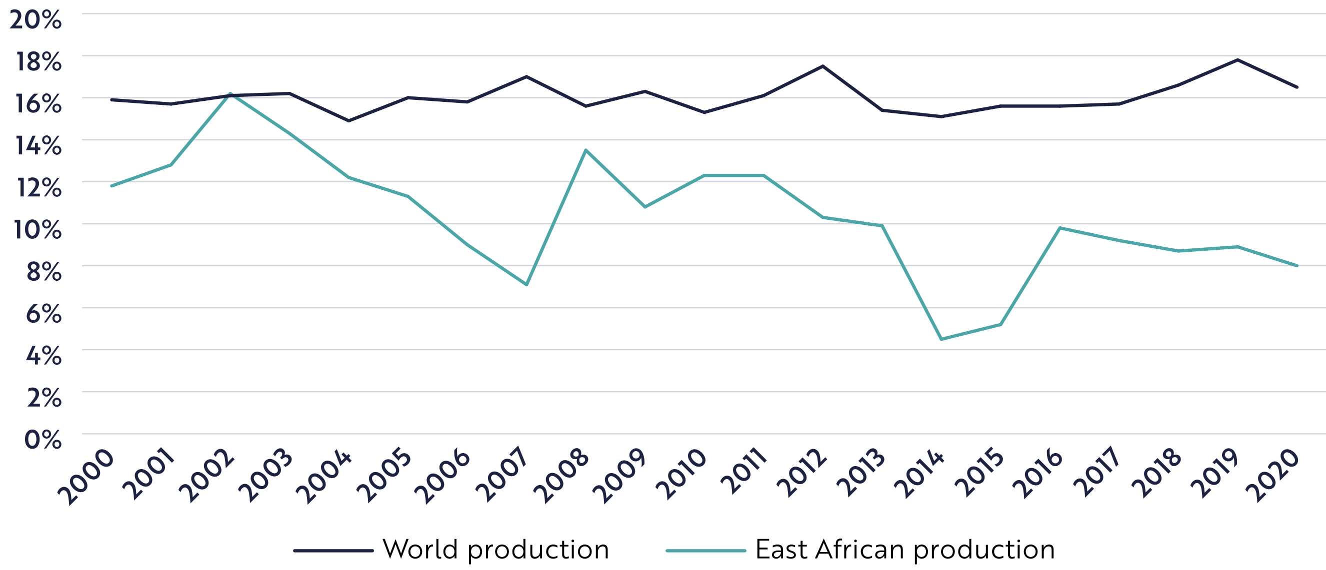
Figure 36: Global commodity prices (USD per MT)
Source: IMF, 2023

A wider range of other edible oils are also consumed in the region, including soya bean, cottonseed, sunflower and other locally produced oils.

As shown in Figure 36 above, soya bean oil is the second most widely produced and consumed edible crop globally, after palm oil. The following chart also shows the recent rise in global prices, particularly of soya bean oil relative to soya beans or soya bean meal, which was trading at USD 1,290 per MT in Q1 2023, having doubled in price since 2019.

The following figure shows the share of soya bean converted to oil, globally and in East Africa. It shows a lower share, which has been declining since the early 2000s in East Africa, whilst globally, the oil share has stabilised around 14% (FAOSTAT, 2023). This could indicate lower oil extraction efficiency in East Africa. Whilst statistics on oil extraction capacity in East Africa are not available, it is likely that they are dominated by mechanical rather than solvent extrusion technology, which has a lower oil recovery rate (60-70% compared to more than a 99% oil recovery rate with solvent extraction). This also reflects the fact that soya bean meal contributes around 75% of total revenues, compared to oil at around 25% (Cheng, 2019).

Figure 37: Oil share of soya bean production (%)
Source: FAOSTAT, 2023



Animal feed protein:

The rapid expansion of meat and fish production and consumption in developing countries is a major driver behind the growing demand for feed and protein meals. This is due to the growing middle class and associated dietary preferences, which have increased the demand for meat as a major source of protein. Between 1967 and 2007 pork production rose by 294%, egg production by 353% and poultry meat by 711%. Over the same period, the relative costs of these products declined (KPMG, 2014).

The increased demand for soya beans is driven by the shift to commercial and processed animal feed. The major farmed animal species diets containing soya bean include poultry, pigs, cattle, and aquatic (Dei, 2011). Soya bean meal is used relatively more in some types of animal feed than in others. For example, in poultry feed, soya bean meal contributes almost 70% of the feed (Dei, 2011).

"Globally, soya bean is the most important protein raw material for animal feed."

Globally, soya bean is the most important protein raw material for animal feed (S&P Global, 2023), compared to substitutes like cotton seed meal, fish meal, insect meal and sunflower seed cake among others. This is driven by its high protein content, suitable amino acid profile and relative cost (Dei, 2011). Growth of the soya bean industry could therefore catalyse the animal and fish protein industry which currently suffers from a lack of availability of high-quality, competitively priced animal and fish feed.

Soya-based food products and protein fortification:

Soya beans can also be used for texturised soya protein, soya fortification of flour, infant formula, and for soya milk for lactose intolerant individuals. In response to high incidence of malnutrition, with the prevalence of undernourishment reaching 26.5% in Eastern and Southern Africa compared to 9.3% globally (World Bank, 2023), there is growing demand for these products from humanitarian organisations (World Food Programme, 2020) as well as private consumers.

The increasing importance of soya bean-based food products requires investments in processing. For example, studies conducted in South Africa observed that processing of soya bean to soymilk increased its value from USD 4.02 (R270) to USD 18.06 (R1,250 while that of soya flour from USD 4.02 (R270) to USD 17.86 (R1,200) (Biam, 2016)[29]. Further analysis of constraints to processing, and policy recommendations, can be made to support value chain development.

Biofuel:

Soya bean oil is increasingly being considered as an option for biodiesel as an alternative to bioethanol from sugar and corn, accounting for 57% of feedstock inputs into US biodiesel production in 2019 (US Energy Information Administration, 2022).

Additionally, its impact on the economy through its multiplier effect could be considerable. A Kenyan study estimates that for every direct job generated in the soya bean value chain, an additional job is created through indirect and induced effects (Nicholson, 2019).

"For every direct job generated in the soya bean value chain, an additional job is created through indirect and induced effects (Nicholson, 2019)."

5.4 Nutritional Security

Generally, Sub-Saharan Africa accounts for more than 950 million people and approximately 13% of the global population (FAO and OECD, 2016). By 2050, this share is projected to increase to almost 22% or 2.1 billion. Undernourishment has been a long-standing challenge, with uneven progress across the region. Despite being reduced from 33% in 2001 to 26% in 2020, the percentage of undernourishment in Eastern and Southern Africa, remains among the highest (World Bank, 2023).

In Africa as a whole, 282 million people were hungry, more than twice the proportion of any other region in the world (World Vision, 2022). Protein deficiency continues to exact a greater toll on infants, children, and pregnant and lactating women in SSA than anywhere else in the world, partially due to the overconsumption of starchy foods (World Vision, 2022). Therefore, due to the high protein and nutrient content of soya bean, as a key input into animal and fish feed to produce animal/fish protein as well as in food products such as soya milk, incorporating soya beans or more animal proteins into mainstream diets could help to alleviate levels of undernourishment. Though it should be noted that preparing soya beans for human consumption is more labour-intensive than for most legumes. Increased incomes from soya bean could also increase purchasing power and access to nutritious foods.

Soya bean has the highest protein content among food legumes (40-42%) and is second only to groundnuts concerning oil content (18-22%) (Marcela et al., 2016). Additionally, the current cost of living crisis makes cheaper alternative protein sources increasingly important for low-income households.

6

Successful soya bean industry case studies

6.1 Malawi

Malawi is now the fifth largest producer of soya bean in Africa, having produced 220,000 MT in 2021 (FAOSTAT, 2023). Malawi's soya bean production has been on an upward trajectory since the early 2000s, as shown in the following figure. Dominated by small-holders and facing similar constraints to the rest of East Africa, Malawi's soya bean industry successes could provide insights for the region.

Figure 38: Soya bean production by country (MT)
Source: FAOSTAT, 2023

Soya bean was introduced in Malawi in 1909 as an intercrop with maize and other crops for smallholders but was not widely grown (Khojely, 2018). Significant research efforts to develop improved varieties of soya bean, adapted to local conditions, started in the 1980s with the release of new varieties after 1990. A range of development projects have contributed to developing the soya bean industry primarily through interventions to improve access to improved seed and inoculants, and adoption of good agricultural practices, since 2010 (Tufa, 2019). Significant private sector investment in processing since the early 2000s which responded to increased production, also served to create the demand pull for further increases in soya bean production. These early large-scale investments were made when production was approaching 50,000 MT per year.

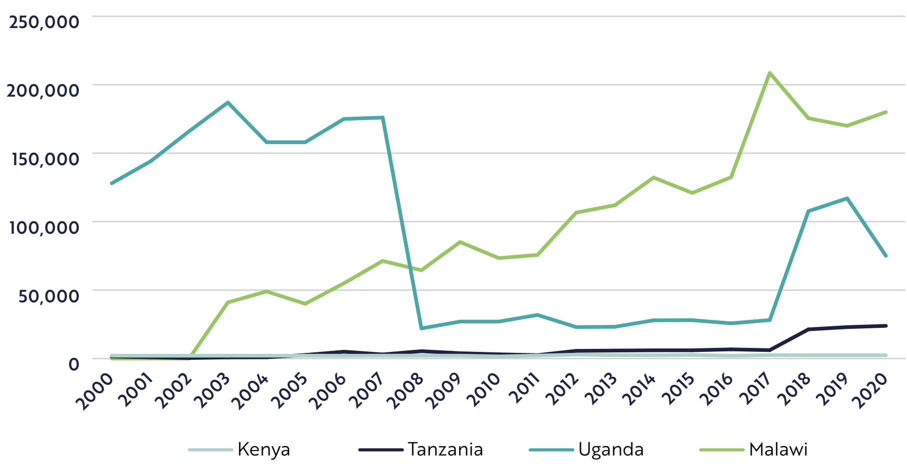
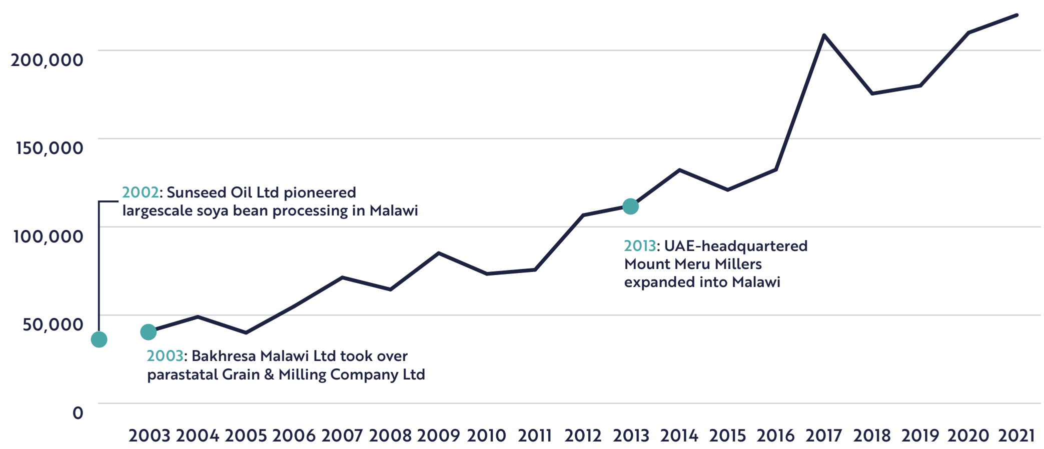


Figure 39: Malawi soya bean production and key processing investments
Sources: Sunseed Oil Limited, 2023 / Bakhresa Malawi Limited, 2023 / Mount Meru Millers, 2023 / ITC, 2023



Malawi is arguably the world's most tobacco dependent economy. Sales of the crop have accounted for 50% or more of the nation's total export value, and Malawi is the top producer of Burley tobacco alongside Brazil and the United States (United Nations, 2017). One of the unique features of Malawian tobacco is that smallholder farmers with less than a hectare are the main producers, cultivating the crop as their main source of income (Otañez, 2007), though the crop was originally cultivated by large estate farms (Lencucha, 2020). In response to both Malawi's economic dependence and health risks associated with consuming tobacco, international donors and health organisations have encouraged the Malawian government to help smallholder farmers move out of tobacco, into alternative crops like maize, soya bean, groundnuts and others. The following figure illustrates the dramatic shift from tobacco to soya bean production in Malawi.

Smallholder soya bean production expansion in Malawi

soya replacing burley tobacco

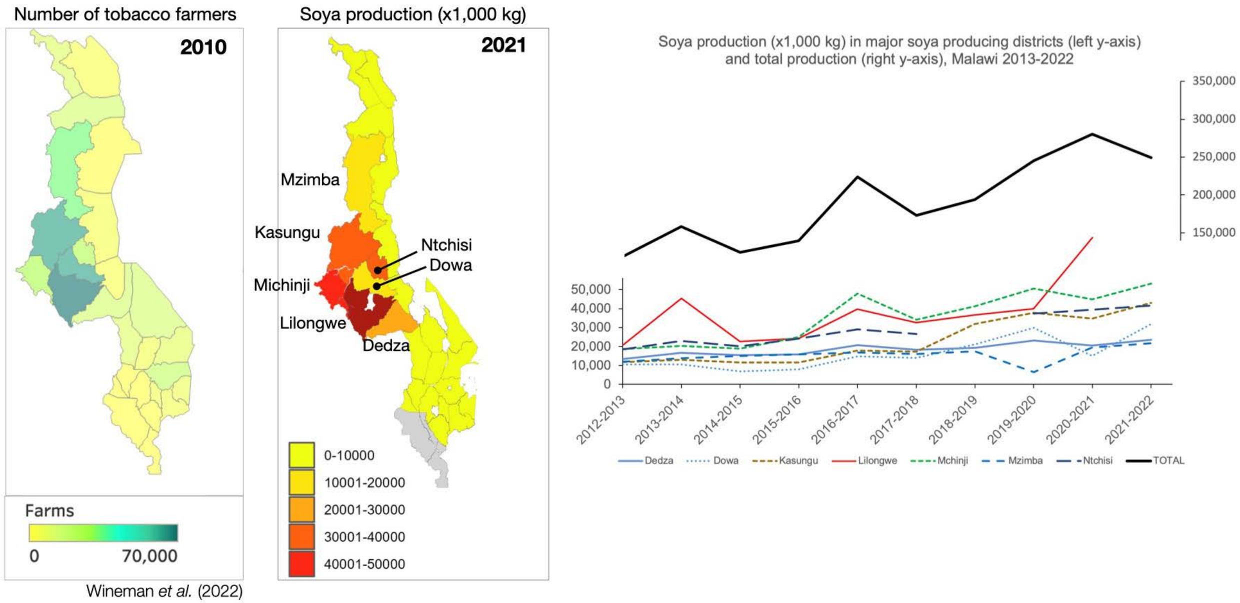


Figure 40a: Malawi's transition from tobacco to soya bean production

Source: Andersson et al (forthcoming)

Whilst there is ongoing support for tobacco production, the Malawian Government itself set out plans to diversify agriculture, in the Malawian Growth and Development Strategy (MGDS) III 2017-2022, The National Export Strategy 2013 and the National Agricultural Investment Plan 2018, all of which highlighted the opportunity in oilseed crops including soya bean (Lencucha, 2020). Earlier, the Agriculture Sector Wide Approach (ASWAp) 2010 prioritised soya bean as one of the priority crops for investment (World Trade Organisation, 2010). Yet, the Malawian Government supported policies such as the Farm Input Subsidy Programme (FISP) that previously promoted traditional crops such as maize, rather than promoting crop diversification into crops such as soya bean (Mubichi, 2017). There were, however, some specific measures taken by the Malawian Government that also supported the expansion of soya bean processing in Malawi. For example, in 2017 the Government of Malawi removed 16.5% Value Added Tax (VAT) on edible fats and oils (Malawi Revenue Authority, 2017). Malawi also has a growing dairy industry and is a net-exporter of poultry and poultry products, which requires animal feed to which soya bean is an important input. Policy measures to promote these industries also helped to enhance the market for soya bean and processed soya bean products in Malawi.

The percentage of smallholders producing tobacco fell from 16% in 2009/10 to 5% in 2018/19, though the remaining farmers find it relatively more profitable than alternatives (Shah, 2021). Whilst there is still significant tobacco production in Malawi (120,000 tons 2018/19), supported by better structured markets with private sector contractual arrangements offering inputs, services and assured output markets as well as the limitations of alternative crops (such as lack of markets and low or volatile prices), various factors could explain the shift away from tobacco, towards crops such as soya bean:

- Unstable tobacco prices – after a peak of nearly USD 5.00 per kilogram during the global commodity boom of the late 2000s, prices since 2010 have declined back towards their levels in the early 2000s (USD 3-5.00) (Shah, 2021).
- Policies to improve competitiveness of tobacco alternatives, through taxation, subsidies for alternative value chains and a range of other policy measures (Dorward A., 2011).
- Lower labour and input intensity of soya bean compared to tobacco (Meyer, 2018).
- Development initiatives promoting alternative crops.

Some of the key development programmes that contributed to the development of the soya bean industry included:

- **2009-2018**: The international Institute of Tropical Agriculture (IITA) in collaboration with Wageningen University and Research (WUR) implemented the **N2Africa programme**[30] which aimed to advance Biological Nitrogen Fixation (BNF) technologies and legume enterprise among small-scale farmers including in Malawi. It led demonstration initiatives, promoted tailored seed, fertiliser and inoculant quality control, availability and use, as well as providing output market information. It also worked with Catholic Relief Services (CRS), World Vision, the National Smallholder Farmers' Association of Malawi (NASFAM), Agro-Input Suppliers Limited (AISL), ICCO/CARD and the government's Department of Agriculture Extension Services (Phiphira, 2017).
- **2012-2016**: USAID's Feed the Future **Integrating Nutrition in value chains project, Malawi**[31], aimed to increase the competitiveness of the legume and dairy value chains and raise productivity through soil and water management practices, whilst contributing to nutrition, value chain development and climate change resilience. It targeted the groundnut and soya bean value chains, with a focus on enhancing productivity, marketing, and income of smallholders as well as providing nutritional education. The project was implemented by DAI, Michigan State University and Save the Children.
- **2013-2017**: DFID's (FCDO) Malawi Oil Seed Sector Transformation (MOST) programme supported cotton, soya bean and sunflower, and the development of Malawi's Oil Seeds Sector Working Group (TWG) to deliver the Government's Oil Seeds Sector strategy. Its soya bean interventions targeted improved access to improved seed and inoculant, agronomic information, finance and policy among other activities. For example, it piloted an 'Incentive Based Contract Farming' (IBCF) model for soya bean (and cotton) farmer-market linkages. It was implemented by Adam Smith International (ASI), Kadale Associates and the African Institute for Corporate Citizenship.
- **2014-2019**: USAID's Feed the Future Malawi Improved Seed System and Technologies (MISST) project, implemented by IITA, ICRISAT, CIMMYT, and CIP, aimed to enhance seed production, distribution and monitoring, strengthen partnerships and develop technologies for the groundnut, pigeon pea, soya bean, Drought Tolerant Maize (DTM) and Orange-Fleshed Sweet Potato (OFSP) Value Chains (USAID, 2017).
- **From 2017**: The Clinton Development Initiative (CDI) began working with soya bean producers implementing the Community Agribusiness (CAB) approach, to create small- and medium-sized cooperatives and business incubation hubs, training their members on good, climate smart agricultural practices, financial and agri-business management, as well as engaging with input suppliers, local and international commodity buyers, financial institutions and

government. It worked with 2,000 farmer groups with 15 officially recognised cooperatives supporting over 30,000 farmers, enabling them to enhance the productivity, quality and prices attained for their produce (Pamuk, 2020).

- **2015-2020**: USAID's Soybean Innovation Lab, through its Pan-African soya bean variety trials, has tested more varieties in Malawi than in any other country (120 lines between 2015 and 2020), where it has also helped, in collaboration with private sector actors, to bring them to market (Soybean Innovation Lab, 2021). It also partnered with Feed the Future's Malawi Ag Diversification Activity (AgDiv) to extend the trial programme into the 2017-2020 growing seasons and is continuing activities with the Feed the Future Innovation Lab for Legume Systems Research.

Likewise, private sector investments have played a critical role in driving the sector forward, with some examples summarised under lessons learned below.

The key lessons from Malawi's soya bean experience are:

- **Promotion efforts**: Soya bean was actively promoted by development partners as an alternative to tobacco (lower production costs and higher profits) using R&D, training, promotion of key inputs (improved seeds, inoculants and legume appropriate fertilisers), contract farming, etc. Whilst there was intention to develop the soya bean industry on the part of Government, as set out in strategy documents, there was use of subsidies, export bans, minimum pricing etc with mixed outcomes. The Malawi Investment Promotion Agency also promoted soya bean processing investments in the early 2000s (How we made it in Africa, 2010). Tobacco companies promoted crop rotation with legumes and supported aggregation (Agar, 2023). Soya bean production has expanded most in traditionally tobacco producing areas.

- **Large-scale processing investments**: As shown in Figure 39 above, large-scale, capital intensive investments in solvent-extraction and other technologies began when production was approaching 50,000 MT. This drove demand for large volumes, which created stronger market pull for produce. This also produces higher quality oilcake/meal for animal and fish feed.

- **Seed research and development**: Despite ongoing constraints related to corruption, counterfeit seed, capacity constraints of the Seed Services Unit and limited land availability for seed multiplication, investment from development partners and a new Seed Policy (2018) are contributing to enhanced availability of quality seed. A 2019 study found that 34% of surveyed farmers were using improved seed and good agricultural practices (Tufa, 2019). Malawi would arguably benefit from the SADC Seed Protocol that would allow for seed tested in two SADC countries to be sold in a third country (Markowitz, 2018).

- **Aggregation and access to output markets**: Most cooperatives are organised under the Farmers Union of Malawi (FUM), the National Smallholder Farmers' Association of Malawi (NASFAM) and the Malawi Union of Savings and Credit Cooperatives from which some processors source soya bean. Contract farming with bundled input packages has also been supported by the Kenyan Export Trading Group (ETG) in collaboration with the Africa Commodities Exchange (ACE). Attraction of FDI has allowed for these investments and innovations in Malawi. It is, however, important to note that there are rarely formal contracts in place due to side-selling, and the Africa Commodities Exchange nor Auction Holdings Commodities Exchange (AHCX) are not readily used by smallholders, whilst large traders and processors can access information from private providers such as Commodity Insights Africa (Markowitz, 2018). Many poultry feed processors, the largest off-takers of soya bean, are vertically integrated into the poultry value chain, though this does not typically extend into soya bean production.

- **Cost competitiveness**: Malawi's labour costs are lower than several competitor countries, and whilst still low, its yields are higher than some competitor countries, owing in large part to the increased availability of improved seed. It is, however, important to note that infrastructure (including high interest costs for storage), transportation and the ban on imports of GM produce act as non-tariff barriers for soya bean imports into Malawi, that undermined the industry's competitiveness. There will also be a need for policy measure to promote commercial viability and mechanisation (Markowitz, 2018).

6.2 Argentina

To understand a very different soya bean sector, we consider Argentina whose soya bean sector transformed in recent decades. Argentina's oil crops industry grew from almost no production in the mid-1970s to currently being a major global player. Whilst Argentina produces a broader range of oil crops, its production is dominated by soya bean, as illustrated in teal in the figure below. As shown above, Argentina is the third largest producer of soya bean globally, after the US and Brazil.

Country	Local consumption			
	Soya bean meal	Soya bean oil	Sunflower meal	Sunflower oil
Argentina	10.6%	26.4%	50.0%	52.0%
Brazil	52.7%	88.4%	100.0%	381.8%
China	98.4%	106.2%	292.3%	349.2%
EU	224.7%	81.8%	151.0%	137.5%
US	73.6%	94.2%	92.9%	128.5%

Table 17: Intensity of local consumption of main oil derivatives by country/region

Source: Terre, 2022

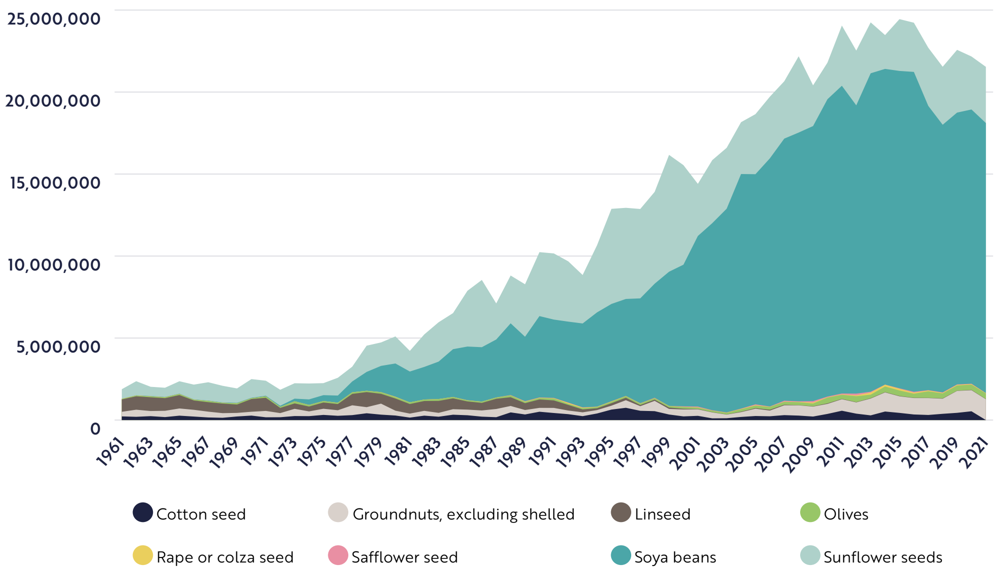


Figure 40b: Oilseed crop production (MT) in Argentina

Source: FAOSTAT, 2023

Export-led strategy:

Argentina implemented an export-led strategy for oil crops and oil crop product exports, as illustrated in the table above, which shows that local consumption of soya bean and sunflower oil and meal is far lower in Argentina than in its competitor countries or regions of Brazil, China, the EU and the US. This may also reflect its smaller population size (46 million – World Bank, 2023), which is comparable to countries like Kenya. China is the major recipient of much of Argentina's oil crop exports (Sly, 2017). It is also important to note the importance of oil crop exports for the Argentinian economy, with Argentina's soya and soya-based products alone reflecting more than 25% of Argentina's exports (Vilella, 2016).

Concentrated industry structure:

The other unique feature of Argentina's industry is that land ownership is heavily concentrated which has driven larger average farm sizes, and Argentina's oilseed processing industry is far more concentrated than its competitors, with a larger average firm size (5,387 MT in Argentina vs. 1,914 MT in Brazil) as well as advanced facilities for processing and refining.

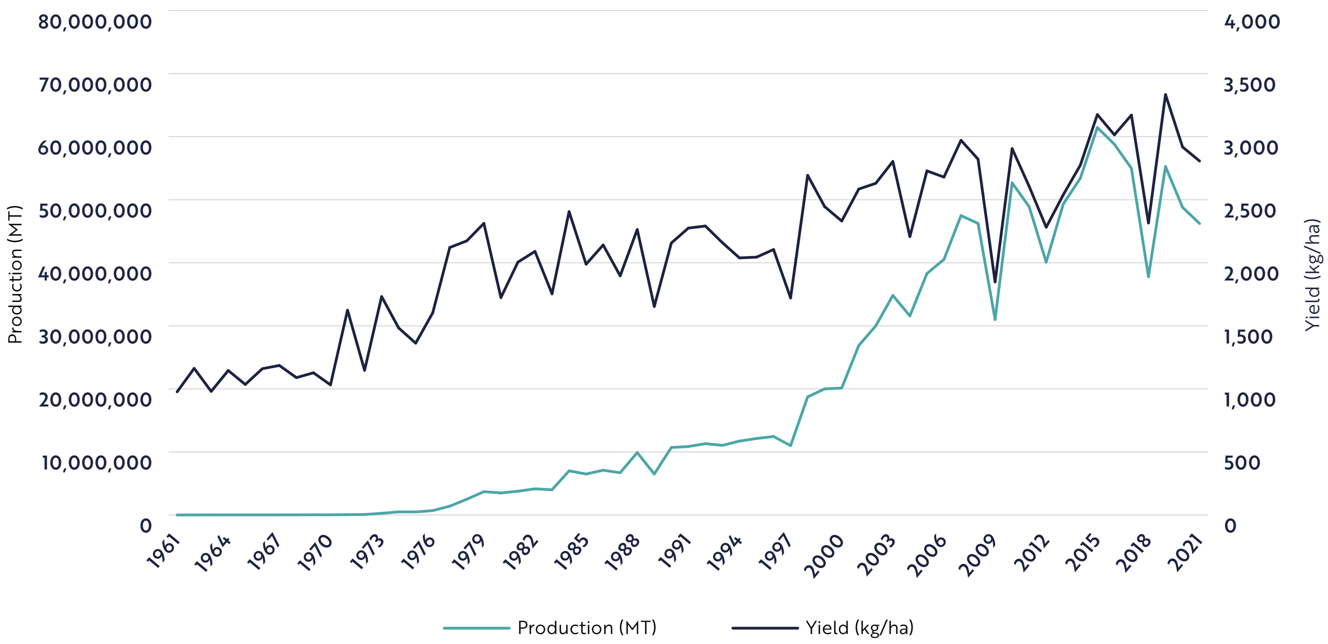
	Argentina	Brazil
No. factories	38	38
Daily capacity (MT)	204.72	168.40
Average capacity per plant (MT)	5.39	1.91
Maximum capacity per plant (MT)	30,000	6,500
Total annual capacity (MT)	67,557,930	55,572,000

Table 18: Oil processing industry structure by country
Source: Terre, 2022

Technology promotion:

A technology package including no-till farming, fertilisers, Round-Up Ready soya bean seeds and glyphosate was heavily promoted in Argentina, with genetically modified soya bean varieties being commercialised from 1996 (Sly, 2017). The following figure shows the significant increase in yields from the late 1990s accorded primarily by the introduction of higher yielding GM varieties. Argentina continues to innovate and has since developed a transgenic, drought-resistant seed (USDA, 2016).

Figure 41: Argentinian soya bean production (MT) and yield (MT/ha)
Source: FAOSTAT, 2023



In terms of additional policy interventions to drive the development of the sector, the Argentinian Government supported the following:

- Promotion of biodiesel industry (e.g. preferential tax rates).
- Investment in rail and waterway (ports and canal) transport infrastructure (though trucks still dominate).

It is important to note that despite the success of Argentina's oil crops industry, the heavy dominance of soya bean leaves both the industry and the economy exposed to forces in the global soya bean industry including international commodity price volatility (Sly, 2017). The following chart demonstrates the dominance of soya bean in Argentina's edible oil exports, accounting for 95% of its edible oil exports.

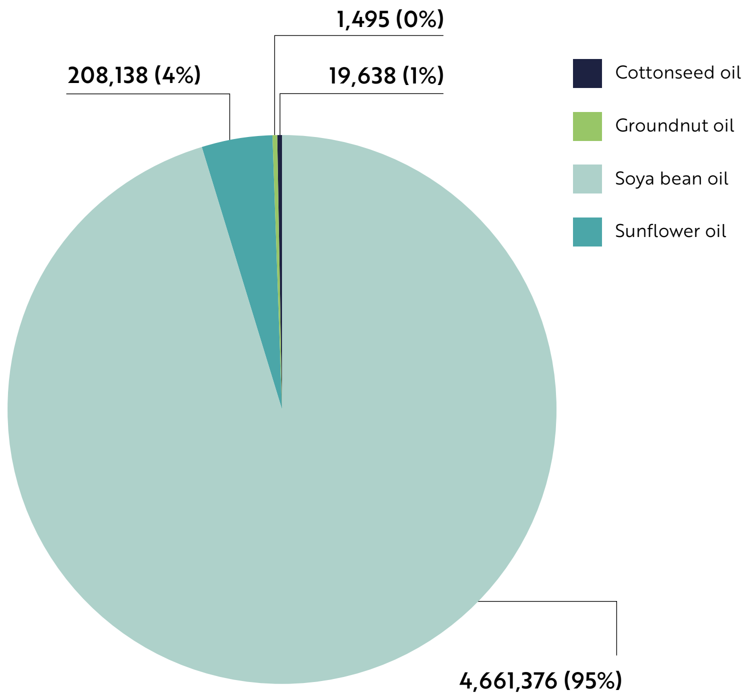


Figure 42: Shares of edible oil exports, 2021 (MT)
Source: FAOSTAT, 2023

The recent decline in Argentina's soya bean production also highlights challenges to which it must respond. Alongside climate change, industry stakeholders are calling for reform of the tax regime (including for imports, exports and biodiesel) as well as increased investment in oilseed research and development for yield improvements and to develop suitable varieties with higher protein content (Vilella, 2016).

7 Potential interventions to develop the soya bean value chain in East Africa

7.1 Soya bean seed systems

Given the shortages reported, it will be critical for agricultural research institutions to have the capacity and resources to scale up their production of foundation seed, for subsequent multiplication. Whilst the solutions are likely to be specific to the institution's situation, financing mechanisms such as the use of royalties, access to credit facilities and other sources of revenue generation might be relevant. Given these capacity constraints, international experience suggests that agricultural research institutions should focus on the research and the production of foundation seed, as opposed to multiplication of commercial seed.

Creating incentives for commercial seed companies to expand their seed multiplication and distribution will require assurance of more predictable market demand for soya bean seed. A number of existing seed companies such as SeedCo and Kenya Seed have the capacity to respond quickly to assured market demand.

Kenya's lifting of the ban on GMO creates specific opportunities to introduce GM seed, particularly where it is better placed to address threats such as Asian Soya bean Rust (Horvath, 2023). Though given the timelines for trials to take place, the most immediate opportunity offered by the lifting of the ban is that GM soya bean and soya bean products can now be imported, which may reduce the cost of animal feed and thereby consumer prices of meat and fish products (The Star, 2022).

As noted above, the main barrier to them scaling up production of commercial seed is the lack of predictable demand, combined with the short shelf life of soya bean seed. There are a range of ways in which this could be addressed:

- Processors, farmer service companies and/or cooperatives could place advance orders for seed, based on planting requirements to meet grain supply requirements.
- Government could provide incentives to stimulate demand for seed e.g. providing a purchase guarantee.

There will also be a need for awareness raising among farmers about the benefits and returns to investment in quality seed, as well as combining it with other appropriate good agricultural practices – including plant spacing, use of certified seed, inoculants, and p fertiliser.

Regional seed trade harmonisation within EAC, SADC and COMESA creates opportunities for at least the short-term import of optimal seed to meet farmers' requirements, until local production can be scaled up.

7.2 Aggregation and market access

Despite growing regional and global demand for soya bean, output market access is a major challenge for soya bean producers, as highlighted by farmers during Gatsby's recent research.

Processors highlight the challenge of a lack of aggregation mechanisms, which are necessary to make it viable or for them to send trucks to procure grain. For example, one Kenyan processor referred to sending a minimum of 10 trucks, each with 5 MT of capacity to make local sourcing viable (Maina, 2022). With Kenyan farmers each producing an average of 262 kg on one acre, this would require produce to be aggregated from 191 farmers.

A range of farmer service companies are supporting aggregation, sourcing and often offering a broader range of inputs and services, such as the critical area of extension services, to soya bean farmers, though their scale and capacity is limited. They are often able to act as a "responsible" intermediary offering value to both farmers and processors by delivering the required quantity and quality of commodities at the required time. Some of the key challenges they highlight are low farmer yields, transport, logistics and storage costs, cost and availability of working capital loans, side-marketing, managing commodity price volatility (Onyango, 2022).

Organisations such as **IDH FarmFit**[32], **2Scale**[33], **the Soybean Innovation Lab's Smart Farm**[34] and the FCDO-funded **Commercial Agriculture for Smallholders and Agribusinesses**[35] Technical Assistance Facility (Technoserve, 2021) are supporting such organisations to enhance their business models and address these challenges. There is a significant need for these efforts to support existing and new businesses to reach more farmers and offer them value services.

Though not an exhaustive list, the following companies are supporting the soya bean value chain in different ways (whilst there are other exciting companies such as **Crop Care**[36] in Kenya that are supporting other crop value chains in similar ways). In Uganda, cooperatives, and in Tanzania, Agricultural Marketing Cooperative Societies (AMCOSs), are able to provide some of these services, though they also face constraints such as limited access to finance.

Table 19: Farmer service companies supporting the soya bean value chain in East Africa

Organisation	Country	Specific locations	Soya bean farmers supported	Soya bean volumes sourced (per season)	Inputs & services offered
Forum for action on sustainable development (FASUD)	Kenya	Migori	1,000 per season (database of 15,000 farmers)	Up to 400 MT	Seed and inoculants (BioFix) on credit, extension, aggregation centres, minimum price and market guarantee, insurance
DigiFarm[37] (Safaricom)	Kenya	Migori, Nakuru	62,000 farmers served in 2019		Inputs on credit, soil testing, digital finance, crop insurance, market access, information
Mezzanine/Connected Farmer[38] (Vodacom)	Uganda, Tanzania	Lira, Gulu	4,000 per season (database of 100,000 farmers)	1,000 MT in Tanzania	Inputs on credit, extension, aggregation centres, insurance, weather information
Smart Logistics Solutions Ltd[39]	Kenya	Machakos	Database of 35,000 farmers (range of crops)		Extension, aggregation, market access
Anglican Development Services Western Regional Investment Company (AWRICO)	Kenya	Kakamega, Busia, Bungoma, Vihiga	3,000 per season (database of 50,000 farmers)	200-300 MT	Extension, soil testing, transport costs, aggregation centres, weighing scales and moisture metres
Alphajiri[40]	Kenya	Migori			Inputs on credit, extension, market access
AgVenture[41]	Kenya	Nakuru, Laikipia, Meru and Isiolo	Database of 4,500 farmers (range of crops)		Inputs on credit, extension, guaranteed market
Rift Valley Products[42]	Kenya	Busia, Kisumu, Homabay	1,200 in 2022	Limited due to side-selling	Inputs on credit, extension, guaranteed market, pre-planting minimum price guarantee
TruTrade[43]	Kenya, Uganda	Busia, Siaya, Homa Bay, Migori (Kakamega, Bungoma, Kisumu promoted)	Database of 18,000 farmers (range of crops)	250 MT	Aggregation and markets only (post-harvest)
e-Granary[44]	Kenya			Target 16,000 MT	Inputs on credit, insurance, extension, post-harvest services, guaranteed market
Rural Outreach Africa[45]	Kenya	Kakamega, Vihiga, Busia, Bungoma			Extension e.g. Integrated soil fertility management (ISFM), market access, cottage-processing

7.3 Labour saving technologies

As set out above, a key issue hampering soya bean production in Africa is the cost of production, particularly labour cost. Labour costs are incurred from land preparation and planting, to weeding, harvesting and post-harvest management. Labour costs are highest in Kenya, at an average USD 95.10 per acre, negatively impacting farmers' profit margins (Gatsby Africa, 2023).

Inefficient post-harvest handing also affects the quality of soya bean produce, often impacting price. Most farmers interviewed during Gatsby's recent research pointed to the lack of post-harvest handling equipment and knowledge. They did not have tarpaulins and driers for drying, nor threshers for threshing their soya bean (with manual threshing methods often causing damage to seed and grain), and therefore mismanaged their produce. The following image shows soya bean threshing by stick beating, which is common across East Africa. These men reported that it takes them over a week to thresh and winnow one acre of soya beans.

Figure 43: Soya bean threshing by stick beating, Malawi

Source: Giller, Family threshing soya bean in Malawi, 2023

Therefore, mechanisation in land preparation, planting, threshing, drying, grading and other activities, as well as the use of herbicides to replace manual weeding, would be of great importance in bringing down the cost of production as well as improving the quality of produce.

Innovation in the realm of threshing, for example, can enhance produce quality and reduce labour costs. The following image shows a movable soya bean thresher operated by young men in Lango, Uganda. Business models are being explored for small-scale service providers to offer this service to small-holder farmers in Uganda (Musoke, 2022).

Figure 44: Soya bean threshing by mechanised thresher, Lango, Uganda
Source: Gatsby Africa, 2023

Other service providers such as Hello Tractor[46], e-TingA [47], Cereal Growers Association (CGA)[48], Farm to Market Alliance[49], Hand in Hand[50], Machinery Ring[51], and Participatory Approaches for Integrated Development (PAFID)[52] are enhancing access to a range of mechanised farm services, which could be scaled up. It will be critical that they enable and promote low tillage solutions, in order to protect soils.

7.4 Promotion of quality rhizobium inoculants

Similar to the case of seed, the lack of predictable and sufficient demand for inoculants is a deterrent to both local production and distribution of inoculants. Yet, evidence suggests that a package of improved seed, phosphorus fertilisers and inoculants combined with broader good agricultural practices delivers more than a 100% return on money invested in soya bean production in Tanzania, Uganda and other countries including Ghana and Zambia (Kiwia, 2022). Efforts to create greater certainty of demand, such as awareness raising and pre-orders from off-takers or processors could therefore incentivise greater production and distribution efforts of inoculants in East Africa.

7.5 Enhance processing capacity

There is a need to increase investment in processing in the various soya bean value chains of meal and animal feed, edible oil, food products and others. Achieving this will entail creating a conducive environment for both local and international investors. However, processing capacity investments must be accompanied by interventions to enhance and increase production capacity so to avoid creating bottlenecks in the value chain.

7.6 Strategy, policy, and regulation

To ensure an effective and efficient soya bean value chain, there is a need for an overarching strategy, as currently in draft for Kenya (Ministry of Agriculture and Livestock Development, 2023), and tailored policies, regulations and budget allocation. Policies in this regard could among others include:

- Increased investment in research and development in soya bean. Investment in research and development of soya bean in Mozambique has driven the growth of the soya bean sector. It has allowed for the development of more than six new soya bean varieties with locally relevant characteristics and innovations of post-harvest technologies. This investment combined with high market demand has contributed to 43% growth of the sector in Mozambique (Cunguara, 2016).

- Policies that create a conducive environment for investment in soya bean seed systems development. This could include policies to expedite seed registration to allow for multiple actors in the value chain.

- Policies that promote both domestic and foreign, large and small-scale processing investments, including upgrading for efficiency improvements. For example, this could include duty exemptions on processing equipment, reducing VAT.

- Policies to support producers and processors of soya bean with access to quality inputs and affordable finance. This could include national development finance institutions creating specific instruments to extend more low interest lending for agricultural development/soya bean value chain development, including soya bean inputs as subsidised inputs in e-voucher schemes.

- Policies to allow for tailored extension to enhance adoption of good agricultural practices. This could promote crop rotation of cereals and legumes such as soya beans as a means of enhancing soil fertility. This could involve retraining Government extension officers, collaborating with private sector and development partners promoting sustainable agricultural practices such as conservation agriculture or sustainable intensification (What is sustainable intensification?, 2020).

- Trade policy, harmonised with EAC, SADC and COMESA to promote import substitution of both soya bean commodity and processed products. This could entail tariffs on importation of processed products whilst allowing for the duty-free importation of soya beans to be processed locally. This approach has worked in China and Egypt making China the largest player in processed soya bean products. There is also a need to ensure the correct classification and implementation of import tariffs on crude and refined oils as means of growing the domestic soya bean processing industry. This applies, for example, to the recent changes to the EAC Common External Tariff on imported edible oils (Abdoulaye Djido, 2022).

- Policies to streamline the value chain through aggregation and increased sector coordination to increase farmer market access. For example, this could cover support to agricultural cooperatives and support (e.g. reduced/zero rated VAT) to farmer service companies for example.

Policymakers have a role to play in stimulating general demand, including through demand for animal proteins and for human consumption of soya bean. This can be achieved through, for example, policies to promote and enhance the competitiveness of local animal feed manufacturing, and for the fortification of foods.

8

Conclusion

In conclusion, promoting soya beans as a major cash crop that could support the edible oils, animal-feed protein and highly nutritious foods production systems could be cost-effective and contribute to addressing the challenges of poverty, malnutrition and climate change resilience that small-scale farmers face. There is an urgent need for East Africa to produce resilient crops that have the capacity to enhance farmers' livelihoods (incomes, health, assets), whilst improving the fertility of the soil.

Yet, our analysis shows that without significant productivity improvements, many farmers will continue to make negative net profits, particularly in Kenya given higher labour costs, whilst there are also likely to be alternative, more profitable crops for farmers to grow across the region.

On this basis, a range of interventions have been proposed, arguably the most important of which being to create the demand pull for enhanced production, through greater linkages with processors and more effective aggregation mechanisms. This will require engagement from the public, private and development sector. This should create the conditions for enhanced supply (including potentially through pre-orders) of key quality inputs including improved seeds and inoculants that are currently in short supply. There will also be a need for promotion of good agricultural practices and labour-saving technologies. Combined, these actions could help to catalyse the growth of the soya bean value chain in East Africa, delivering a range of benefits across the value chain and contributing to higher level goals including employment creation in processing and supporting industries, as well as reducing the trade deficit.

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Annex 1: Key soya bean seed varieties, East Africa

Source	Seed	Countries			Oil content (%)	Protein content (%)	Yield potential (kg/ha)	Maturity	Seed rate (kg/ha)	Special characteristics
		Kenya	Tanzania	Uganda						
SeedCo[53]	SC Saga	X			High			Short		Resistant to soya bean rust disease, Frog Eye disease, Leaf brown spot and pod shattering
	SC Salama	X					2,500-4,500	3-4 months		
	SC Semeki		X				4 200		100	Long pod shatter free period, high resistance to Frogeye Leaf Spot, Wildfire & Downy Mildew, acceptable tolerance to Red Leaf Blotch & Bacterial Blight
Makerere[54]	Maksoy 1N			X	17	41	2,000-2,500	90 days	50-60	Resistant to soya bean rust disease, lodging, pod shattering
	Maksoy 2N			X	20	38	2,000-3,000	105 Days		
	Maksoy 3N			X	22	36	2,000-3,500	100 days		
	Maksoy 4N			X	21	38	2,000-3,500	103 days		
	Maksoy 5N			X	19	38	2,000-3,500	96 days		
	Maksoy 6N			X	20	41	3,000-3,500	96 days		
KALRO[55]	Kensoya 009	X			24	35	1,500-3,000	4-5 months		0-2,000m altitude
	DPSB 8	X			18	38	1,200-2,500	4-5 months		900-2,400m altitude
	DPSB 19[57]	X	X		17	40	600-1,700	3-4 months		900-2,400m altitude
	Gazelle	X			22	36	800-2,500	4-5 months		1,200-2,400m altitude
	Nyala	X			17	37	1,200-2,500	4-4.5 months		From Seed Co Zimbabwe, 1,200-2,400m altitude
TARI[56]	Uyole Soya 1									
	Uyole Soya 2									
	Uyole Soya 4		X				2,000			Tolerant to leaf rust, early maturing

Annex 2: Key soya bean seed companies, East Africa

Country	Company	Location	Seed varieties produced	Seed production capacity (MT)
Kenya	SeedCo Kenya[59]	Mombasa Road, Nairobi	Salama, Saga	200
	KALRO[60]	Kaptagat Rd, Loresho, Nairobi	Gazelle, Bozi, SB19	
	Kenya Seed Company Ltd[61]	Nairobi	SB19	
	MEA Ltd[62]	Nakuru	SB19	
Tanzania[58]	SeedCo Tanzania[63]	Arusha	Saxon, Signal, Semeki	
	TARI Uyole[64]	Mbeya	Uyole Soya 4	
Uganda	Pearl Seeds Ltd[65]	Entebbe Road, Kampala		150
	FICA Seed[66]	Kampala	Maksoy 3N & Maksoy 6N	
	Gold Seed International[67]	Kampala		
	Soya bean Africa Limited[68]/ Hatches Ltd[69]	Gayaza	Maksoy 3N & Maksoy 6N	

Annex 3: Key soya bean processing companies, East Africa

Country	Company	Location	Major product focus				Soya bean processing capacity (MT)
			Edible oils	Animal feed	Nutritious food	Other soya bean products	
Kenya	Promasidor[70]	Nairobi			X		
	Bidco Ltd[71]	Thika, Nairobi, Nakuru	X	X		X	
	Eni[72]	Nairobi, Makueni	X		X		15,000 (total edible oils)
	Soy Afric[73]	Nairobi, Ruiru			X		
	Rift Valley Products Ltd[74]	Thika	X	X			
	Unga Feeds (inc. Tunga Nutrition Kenya)[75]	Nairobi, Eldoret, Nakuru		X			100,000
	ProSoya[76]	Nairobi			X		
	Equatorial Nut[77]	Nairobi		X	X		
	Wonder Feeds[78]	Nakuru		X			
	Crown Paints[79]	Nairobi				X	
Tanzania	Falcon Animal Feeds[80]	Dar es Salaam		X			
	Silverlands Ltd[81]	Iringa		X			
	Tanfeeds[82]	Morogoro		X			
	Hill Feeds[83]	Bagamoyo		X			
	Interchik[84]	Dar es Salaam		X			
Uganda	Mukwano Industries Ltd[85]	Kampala, Lira	X	X		X	
	MMP factories[86]	Kampala, Lira, Bukubizi					
	Soya Solutions Eastern Africa Limited (SSEAL) (not yet operational)[87]	Aboke, Lira	X	X	X		
	SESACO Uganda Limited[88]	Kampala			X		
	Smart Foods Uganda Ltd[89]	Kampala			X		

Footnotes

Page 18
1. https://www.thecitizen.co.tz/tanzania/news/national/soybeans-can-transform-tanzania-s-fortunes-fora-3594136

Page 26
2. Kenyan oil demand covers all edible oils, currently 98% met by palm oil.
3. 2018 estimate so likely to be significantly higher.
4. Kenyan oilcake demand covers all oilcake to which other crops such as sunflower contribute.
5. Likely to be underestimated, as based on outdated animal feed demand statistics (2018), and assuming an average oilcake share for different animal feed products.

Page 32/33
6. https://agra.org/scaling-out-maize-and-soybean-production-and-value-addition-for-improved-nutrition-and-incomes-among-smallholder-farmers-in-western-kenya/
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17. https://sagcot.co.tz/images/documents/SoyaValuechain.pdf
18. https://leg4dev.org/

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19. https://www.snv.org/project/climate-resilient-agribusiness-tomorrow-craft

Page 40
20. Basic seed results from the production of breeder seed and then pre-basic seed, and is available for (commercial) multiplication, typically through another two cycles, to deliver "certified two" seed for planting by farmers.
21. DPSB19 was selected from the IITA Tgx varieties brought from Nigeria, and later released through KALRO (Vanlauwe, Bernard, IITA, 2023).
22. https://www.soybeaninnovationlab.illinois.edu/

Page 42
23. This cost breakdown is based on the most common practices in each country, so for example, less than 20% of farmers use herbicides across all three countries so we have not included this cost.

Page 43
24. FAO estimates that average fertiliser use in kg per ha was 3.3 kg in Uganda, 15.8 kg in Tanzania and 57.3 kg in Kenya, compared to 121.8 globally (FAOSTAT, 2023).

Page 44
25. All USD values related to Gatsby's farmer survey were calculated using National Bank Exchange Rates (https://www.bou.or.ug/, https://www.bot.go.tz/, https://www.centralbank.go.ke/) in January 2023. The specific exchange rates were USD 1: UGX 3,650, USD 1: TZS 2,332, USD 1: KES 124.1.

Page 57
26. Whilst higher yields were reported by farmers, through validation with country experts at IITA and Makerere University, we revised down the highest attainable yields to 3,500 kg per ha for Tanzania and 3,000 kg per ha for Uganda based on observed farmer experience.

Page 59
27. Though weed control, recommended spacing, fertiliser and pesticide application are recommended good agricultural practices for soyabean, they were found to be insignificant in boosting yield. This is explained by the fact that there is minimal yield gain in adopting these practices without using improved seed. Few farmers adopted these practices. For example, although sufficient rates of fertiliser were used (average 87 kg/ha or 35 kg/acre), only 15% of farmers used fertilizer.
28. Small scale: <1.2 ha (3 acres), medium scale: 1.2-5 ha (3.1 - 12.4 acres), Large scale: > 5 ha (12.4 acres).

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29. Average exchange rate for 2016: https://www.exchangerates.org.uk/USD-INR-spot-exchange-rates-history-2016.html

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57. From the IITA breeding programme in Nigeria.

Page 96
58. Agriseed Technologies which produced and distributed pre-basic, basic and certified seed, distribution of basic and certified soyabean seed, based in Morogoro and founded in 2008, is reported to be out of business.
59. https://www.seedcogroup.com/ke/
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Gatsby Africa

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