ASSESSING THE ECONOMIC CONTRIBUTION OF THE SOY VALUE CHAIN IN KENYA TO ENHANCE ITS ECONOMIC DEVELOPMENT CONTRIBUTION

Charles Nicholson, Cornell University
Guustaaf van de Mheen and Peter Matyoko, Agrics[1]
Todd Schmit, Cornell University
Peter Goldsmith, University of Illinois and Soybean Innovation Lab

Executive Summary

There is limited information about the economic contribution made by soybean value chains (SVC) in lower- and middle-income country settings. This information is relevant to the formulation of agricultural sector investment strategies, which can benefit from information about the current contribution of the SVC and *ex ante* impact assessment of selected investments. This document provides an initial case example of an analysis of the economic contribution of the SVC for Kenya, which serves as a template for future similar studies.

We use primary information collected through farmer focus groups and interviews with Kenya SVC stakeholders to develop estimates of expenditures on farm inputs, transportation to processing (from farms and imports of soybeans, meal and oil), processing and distribution to end users of soybean products. This information is summarized as production functions that describe direct effects and are then integrated into a Social Accounting Matrix (SAM) and used to estimate indirect and induced effects. The direct, indirect and induced effects combined comprise the overall economic contribution of the Kenya SVC. We model an additional four economic impact scenarios: 1a) a 4x increase in soybean production; 1b) a 4x increase in soybean production and maize acreage offsets; 2) a reduction of soybean oil imports to zero through local soybean production; 3) a 4x increase in soybean production and a corresponding impact on production in the broiler industry.

Key findings of this study are:

- The overall contribution of the SVC to the Kenyan economy is about $78 million. The far larger component is soybean processing, in part because domestic soybean production is relatively small; Kenya is a major net importer of soybeans, soybean meal and oil.
- Direct effects account for $50 million, with indirect effects (business to business spending) of $13 million and induced effects (household spending) of $16 million.

[1] Van de Mheen and Matyoko worked for Agrics at the time of the study, although neither is currently affiliated with that organization.

- The total employment generated by the Kenya SVC is estimated as 3,359 FTE positions, about half of which are in soybean production and processing, and half due to indirect and induced effects.
- The multiplier for the value of SVC output is about 1.6—each dollar of output generates an additional $0.56 in backward-linked sectors of the Kenyan economy due to indirect and induced effects.
- The multipliers are larger for employment-related metrics, with a value of 2.4 for employee compensation and 2.0 for FTE positions. Thus, each dollar of employee compensation in the Kenya SVC generates additional compensation of $1.40 of indirect and induced effects, and each FTE in the Kenya generates about 1 additional FTE position through indirect and induced effects.
- The largest upstream linkages for soybean production in Kenya are for fertilizers, transportation and retail trade (e.g., agro-vets) based on our estimated production functions.
- The largest upstream linkages for soybean processing include soybeans (domestic and imported), soybean meal and oil (much of which are further processed or packaged within Kenya), supplies for processing (including chemicals), energy, and transportation services.
- Investments to increase domestic soybean production by four times to replace imported soybeans would increase the annual total economic contribution of the SVC by about $10 million and create 1,500 additional FTE positions;
- Investments to increase domestic production of soybeans to replace imported soybean oil (and some soybean meal; 2.4 times 2015 production) would increase the annual total economic contribution of the SVC by about $8.5 million and create about 1,250 additional FTE positions;
- Coordinated investments to increase domestic soybean production (by four times), domestic processing and the use of this additional soybean meal in broiler meat production would have substantively larger effects than for the (bean, oil or meal) import substitution scenarios, with an annual contribution of $85 million and about 4,800 new jobs. However, this scenario assumes that all additional output is absorbed with new demand (which may not be reasonable) and that a coordinated investment strategy across SVC and broiler producers is feasible;
- Similar studies of the economic contribution of the SVC in other countries are likely to be feasible, but implementation depends on access to relevant input-output or social accounting matrix information, and ability to gather data to develop farm-level and processing sector production functions.

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Background and Justification

The Soybean Innovation Lab (SIL) has previously supported numerous economic studies related to soybean value chains in lower- and middle-income countries (LMIC). However, to date there is limited information about the economic contribution (e.g., total revenues, total contribution to GDP) made by soybean value chains (SVC) in these settings. This type of study has been undertaken for SVC in high-income settings, e.g., for Canada (MMN, LLP, 2016) and North Dakota (Bangsund and Leistritz, 1999) but has not yet been developed for LMIC. This information is highly relevant to the formulation of agricultural sector investment strategies, which can benefit from information about the current size of the SVC and *ex ante* impact assessment of selected investments. Moreover, given the more limited availability of the data necessary for this type of assessment in LMIC, a generalizable, replicable approach that develops reliable estimates of SVC contributions is needed to facilitate comparative analyses of the SVC in multiple countries.

Objectives

Given the foregoing, we estimate the economic contribution of SVC in Kenya as a first example of this type of analysis and to identify a generalizable approach that can be applied in other countries.

The specific objectives of this project are:

1) Describe the current structure, status and key stakeholders of the Kenya SVC from input supply to production, processing and distribution to end users of soy products;
2) Assess the economic contribution of the Kenya SVC;
3) Use the information from 2) to infer the impacts of selected SVC development outcome scenarios on the economic contribution of the Kenya SVC;
4) Assess the feasibility of a generalizable approach for 1) and 2) to facilitate comparative analysis of SVC in other countries of sub-Saharan Africa.

Methods and Data

Descriptive Analysis of the Kenya SVC (Objective 1)

We reviewed information from previous published sources, data from publicly available sources (e.g., FAO), interviews with SVC stakeholders (input suppliers, farmers, processors, traders), and the experience of the Agrics' team as an intermediary in the Kenya SVC.

Economic Contribution of the Kenya SVC (Objective 2)

Estimating the economic contribution of the SVC in Kenya requires detailed information on the linkages of the different components of the SVC with other sectors of the Kenyan economy. The core information needs for this comprise the types and amounts of inputs and services purchased by SVC participants from other businesses within Kenya, while accounting only for the proportion of expenditures within Kenya. As an example of within-Kenya expenditures, most fertilizers used in soybean production are produced outside Kenya (in Germany, UAE, India and China), and arrive in bulk shipments via the port of Mombasa. The expenditures within Kenya include the transportation from a port to a blending facility, blending at that facility, packaging, and distribution of fertilizers through retail agro-vets, but does not count the value of the fertilizer manufacturing. A similar valuation procedure applies to other imported inputs, such as equipment (e.g., hoes or spray pumps) or materials (e.g., boots).

We estimated the within-Kenya expenditures for five separate SVC components: farm-level, post-farm transportation services, import transportation services, processing, and post-processing distribution. At the farm level, we collected information through four farmer focus group discussions (FGD) in Western Kenya that were developed and facilitated by Agrics' field staff in May 2019. Information on transportation from farm to processing facilities (and imports to processing facilities) was obtain through interviews with soybean processing companies, input suppliers and trading companies. Information on processing margins was provided by soybean processors and specific cost details were developed based on modification of processing cost components for low-volume soybean processing facilities in the US provided by a consultant with international experience. Distribution costs were estimated based on margins and cost information provided by soybean processors and trading companies.

Input-output (I-O) methods have proven to be an effective tool to assess the economic effects from expenditures or the initial expansion of output in specific sectors of economies that come about as the result of public policy or private sector initiatives at the national, state, and local levels. In contrast to more aggregate economic analyses, I-O methods differentiate the effects of initiatives by important economic sectors. Conventional macroeconomic models trace changes in aggregate economic indicators such as national or regional income, gross national or regional product and employment and investment due to changes in taxes, spending, etc. These models, however, do not address the composition of these changes by production sector, nor do they trace the resultant effects throughout the economy.

To evaluate the economic contribution of the SVC in Kenya, we start with a full Social Accounting Matrix (SAM) for Kenya (based on the year 2014) developed for European Commission in 2018 (Mainar Causape et al. 2018). A SAM is defined as a matrix representation of all transactions and transfers between different production activities, factors of production, and institutions (households, enterprises, and government) within an economy and with respect to the rest of the world (i.e., imports and exports). A SAM has an input-output model at its core (reflecting inter-industry activity), but also incorporates transactions and transfers

between institutions related to the distribution of income in the economy (Miller and Blair, 2009, p. 499). In so doing, the impacts and multipliers based on the SAM reflect the ripple-effects throughout the economy with somewhat greater precision than do those based on an I-O model alone. We then customize the SAM to disaggregate soybean production, processing, and related activities from existing, more aggregate, sectors (i.e., in farm production and food manufacturing sectors). Primary data were collected to quantify the production functions (SAM columns) and marketing activities (SAM rows) of the soybean value chain components and inputted into the SAM. Once completing the customization , we compute the (Leontief) multipliers matrix and estimate the direct effects of the soybean value chain. Schmit and Boisvert (2014) provides a framework and example of this type of analysis, which is used to estimate the "indirect" and "induced" effects of "direct" expenditures by SVC participants, as well as the multiplier effects of additional SVC activity. (Appendix 2 provides are more detailed general description of Input-Output analysis.)

Analysis of the Impact of Selected Soybean Development Outcomes on the Economic Contribution of the Soybean Value Chain in Kenya (Objective 3)

The SAM developed for Objective 2 was modified to assess the impact on the economic contribution of the Kenya SVC for four scenarios representing outcomes of additional investment in soybean production and processing in Kenya, including increases in soybean production, soybean processing and increased broiler chicken production. For ease of exposition, additional details on the changes made to the SAM to implement each of the scenarios are provided below. It is important to note that these analyses assume that the supportive, underlying investments necessary for increased soybean production, soybean processing, transportation and broiler production would have made prior to 2014. The costs and feasibility of these relevant investments are not assessed as a part of these analyses—only the impacts on the economic contribution of the SVC from achievement of these outcomes.

Feasibility of a General Approach for Assessment of Economic Contributions of Soybean Value Chains in Other Low-Income Country Settings (Objective 4)

We documented the sources of information (and assumptions) required to provide an assessment of the feasibility of a generalizable approach to facilitate this type of analysis for other countries in sub-Saharan Africa.

Results

Structure of the Soybean Value Chain in Kenya (Objective 1)

A number of previous studies (Tinsley, 2009; Collombet, 2013, Jackson, 2016) have described the structure and actors in the soybean value chain (SVC) in Kenya (Figure 1[2]). Soybean

[2] Appendix 1 provides a series of more detailed process diagrams for different components of the Kenya SVC.

production is small relative to that of major grain crops such as maize—soybean acreage has less than 0.1% of maize acreage in recent years—but there is a strong demand for soybean meal for poultry, pork and dairy production. As a result, Kenya is a large net importer of soybeans for processing and soybean meal. Soybean oil is also imported in substantive quantities. Soybeans grown and processed in Kenya accounted for only 11% of the domestic availability of soybean cake and 17% of soybean oil during 2000 to 2016. The remainder is from imported soybeans processed in Kenya or from imports of soybean meal or oil. Thus, much of the economic activity derived from the SVC in Kenya is due to transportation, processing and use of imported soybeans or soybean products. Moreover, the quantities imported and resulting domestic availability show considerable year-to-year variation, which will affect the value of the economic contribution of the SVC.

Soybean production generally occurs on smallholder farms with less than 2 acres[3], with main production regions in western Kenya and the Central Highlands (Table 1). The predominant purchased inputs are fertilizer (comprising roughly half of cash costs), hired labor, equipment and machinery costs (for inputs such as hoes and boots), seeds and agricultural chemicals. Estimated acreage has remained relatively small (between 1500 and 3000 ha/year) since 2000 (Figure 3). Estimated yields were largely unchanged through 2009, then increased through 2012 and have declined since (Figure 2). Most observers agree that yields are below potential despite the availability of inputs such as fertilizer, averaging less than 1000 kg/ha, with a range from 750 to 1500 kg/ha during 2000 to 2017 (FAOSTAT, 2019). Inputs for soybean production are provided by numerous agro-vet retail shops, who purchase inputs from major suppliers (e.g., Mavuno and Baraka for fertilizers). Most fertilizer components and production suppliers (materials and equipment) are imported, with the main value addition within Kenya being transportation and packaging.

Post-production marketing of soybeans occurs through a variety of intermediaries. Itinerant traders purchase product at the farm-gate, offering prices lower than other marketing channels but with immediate cash payment. Prices paid to farmers vary from 30 to 80 KSh/kg[4] ($0.32-$0.84 USD) depending on buyer and season. Some processing companies (e.g., Bidco and Promisador) contract with farmers and aggregators to arrange for consolidation of production and shipment to processing facilities (often near Nakuru or Nairobi). Transportation is by trucks of various capacities (typically, 7 to 15 MT) and transit times are less than one day. A small amount of domestic production is consumed in local markets.

The soybean processing component of the SVC in Kenya relies heavily on imported soybeans and soybean products (cake, meal and oil). Soybean imports have generally been much larger than domestic production (Table 2, Figures 2 and 3) during the past two decades. Soybeans are sourced primarily from other countries in the region, including Uganda, Ethiopia, Tanzania, Malawi and Zambia. Because the production season varies in each of these countries, imports

[3] Larger "commercial-scale" soybean farms exist, but apparently provide a relatively small proportion of the Kenya production volume, according to soybean processors interviewed.

[4] Prices are often expressed per 2-kg unit called a *gologolo*.

from these countries vary within the year (and year-to-year). Kenya has also imported considerable quantities of soybean cake and meal and soybean oil, although the former has grown in recent years and the latter has declined (Table 2, Figures 4 and 5).

Soybean Oil in the Context of Food Oil Consumption in Kenya

Soybean oil represents a very small share of both the domestic availability of food oils and imports of those oils. Based on FAO data, the soybean oil comprised generally less than 1% of the total of edible oils during 2010 to 2013 (the latest years for which FAO data are available). Palm oil—nearly all imported—accounted for 80 to 90% of oil domestic supply during those same years, with maize and other oils accounting for 5 to 15%. Despite the considerable imports relative to domestic supplies mentioned above, soybean oil also accounted for less than 1% of edible oil imports during 2010 to 2017. The predominant edible oil import was palm oil, which generally accounted for more than 95% of total edible oil imports. The large share of import palm oil in food consumption in Kenya suggests that the potential for domestic soybean oil to substitute for palm oil merits additional study. (Appendix Tables 6.1 and 6.2 provide more details on Kenya food oil availability and imports.)

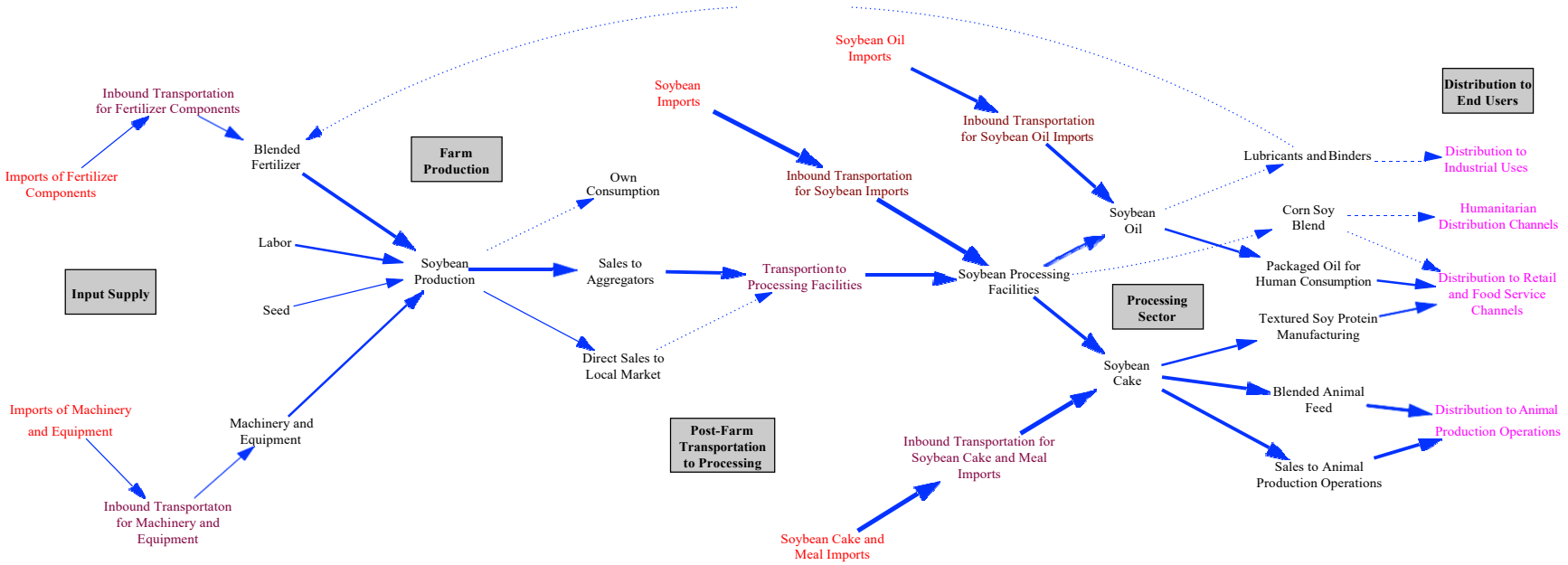

Figure 1. Structure of the Kenya Soybean Value Chain, With Emphasis on Components Assessed for the Economic Contribution Analysis

Note: Developed based on interviews and previous SVC diagrams (e.g., Collombet, 2013). Width of arrows indicates relative magnitudes of flows (detailed information about each pathway not available).

Table 1. Summary of Characteristics of Soybean Production and Marketing Systems in Kenya

Characteristic of Kenya Soybean Value Chain	Key Observations or Data	Source
Production Systems		
Production areas	Western Kenya (~90%; Kakamega, Vihiga, Busia, Bungoma, Tranzoia, Siaya, Homa Bay, Migori, Kisii and Nyamira counties) and Central highlands (Kirinyaga, Embu, Meru and Tharaka Nithi Counties)	Interview data, Jackson (2016)
Production systems	Primarily by smallholders with < 2 acres land, sometimes under "contract grower" arrangements with processors	Interview Data, Collombet (2013), Tinsley (2009)
Soybean area	1600 to 3000 ha during 2000 to 2017; average 2330 ha (Figure 1)	FAOSTAT
Soybean production	2000 to 2900 MT/year during 2000 to 2017; average 2175 MT/year (Figure 1)	FAOSTAT
Soybean yields	715 to 1500 kg/ha during 2000 to 2017; average 951 (Figure 1)	FAOSTAT
Factors constraining production	Seed availability, production knowledge, marketing coordination, importance of maize production, cash price and immediate payment	Interview data with soybean buyers
Marketing Systems		
Intermediaries	Traders, Brokers, NGOs, Processors, Transportation providers	Interview Data, Collombet (2013), Tinsley (2009)
Sales price, farm gate	30 - 80 KSh/kg, ($0.32-$0.84 USD) depending on season and market outlet—higher for sales direct to market	Farmer Focus Groups
Key processing and trading companies	Bidco, Promasidor, Export Trading Group, SoyAfric, UNGA, Sigma Feeds, Proctor & Allen	Interview data with soybean buyers
Soybean crushers	Mt. Meru, Pargate, Cargill, Bidco, Soypro	Interview data with soybean buyers

Domestic availability and use of soybean cake and oil has varied considerably during 2000 to 2017 (Table 3, Figures 6, 7 and 8), with increases in the former and decreases in the latter. As noted above, domestic production of soybeans provides a relatively small proportion of the domestic availability of these soybean products. The primary use of soybean cake and meal is for animal feed, either through blended feeds or cake and meal sold directly to larger animal operations to be blended by them (Table 3). Some processors make textured soy protein for household consumption (often sold in retail packaging). Soybean oil is primarily used for human consumption, but some processors sell it as a binding or coating (e.g., in the fertilizer industry) or as a lubricant. In past years, the use of soybeans in corn-soy blend for humanitarian relief efforts may have accounted for as much as 10% of soybean use (Collombet, 2013), although the magnitude of this use is likely smaller at present. Overall, it is estimated that about two-thirds of soybean use in Kenya is for animal production, which is consistent with growing use of soybean meal and cake and increases in animal production.

Table 2. Summary of Characteristics of Soybean Imports and Exports for Kenya

Characteristic of Kenya Soybean Value Chain	Key Observations or Data	Source
Soybean import volume	1500 to 20000 MT/year during 2000 to 2017; average 6890 (Figure 2)	FAOSTAT
Soybean export volume	22 to 6300 MT/year during 2000 to 2017; average 1105 MT/year (Figure 2)	FAOSTAT
Value of soybean imports	$0.2 to $8.5 million / year during 2000 to 2017; average $2.7 million / year (Figure 3)	FAOSTAT
Value of soybean exports	$0.03 to $3.3 million / year during 2000 to 2017; average $0.6 million / year (Figure 3)	FAOSTAT
Soybean cake imports	3600 to 26600 MT / year during 2000 to 2017; average 15524 MT /year (Figure 4)	FAOSTAT
Soybean cake exports	0 to 17 MT / year during 2000 to 2017; average 4 MT /year (Figure 4)	FAOSTAT
Soybean oil imports	100 to 23000 MT / year during 2000 to 2017; average 5782 MT / year (Figure 4)	FAOSTAT
Soybean oil exports	1 to 6500 MT / year during 2000 to 2017; average 2480 MT / year (Figure 4)	FAOSTAT
Value of soybean cake imports	$1.2 to $20.6 million / year during 2000 to 2017; average $ 6.9 million / year (Figure 5)	FAOSTAT
Value of soybean cake exports	$0 to $0.023 million / year during 2000 to 2017; average $0.002 million / year (Figure 5)	FAOSTAT
Value of soybean oil imports	$0.015 to $14.0 million / year during 2000 to 2017; average $4.1 million / year (Figure 5)	FAOSTAT
Value of soybean oil exports	$0.003 to $9.6 million / year during 2000 to 2017; average $2.6 million / year (Figure 5)	FAOSTAT

Table 3. Summary of Characteristics of Domestic Availability and of Soybean Cake and Soybean Oil in Kenya

Domestic availability of soybean cake	790 to 16230 MT / year during 2000 to 2017; average 4965 MT /year (Figure 6, Figure 8)	Calculated from FAOSTAT and cake-oil yield data
Domestic availability of soybean oil	9200 to 75500 MT / year during 2000 to 2017; average 22510 MT /year (Figure 7, Figure 8)	Calculated from FAOSTAT and cake-oil yield data
Source countries for soy imports	Uganda, Ethiopia, Malawi, Tanzania, Zambia, India	Interview data with soybean buyers
Principal uses of meal	Animal feed, textured soy protein (TSP), corn-soy blend (CSB) for humanitarian relief	Interview Data, Collombet (2013), Tinsley (2009)
Principal uses of oil	Cooking oil, fertilizer binder/coating, animal feed (in soybean cake)	Interview Data, Collombet (2013), Tinsley (2009)
Key processing and trading companies	Bidco, Promasidor, Export Trading Group, SoyAfric, UNGA, Sigma Feeds, Proctor & Allen	Interview data with soybean buyers
Soybean crushers	Mt. Meru, Pargate, Cargill, Bidco, Soypro	Interview data with soybean buyers

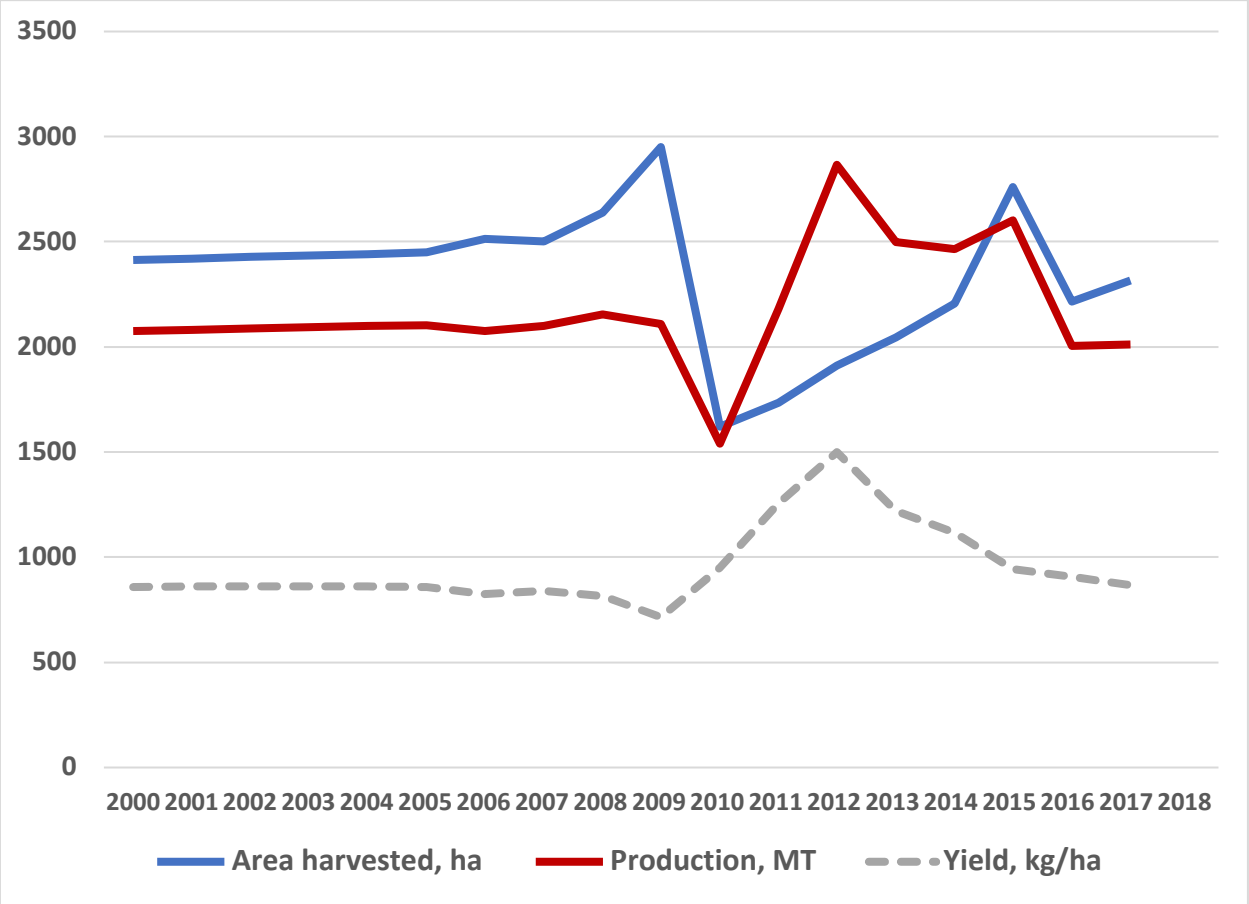

Figure 2. Kenya Soybean Acres, Production and Yields, 2000 to 2017

Source: FAOSTAT Database.

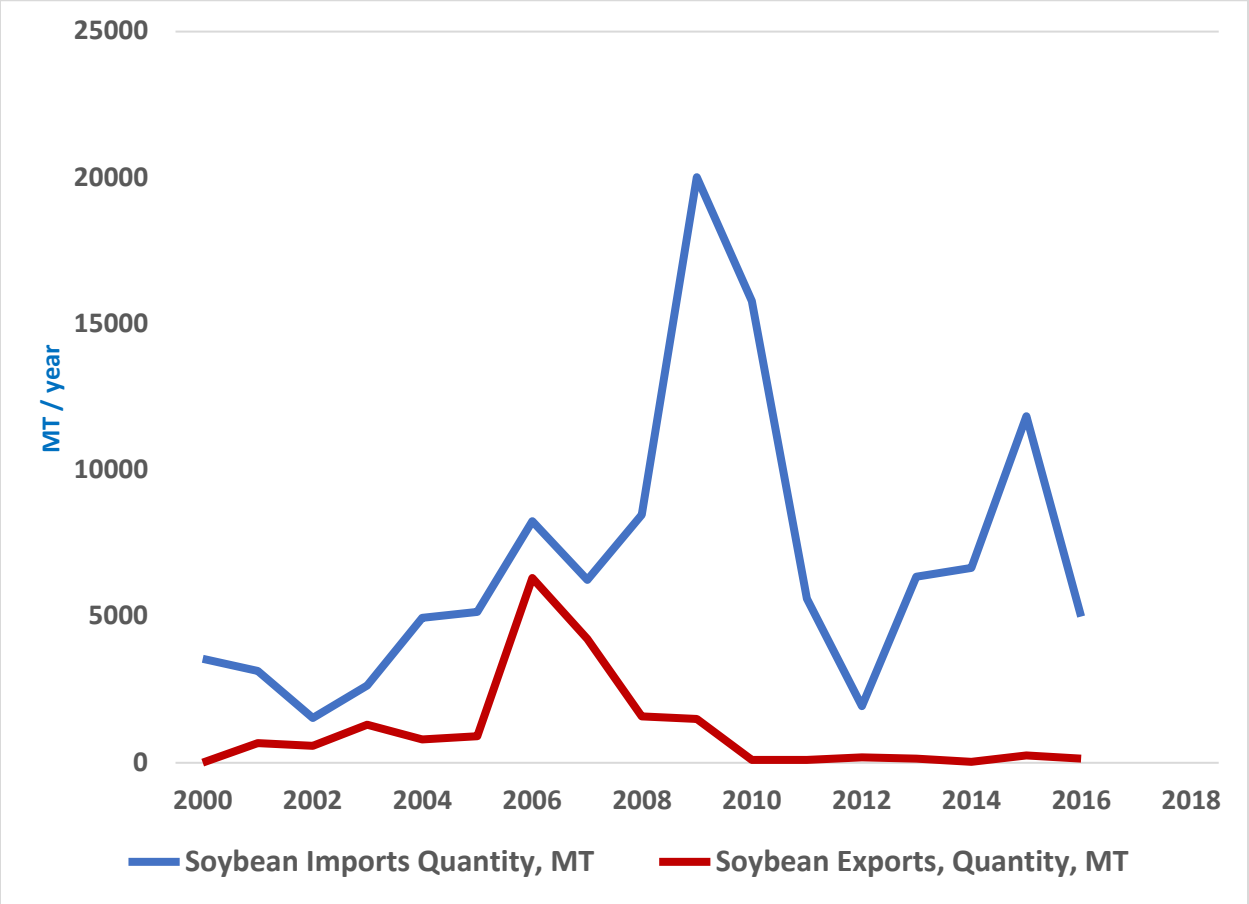

Figure 3. Kenya Imports and Exports of Soybeans, 2000 to 2017

Source: FAOSTAT Database.

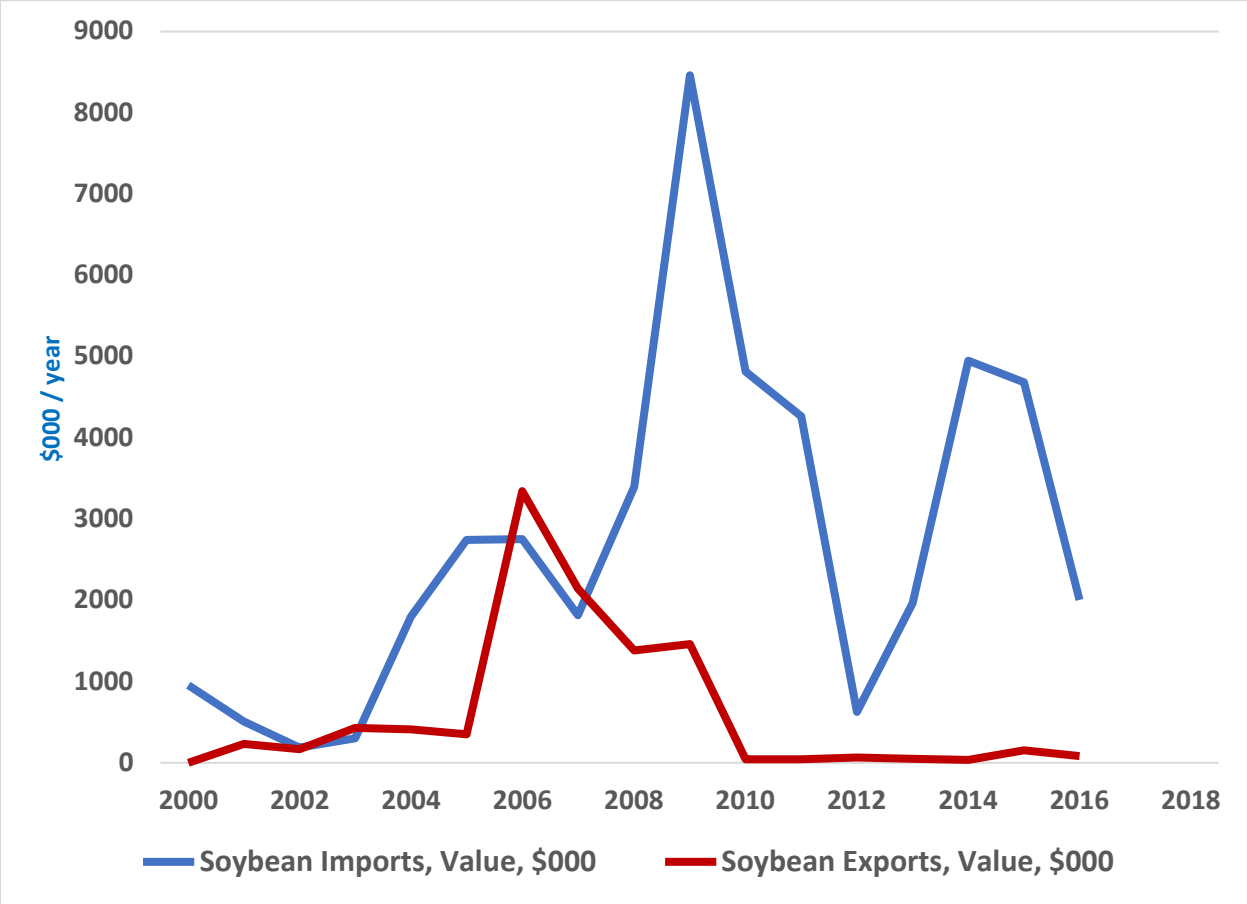

Figure 4. Value of Soybean Imports and Exports, 2000 to 2016

Source: FAOSTAT Database.

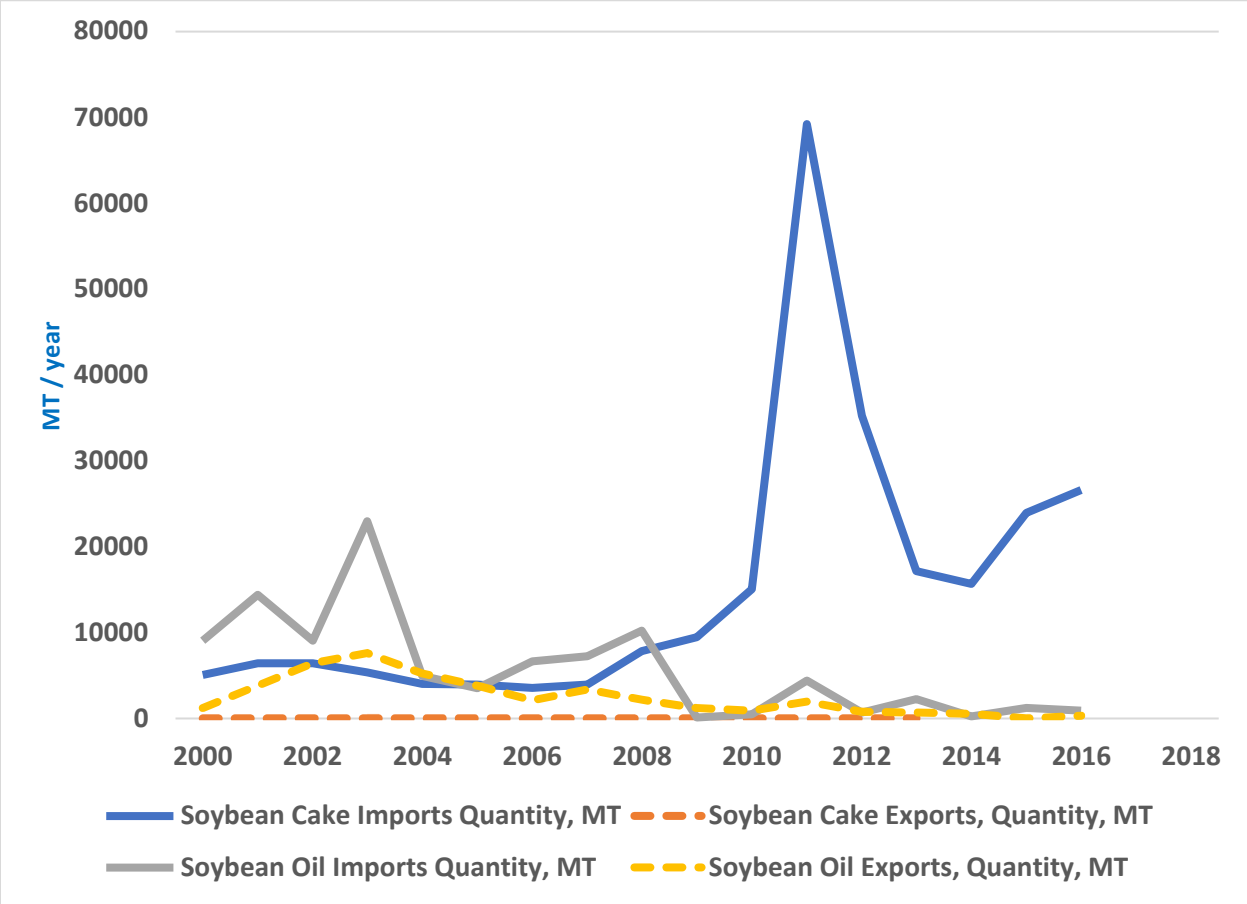

Figure 4. Kenya Soybean Cake and Soybean Oil Imports and Exports, 2000 to 2016

Source: FAOSTAT Database.

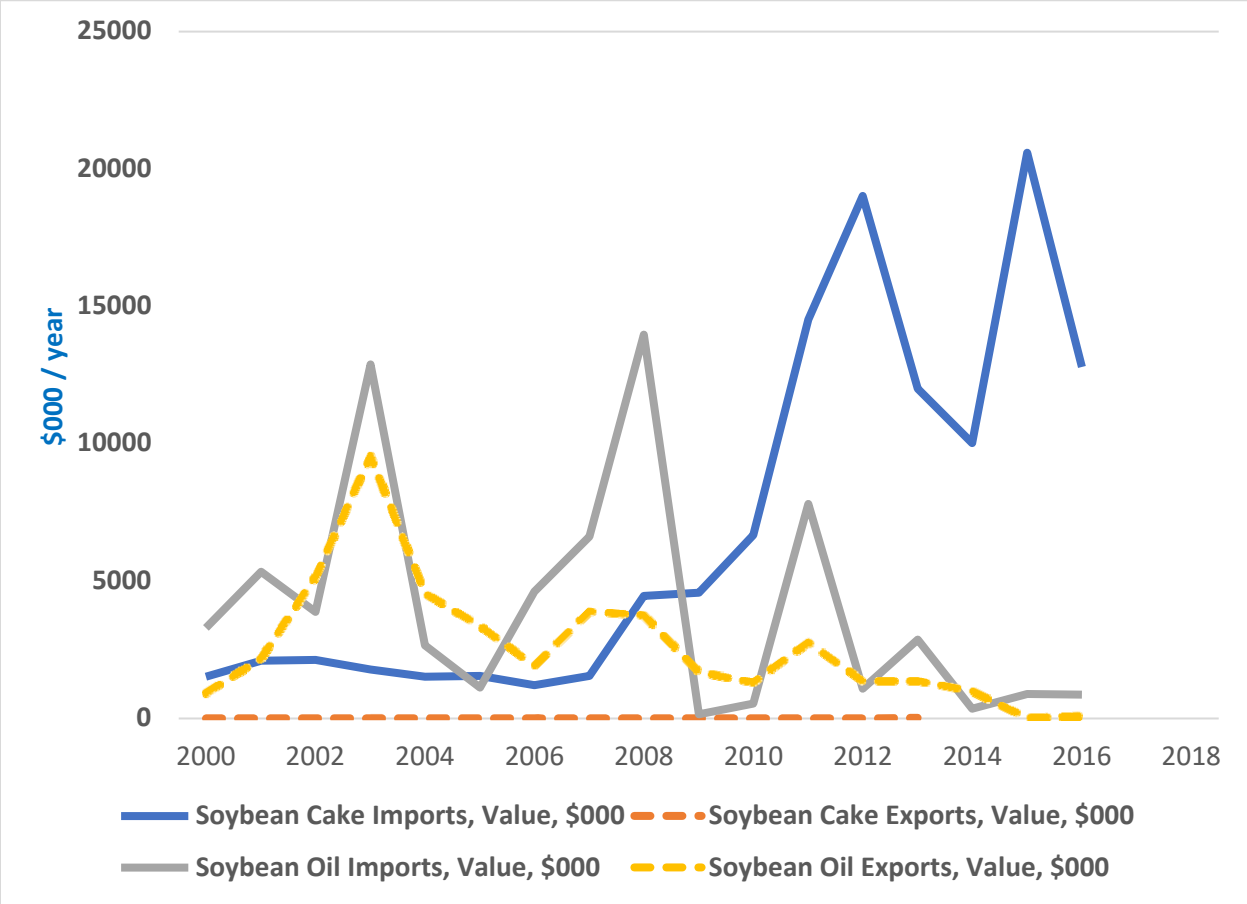

Figure 5. Value of Kenya's Soybean Cake and Soybean Oil Imports and Exports, 2000 to 2017.

Source: FAOSTAT Database.

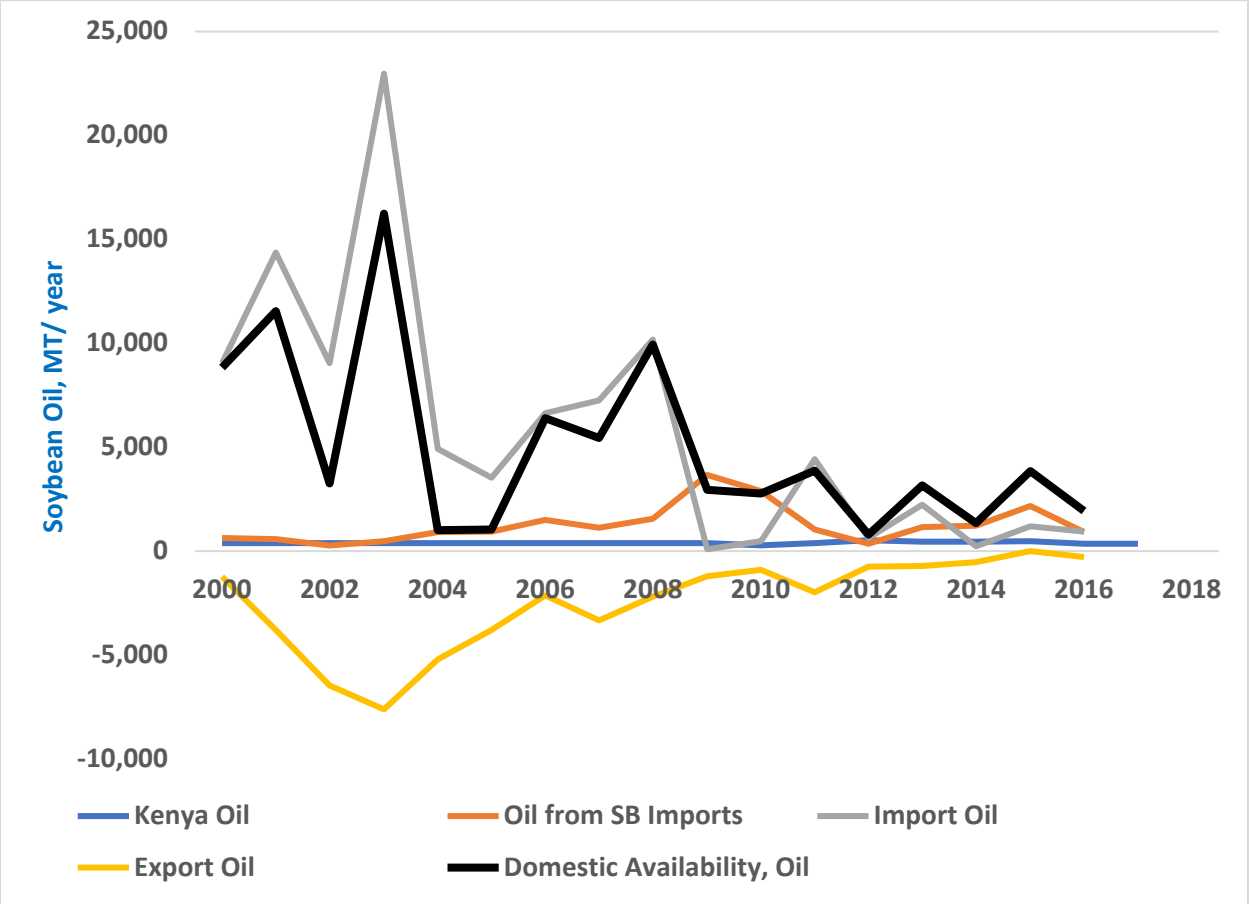

Figure 6. Kenya Soybean Oil Sources and Domestic Availability, 2000 to 2016

Source: Calculated using data from the FAOSTAT Database.

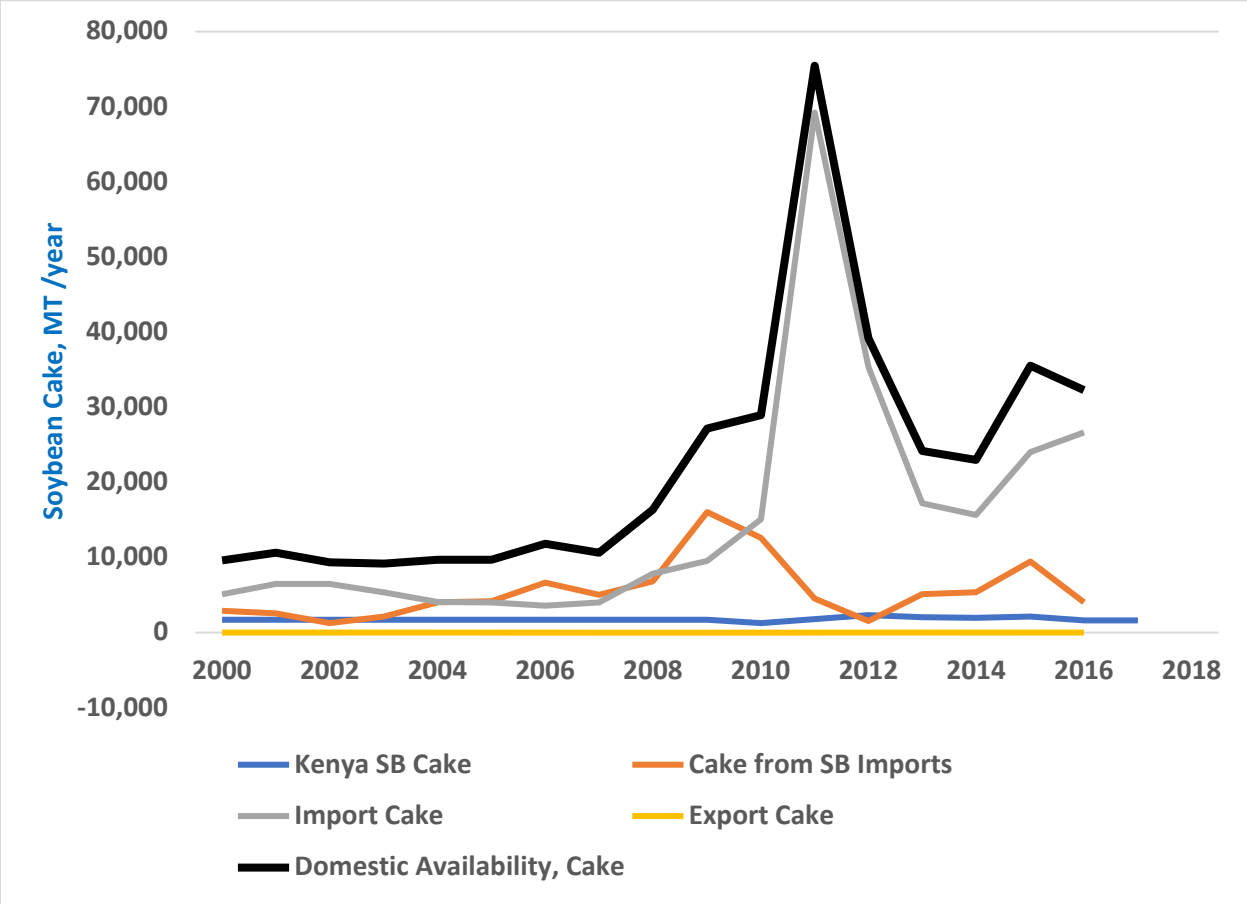

Figure 7. Kenya Soybean Cake Sources and Domestic Availability, 2000 to 2016

Source: Calculated using data from the FAOSTAT Database.

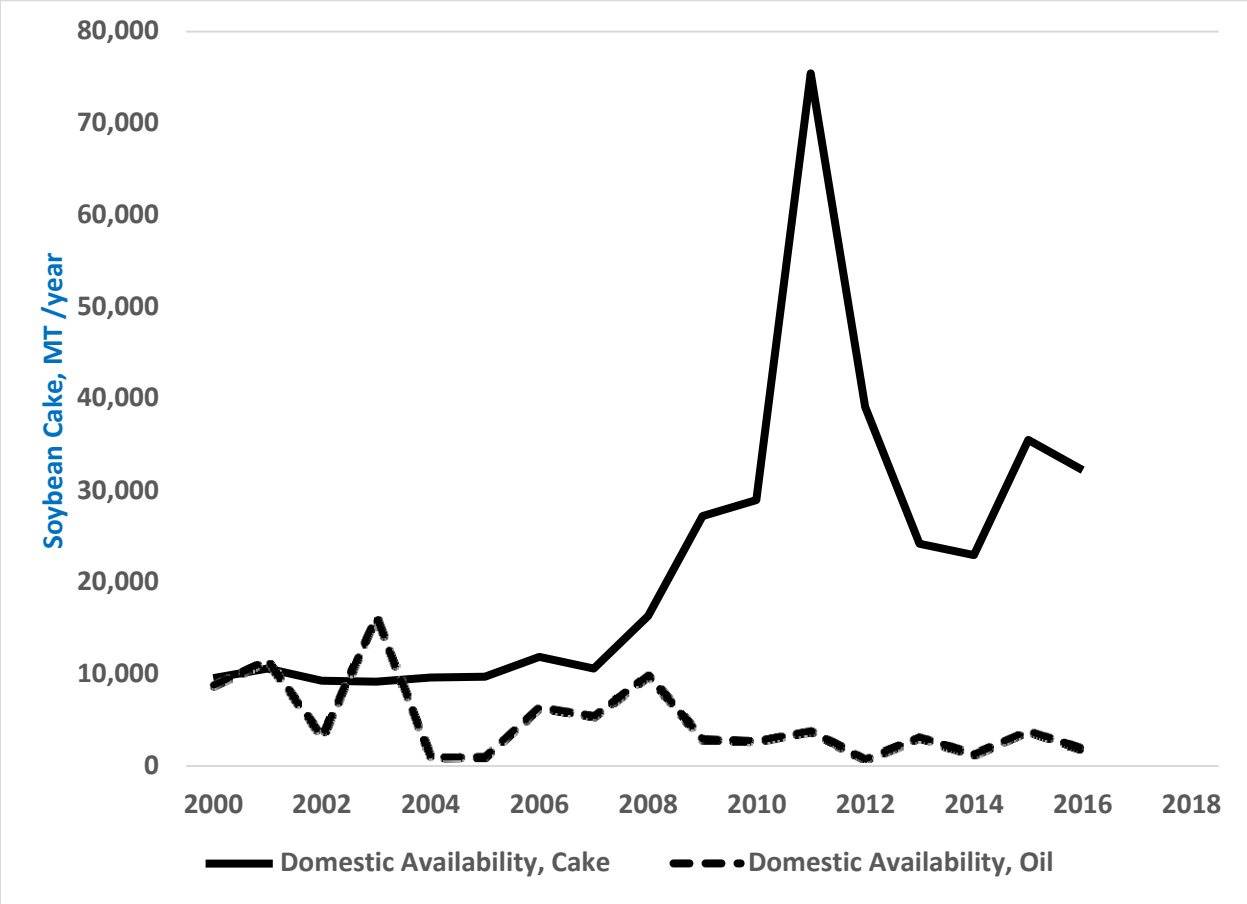

Figure 8. Kenya Domestic Availability of Soybean Cake and Soybean Oil, 2000 to 2016

Source: Calculated using data from the FAOSTAT Database.

Economic Contribution of the Soy Value Chain in Kenya (Objective 2)

The overall economic contribution of the SVC in Kenya comprises the direct, indirect and induced effects of farms, transportation to processing and export, processing and post-processing distribution to end users. This section summarizes the information used to assess the direct and selected indirect contributions of these SVC components. The treatment of each of these components (i.e., as direct or indirect) is described in the more detailed discussion of the economic contribution analysis.

Farm-Level Information

The farm-level assessment is based on production characteristics indicated by farmer focus group discussions in western Kenya (Table 4). These indicate that the average area per farm was about one-third of acre, consistent with the importance of maize production in these cropping systems. Given the relatively small area planted 2015 (and most other recent years) of about 2700 ha, and the relatively small proportion of within-Kenya value for key inputs (e.g., fertilizer) the overall value of input purchases at the farm-level is relatively small. The value of input purchases excluding labor in 2015 is estimated at about $960,000 per year (Table 5), and about 60% of this is associated with fertilizer purchases. Annualized purchases of equipment and machinery (mostly simple tools and spray pumps) and seeds comprise the next largest economic contributions. The total value of Kenyan soybean production in 2015 is estimated as $1.5 million.

Table 4. Farm-level Soybean Production Characteristics

Production Characteristic	Value
Land Use	
Total land cropped, acres	0.78
Soybeans planted, acres	0.31
Soybean harvested, acres	0.31
Land area to maize crop, acres	0.38
Mean Yield, kg/acre	495
Hired labor, hours/acre	158
Revenues from soybean production, KSh/farm	8,508 ($90 USD)

Source: Farmer Focus Group Discussions.

Table 5. Value of Farm-level Input Purchases and Soybean Production in the Kenya SVC

Input Expenditure Category, Other Effects	Value for Soybean[a] (KSh)	Estimated proportion of value within Kenya	Kenya Value for Soybean[b] (KSh)	Kenya Value for Soybean (KSh/MT)[c]	Total Value (KSh)[d]	Total Value (USD)[e]
Fertilizer						
DAP (Diammonium Phosphate)	1,817	64%	1,163	7,516	19,564,744	205,945
NPK	1,817	64%	1,163	7,516	19,564,744	205,945
CAN (Calcium ammonium nitrate)	1,317	64%	843	5,448	14,179,952	149,263
Seeds or plants, from:						
Retailers	400	64%	256	1,655	4,307,834	45,346
Packaging or other materials, from:				0	0	0
Plastic storage bags	144	64%	92	1,655	4,307,834	45,346
Maintenance or Repair Costs for:						
Vehicles, machinery, equipment						
Bicycle	105	100%	105	679	1,766,885	18,599
Rental or leasing costs:						
Vehicles, machinery, equipment						
Spraying equipment	267	100%	267	1,724	4,487,327	47,235
Wheelbarrow	121	100%	121	781	2,033,300	21,403
Communications (mobile, internet)	201	90%	181	1,168	3,040,304	32,003
Contract product storage	265	100%	265	1,711	4,452,483	46,868
Contract transportation services	167	100%	167	1,077	2,804,579	29,522
Machinery and equipment[f]						
Jembe (hoe)	125	50%	63	404	1,051,717	11,071
Gum boots	280	50%	140	905	2,355,846	24,798
Spraying equipment	287	50%	143	927	2,411,938	25,389
Wheelbarrow	122	80%	98	632	1,643,994	17,305
Bicycle	167	20%	33	215	560,916	5,904

Input Expenditure Category, Other Effects	Value for Soybean[a] (KSh)	Estimated proportion of value within Kenya	Kenya Value for Soybean[b] (KSh)	Kenya Value for Soybean (KSh/MT)[c]	Total Value (KSh)[d]	Total Value (USD)[e]
Motorcycle	200	20%	40	259	673,099	7,085
Mobile phone	135	20%	27	175	454,342	4,783
Total, Input Expenditures				**33,388**	**86,910,061**	**914,843**
Increased Maize Yield Effects[g]	788	100%	788	**1,591**	**4,141,136**	**43,591**
Total Value of Soybean Production				**55,000**	**143,165,000**	**1,507,000**

Note: Estimated proportions of value within Kenya were estimated based on cost data from Agrics and other input suppliers, and discussions with soybean processors and traders.

[a] Total value of inputs for soybean production on average harvested area of 0.31 acres per farm.

[b] Total value multiplied by proportion within Kenya, for average harvested area of 0.31 acres per farm.

[c] Kenya value divided by 0.495 (based on average yields of 495 kg / acre).

[d] Kenya value per MT multiplied by total production in 2015 of 2,603MT

[e] Total Kenya value in KSh divided by the average 2015 KSh-USD exchange rate of 95 KSh/USD.

[f] Three-year estimated expenditure totals divided three to calculate annualized values.

[g] Assumes 10% mean yield increase for maize crop due to additional N planted on 0.31 acres planted to soybeans on average maize yield of 1,260 kg/acre, or an additional 39 kg maize per farm at a price of 1,800 KSh/90 kg bag.

Because planting soybeans can have beneficial effects on subsequent maize yields due to N fixation, we also estimated the value of this maize yield effect. Previous studies have indicated that soybeans can provide the equivalent of 44 to 300 kg N per ha. Based on previous studies of the maize yield response to N fertilization (Sheahan et al., 2012; Njoroge et al., 2018; Ichami et al., 2019), which depends on current N soil levels and fertilization practices, we estimated a conservative increase of 10% in maize yields on land previously planted in soybeans. Given the mean value of 0.31 acres of soybeans planted per year (often alternated with maize between the short and long rains), a mean maize yield reported from FGDs of 1,260 kg/acre, this implies an increase of 39 kg of maize per farm, with a value of 788 KSh per farm, or about $44,000 USD total contribution per year. This assumes that the additional N from soybean fixation is not offset by reductions in other fertilization (so that all the soybean N constitutes additional N available for maize).

Farm to Processing Transportation Information

Soybean processors and traders agreed that the cost of transportation services (including assembly) to deliver soybeans from farms to processing locations (mostly in the Nakuru and Nairobi areas) was about 3 KSh/kg ($0.03 USD/kg), or about 3,000 KSh/MT ($32 USD/MT) in trucks transporting 7 to 15 MT per load. Values for soybean imports and (the small volumes of) soybean exports were estimated to be higher due to longer distances and port-related fees, with similar assumptions for imported soybean oil and soybean meal. The total cost for this component is larger than the farm level component (Table 6), about $2.5 million, largely due to the volume soybean and soybean meal imports being many times larger than domestic production volumes.

Table 6. Farm to Processing or Export Transportation Expenditures in the Kenya SVC

Cost Category	Transportation Cost (KSh/MT)[a]	Volume Transported (MT)[b]	Total Cost (KSh)[c]	Total Cost (USD)[d]
Transport of Domestic Production	3,000	2,603	7,809,000	82,200
Transport of Imported Soybeans	6,000	11,835	71,010,000	747,474
Transport of Exported Soybeans	5,000	245	1,225,000	12,895
Transport of Imported Soybean Oil	7,500	1,192	8,940,000	94,105
Transport of Imported Soybean Meal	6,000	23,975	143,850,000	1,514,211
Total, Transportation to Processing or Export		**39,850**	**232,834,000**	**2,450,884**

[a] Estimated based on interviews with soybean processors and traders.
[b] Volumes based on FAOSTAT data.
[c] Transportation cost multiplied by volume transported.
[d] Transportation cost in KSh multiplied by average 2015 exchange rate of 95 KSh/USD.

Soybean Processing Information

Soybean processing in Kenya involves the crushing of beans, and the use of soybean cake and oil in products for animal nutrition and human consumption. Soybean processors and traders were reluctant to provide detailed cost estimates for their operations. Three processors (two in Kenya, one in Tanzania, focused on both animal and human final products) were willing to provide approximate values for their total costs through a margin over soybean acquisition costs. For all three processors total costs for processing were estimated as 1.5 times the soybean purchase price. This value provided an overall estimate of the total direct contribution, but additional disaggregation is needed to implement the economic contribution analysis. In the absence of detailed cost information, we used recent information on soybean processing costs for low-volume US operations to approximate the disaggregated cost categories based on the overall margins indicated by 1.5 times the soybean price[5]. This structure included values for labor (examined separately subsequently) and the value lost in processing (e.g., refining oil results in losses of 3.5% of the volume). When these costs are removed from the calculation, the expenditures for processing—inputs and services purchased from other sectors—is $5.4 million per year (Table 7a).

Investments in new plant and equipment during the past three years are also typically included in computation of the economic contribution. Processors were also reluctant to share information about past or planned investments but indicated that the annualized cost of investments was approximately 5% of the total other costs. This value was used to approximate annual investment costs for the processing component of the SVC in Kenya. This investment component accounted for an additional $270,000 per year, for a total expenditure from processing soybeans approaching $5.7 million (Table 7a).

Imported soybean oil and meal are also important in the Kenyan SVC. We estimated processing costs for packaging, power, supplies and labor based on the previous estimates of unit costs for these items in soybean processing. Imports of soybean oil (1,192 MT in 2015) and soybean meal (23,975 MT in 2015) were multiplied by these unit processing costs to estimate the direct contribution of processing of these imported soybean products. The overall value of the expenditures was $3.6 million, with a much larger share for soybean meal given the much larger import volume for that product (Table 7b).

Soybean Product Distribution Information

Soybean processors and traders were also reluctant to provide detailed information about distribution costs, although they would describe basic components of their distribution networks, often relying on small delivery trucks for local areas (e.g., around Nairobi) and larger shipments for longer-distances coupled with smaller local delivery networks elsewhere in the country. Given the nature of these distribution networks and the much smaller volumes per truck and more frequent deliveries, costs per MT of product were estimated to be about twice that for larger-volume, longer-haul transportation. This approximation was multiplied times

[5] This cost information was provided by an experienced industry consultant with considerable US and international experience.

the total volumes of soybeans processed (production plus imports less exports), soybean oil and soybean meal to calculate expenditures on distribution activities[6], estimated at $5.0 million per year (Table 8).

Table 7a. Soybean Processing Expenditures in the Kenya SVC

Input Expenditure Category	KSh/MT	USD/MT	Total, KSh	Total, USD
Packaging	1,485	15.63	21,076,605	221,859
Maintenance and repair for vehicles, machinery and equipment	34	0.36	485,828	5,114
Insurance	3	0.03	46,269	487
Communications (mobile, internet)	2	0.02	23,135	244
Electricity	5,849	61.57	83,018,050	873,874
Steam (NG)	13,787	145.13	195,685,403	2,059,846
Labor	5,151	54.22	73,105,579	769,532
Product Loss in processing	33,060	348.00	469,226,772	4,939,229
Chemicals and other raw materials	14,879	156.62	211,173,331	2,222,877
Miscellaneous	7	0.08	101,793	1,072
Depreciation	21	0.22	300,751	3,166
Total	**74,279**	**781.89**	**1,054,243,517**	**11,097,300**
Total without labor, product loss, depreciation				**5,385,373**
Annual investment in plant & equipment[a]				**269,269**
Total				**5,654,641**

Note: Values based on margins (markup) of soybean products from soybean value to total costs in terms of soybean equivalents according to soybean processors. Cost proportions for low-volume US soybean processing facilities applied to margin values to determine cost categories.

[a] Estimated based on interviews with soybean processors and traders as approximately 5% of other cost, roughly aligned with a 20-year time horizon.

[6] Note that this does not include activities associated with product retailing (for humans), for additional mixing and blending of animal feeds (for those operations doing these for themselves) or the value of animal production.

Table 7b. Soybean Oil and Meal Processing Expenditures in the Kenya SVC

Input Expenditure Category	KSh/MT	USD/MT	Total, KSh	Total, USD
Soybean Oil				
Packaging	1,484	15.63	1,770,120	18,633
Power	5,868	61.77	6,994,682	73,628
Chemicals and Raw Materials	4,499	47.36	5,362,590	56,448
Labor	1,565	16.47	1,865,249	19,634
Subtotal, soybean oil	13,417	141.23	15,992,641	168,344
Soybean Meal				
Packaging	1,484	15.63	35,602,875	374,767
Power	5,868	61.77	140,685,829	1,480,903
Chemicals and Raw Materials	4,499	47.36	107,859,135	1,135,359
Labor	1,565	16.47	37,516,221	394,908
Subtotal, soybean meal	13,417	141.23	321,664,060	3,385,937
Total			**337,656,701**	**3,554,281**

Note: Values based on components of soybean processing costs relevant for oil and meal, with costs estimated as described in Table 7a. Soybean oil imports in 2015 were 1,192 MT and soybean meal imports were 23,975 MT.

Table 8. Distribution of Soybean Products Expenditures in the Kenya SVC

Cost Category	Distributions Cost (KSh/MT)[a]	Volume Transported (MT)[b]	Total Cost (KSh)[c]	Total Cost (USD)[d]
Distribution to Domestic Markets	12,000	39,360	472,320,000	4,971,789
Total, Distribution		**39,360**	**472,320,000**	**4,971,789**

[a] Estimated based on interviews with soybean processors and traders.
[b] Volume transported includes soybeans, oil and meal based on FAOSTAT data (Production + imports – exports).
[c] Transportation cost multiplied by volume transported.
[d] Transportation cost in KSh multiplied by average 2015 exchange rate of 95 KSh/USD.

Overall Expenditures the Kenyan SVC

Overall the estimated total expenditures of the SVC in Kenya are nearly $19.1 million per year (Table 9), including the value of soybean production, transportation, processing and distribution. About half of this expenditure arises in processing, with an additional 40% from inbound transportation to processing and post-processing distribution activities. Only about 8% is the value of Kenya soybean production, due to the importance of imports and the proportion of value for farm inputs that occurs within Kenya. Variations during the past decade in both production and imports (both soybeans and soybean products) have been reasonably large, which would affect the overall estimated magnitude of expenditures. However, 2015 seems similar in many ways to other years between 2010 and 2017 (other than the rather anomalous year 2011 with very high imports). Thus, 2015 appears to be reasonably representative of the magnitudes of impacts in recent years[7].

Table 9. Total Expenditures in the Kenya SVC

Cost Category	Total Expenditures (KSh)	Total Expenditures (USD)[a]
Farm-level inputs (excluding labor)	91,051,198	958,434
Value of soybean production[b]	143,165,000	1,507,000
Transportation to processing or export	232,834,000	2,450,884
Processing of soybeans	537,190,895	5,654,641
Processing of imported soybean oil and meal	337,656,701	3,554,281
Distribution to domestic markets	472,320,000	4,971,789
Total, Transportation to Processing or Export	**1,814,217,794**	**19,097,029**

[a] Total direct contribution in KSh multiplied by average 2015 exchange rate of 95 KSh/USD.
[b] Total value of soybeans is 2,603 MT produced in 2015 times a price of 5500 KSh per MT.

Employment Generation

The employment generated by SVC activities in Kenya is also of interest—but is more challenging to quantify, other than for hired labor by farmers. We attempt to approximate the number of full-time equivalents (FTE) of employment using values for costs and hourly wages. At the farm level, FDGs indicated that each farm employed labor for many of the production stages, with a total of 319 hours per MT of production. (This value does not include family labor, for which we did not collect data.) The average working week in Kenya is often 45 hours, with an annual equivalent of 2,250 hours per year (50 weeks times 45). Wages for agricultural labor averaged about 55 KSh/hour ($0.58 USD/hour) for all farming activities based on

[7] Although it may appear that there exists an inconsistency between the use of 2015 production and import data to aggregate farm production and processing expenditures and the 2014-based SAM used to calculate direct and indirect effects, this is quite likely not the case. Data from 2015 were initially chosen to match with the 2015 EORA IO matrix. The mismatch between data years and IO/SAM tables is really only an issue if the structure of Kenyan industries has changed appreciably between 2014 and 2015. The output of the IO/SAM is the relative exchanges of dollar flows, not the levels.

information from the FGD. This suggests 372 FTE positions in soybean farming (Table 10)—although the actual number of hired laborers, who thus benefit from soybean production—is likely to be substantively larger.

Labor requirements for transportation are difficult to estimate. We assumed an average shipment size inbound of 4 MT from farm to processing, which reflects the diversity of vehicles used for inbound transportation. If an average shipment size is 4 MT and the total volume shipped from farms to processing or export is 14,683 MT (based on FAO data), this implies about 3,670 trips. We assumed that FTE trips would be 200 (to account for the lack of a backhaul opportunity in about half of the cases), which would imply about 18 FTE positions (Table 10)—again, the actual number of employees involved is likely to be much larger as few would be employed exclusively for soybean transportation. A similar approach was applied to estimate FTE for imported soybean oil and meal. Given that labor costs are often the largest component of transportation costs, we assumed that 50% of direct costs were for estimated wages. We used a similar approach to estimate employment in distribution, with much smaller per-shipment volumes, and the total volume of product shipped (39,360 MT) including soybeans, soybean oil and soybean meal.

We estimated the employees in processing using the estimated total labor expenditures divided by the 2015 minimum wage value for labor of a comparable skill level to that used in soybean processing. The calculation used the average of minimum wage values for Nairobi and the remainder of the country in 2015, 88 KSh/hour ($0.98 USD/hour).

Although our estimates of FTE employment and wages paid are approximations, they suggest the substantive value of the SVC in Kenya: nearly 1,800 FTE positions and $5.4 million in wages.

Table 10. Estimated Employment Generation of the Kenya SVC

Cost Category	Estimated Employment, FTE	Estimated Wages Paid, USD/Year
Farm-level[a]	372	477,471
Transportation to processing or export[b]	50	1,225,442
Processing[c]	564	1,184,074
Distribution to domestic markets[d]	787	2,485,895
Total	**1,772**	**5,370,344**

[a] Based on 319 hours of hired labor per MT times 2603 MT produced in 2015, divided by FTE of 2250 hours per year. Value is total hours times estimated average wage of 54 KSh/hour for agricultural labor from focus group discussions. Also includes 2 FTE due to increased maize yields.

[b] FTE based on 2,602 MT soybeans, 1,192 MT soybean oil and 23,975 MT soybean meal transported per year with 4 MT per trip, with 200 trips per year equal to 1 FTE. Value assumes 50% of transportation cost is labor. This is treated as an indirect effect.

[c] Based on total estimated labor cost for processing soybeans, imported oil and imported meal divided by average minimum wage of 88.65 KSh/hr for machine attendants applicable in mid-2015 based on information from https://africapay.org/kenya/salary/minimum-wages/archive/minimum-wages-in-kenya-with-effect-from-01-05-2013, assuming a 45-hour week for 50 weeks per year.

[d] FTE based on 39,360 MT of oil and meal transported per year with 0.25 MT per trip, with 200 trips per year equal to 1 FTE. Value assumes 50% of transportation cost is labor.

Indirect and Induced Effects and Multiplier Values

Production Functions

The constructed production functions for soybean farming and soybean processing indicate the intermediate inputs and value-added factors (Tables 11 and 12). By definition, the sum of intermediate input purchases and value-added factors equals total output; i.e., every dollar of sales is allocated. Purchases from retailers (i.e., for capital and intermediate input purchases) were margined to include the local trade and transport components commodities, as well to input commodities themselves as local and imported values. Capital commodity input values are excluded from the production function by convention. The tables also show the gross absorption coefficient for each input purchase and factor outlay and interpreted as the input or factor requirement per dollar of output. Finally, local purchase percentages (LPPs) are included and reflect the amount of purchases or outlays to local sectors. Estimates from primary data were included where they existed, where not, average industry values in the Kenyan SAM were applied.

For soybean farming, the production function was constructed to include nine input purchase and four value-added categories. Maintenance and repair, equipment rental, and contract storage from the primary data are mapped to the other services commodity (c_osrv) in the Kenyan SAM. The soybeans commodity (c_sb) was created and added to the SAM as discussed above. For intermediate inputs, this represents soybeans (i.e., seed) for planting. The labor factor represents payments to employees, while the remaining factors represent returns to the owners of the factors of land (irrigated and non-irrigated) and capital. The sum of intermediate input purchases and labor payments exceeded the value of total farm output (sales) based on the assumed average value of the farm-level soybean price, so a negative return of $253,873 was applied to the remaining factors, in distribution to the same distribution of the industry from which they were extracted from in the original SAM. Although negative returns are not sustainable in the long run, for the year investigated (2015), this was the result and were applied as estimated. Negative returns to factors in the customized SAM imply a reduction in the induced effects for the soybean production sector to the degree those translate back to households (rather than corporations) and are spent.

For soybean processing, the production function was constructed to include eleven input purchase and two value-added categories. As with farming, maintenance and repair and equipment rental are mapped to the other services commodity (c_osrv) in the Kenyan SAM. Soybean commodity purchases (c_sb) represent both domestic production ($1,365,158) and imported soybeans ($6,710,000), while soybean oil (c_sbp) and soybean meal (c_sbp) purchases are included as processed soybean commodities that were fully imported. The labor factor represents payments to employees for processing activities and for distribution of manufactured soybean products. After subtracting intermediate input purchases and labor payments from total output, $12,194,472 remained as an outlay to the owners of capital (nonagricultural), consistent with other food processing industries in the Kenyan SAM. These

returns increase the induced effects of the soybean processing industry to the degree that they translate back to Kenyan households and are spent.

Table 11. Production Function for Soybean Farming in Kenya[a]

Intermediate inputs	Model code[b]	Input cost or factor allocation ($)	Gross absorption coefficient [c]	Local purchase percentage
Soybeans (seed)	c_sb	48,180	0.032	47
Fertilizer: CAN	c_ferN	121,276	0.080	31
Fertilizer: DAP	c_ferP	167,330	0.111	31
Fertilizer: NPK	c_ferK	167,330	0.111	31
Plastic bags	c_oman	13,308	0.009	31
Trade (wholesale & retail)	c_trad	210,645	0.140	100
Transportation	c_tran	369,076	0.245	100
Maintenance & Repair	c_osrv	18,599	0.012	100
Equipment rental	c_osrv	68,638	0.046	100
Contract storage	c_osrv	46,868	0.031	100
Communications	c_comm	41,936	0.028	81
Sub-total		**1,285,940**	**0.853**	**72**
Value added factors: [d]				
Labor factor	flb	474,933	0.315	100
Land factor – irrigated	fland_irr	-10,155	-0.007	100
Land factor – nonirrigated	fland_nirr	-203,099	-0.135	100
Capital factor, agricultural	fcp_ag	-40,620	-0.027	100
Subtotal		**221,060**	**0.147**	**100**
Total	**a_sb**	**1,507,000**	**1.000**	**76**

[a] The production function is fully margined, whereby trade and transport margins are applied for intermediate input and capital purchases, where applicable. Capital product values are excluded. Individual trade and transport margins are summed across inputs(c_trad, c_tran)

[b] Model codes follow Mainar Causape et al. (2018) but for the author-created soybean production (c_sb, a_sb) and soybean processing (c_sbp, a_sbp) commodities and industries (or activities).

[c] Gross absorption coefficients (GACs) are computed as the total cost (or factor allocation) divided by total output.

[d] Residual returns (post labor) were distributed based on the distribution for the farm food production industry in Mainar Causape et al. (2018); i.e., to land (irrigated and nonirrigated) and agricultural capital factors.

Table 12. Production Function for Soybean Processing in Kenya[a]

Intermediate inputs	Model code[b]	Input cost or factor allocation ($)	Gross absorption coefficient [c]	Local purchase percentage
Soybeans	c_sb	8,075,158	0.167	17
Soybean Oil	c_sbp	126,519	0.003	0
Soybean Meal	c_spb	11,104,211	0.223	0
Petroleum	c_petr	3,399,916	0.070	59
Electricity	c_elec	1,336,926	0.028	100
Chemicals	c_chem	3,414,685	0.070	74
Other manufactured products	c_oman	616,330	0.013	41
Trade (wholesale & retail)	c_trad	994,358	0.020	100
Transportation	c_tran	2,437,999	0.050	100
Maintenance and repair	c_osrv	1,248,061	0.026	100
Equipment rental	c_osrv	68,638	0.046	100
Financial services	c_fsrv	487	0.000	100
Communications	c_comm	244	0.000	100
Sub-total		**32,754,884**	**0.674**	**37**
Value added factors: [d]				
Labor factor	flb	3,669,969	0.075	100
Capital factor, non-agricultural	fcp_na	12,194,472	0.251	100
Subtotal		**15,864,441**	**0.326**	**100**
Total	**a_sbp**	**48,619,325**	**1.000**	**58**

[a] The production function is fully margined, whereby trade and transport margins are applied for intermediate input and capital purchases, where applicable. Capital product values are excluded. Individual trade and transport margins are summed across inputs (c_trad, c_tran).

[b] Model codes follow Mainar Causape et al. (2018) but for the author-created soybean production (c_sb, a_sb) and soybean processing (c_sbp, a_sbp) commodities and industries (or activities).

[c] Gross absorption coefficients (GACs) are computed as the total cost (or factor allocation) divided by total output.

[d] Residual returns to factors (post labor) were distributed based on the distributions for food processing industries in Mainar Causape et al. (2018); i.e., the nonagricultural capital factor.

Contribution Analysis

Our approach to assessing the soybean value chain's effects is through an *economic contribution analysis*. A contribution analysis for an industry (or collection of industries) describes that portion of an economy that can be attributed to the *existing* industry (or industries) by using data internal to the underlying SAM to identify all backward linkages in the study area. This is different than an *economic impact analysis* that considers marginal changes in deliveries to final demand induced by public or private initiatives to increase investments in an industry. In a contribution analysis, existing total output, not just final demand, provides the initial (direct) effects of the analysis and, when compared to the entire economy, the results

provide insight into the relative extent of the industry in the economy and the strength of its backward linkages.

The direct effects of the soybean value chain in Kenya in (Table 13). The value of soybean production (farming) output was estimated at $1,507,000, requiring 369.3 FTE jobs and $474,933 in labor compensation (Table 1). As discussed above (Table 11), total value-added allocations (including labor compensation) were lower ($221,060) due to negative returns to other factors. The nitrogen fixation capability of soybean production also has a yield affect to the next crop, here assumed as maize. The value of the yield boost, using maize prices, was estimated at $43,591. The associated jobs effect was computed by using the ratio of total jobs in that sector from ILO (2014) to total output for that sector in the SAM. Labor compensation and total value added were similarly computed based on the factor allocations in the SAM.

Table 13. Direct Effects for the Soybean Value Chain in Kenya

Industry	Model code[b]	Output ($)	Jobs (FTE)	Labor Comp-ensation ($)	Total Value Added ($)
Soybean Production[a]	a_sb	1,507,000	369.3	474,933	221,060
Other Crop Production[b]	a_ahf	43,591	2.2	2,973	29,375
Soybean Processing[c]	a_sbp	48,619,325	1,351.2	3,669,969	15,864,441
Soybean Value Chain[d]		50,169,916	1,722.7	4,147,876	16,114,876

[a] Soybean farming includes contractual transportation services for soybean exports to ports; i.e., the costs are included as part of c_tran in Table 1.

[b] Other crop production is estimated at the yield benefit for N-fixation associated with the maize crop.

[c] Soybean processing includes direct jobs (FTE), labor compensations, and total value added for processing activities and for distribution of manufactured soybean products. Contractual transportation services are applied for transport of domestic soybean production and imports of soybeans, soybean oil, and soybean meal to processors; i.e., the costs are included as part of c_tran in Table 2.

[d] Direct effects of the soybean value chain are additive across individual components. The indirect and induced effects presented later are not.

Total output in soybean processing was valued at $48,619,325, including 1351.2 FTE jobs (564.0 in processing and 787.2 in distribution of finished products), $3,669,969 in labor compensation ($1,184,074 in processing and $2,485,895 in distribution), and $15,864,441 in total value added.

The contribution analysis conducted here generally follows the methods outlined in Schmit (2016), albeit conducted in Excel and with some particularities of the industry activities constructed from primary data. In particular, two steps are required before applying the direct effects to the multiplier matrix. First, we must account for intra-industry purchases. In the case of soybean production, this largely concerns the purchases by farmers for soybeans as seed to produce soybeans as a crop. Since the industry both purchases and sells the soybean commodity, we adjust the direct output effect by the relative value of those industry purchases.

Specifically, this entails dividing total industry output by the diagonal coefficient in the multipliers matrix associated with the soybean production industry (in our case, 1.0059). The same procedure is applied for other crop production (again, relevant for seed purchases) and soybean processing (relevant to other processed soybean products purchased and used in further processing). Doing so prevents the production of output in production and processing beyond existing total output (Table 13).

The second step involves the estimation of the economic contribution for the multiple-industry, soybean value chain. Here, part of the intermediate inputs for processing include the purchase of soybeans from the local production sector. Including the full direct output effects of both production and processing in Table 3 double counts the soybeans originating at the farm level (i.e., since they are sold at the farm level and purchased at the processing level). Accordingly, in the value chain computation, we include the full direct output effect of soybean processing but exclude from the farm direct output effect that portion of production sold to local processors ($1,365,158). In this way, only the exported value of soybeans at the farm level ($141,842), even though all farm output is accounted for. Step one above then follows on the exported value of soybeans; i.e., adjusted by intra-industry coefficient of the soybean production sector.

Given the adjustments described above, the direct and indirect effects reported in a contribution analysis have slightly different interpretations than those for a traditional impact analysis. Specifically, the direct effects (with respect to output) represent all sales by the industries of interest (in our case, the soybean value chain). Total gross output is used as the direct effect, including final demand and the indirect and induced effects associated with that final demand. The indirect effects represent all sales by the backward-linked supply chain industries. In other words, all indirect purchases in upstream sectors outside of the soybean value chain industries considered in the direct effect. The induced effects (by households) have their common interpretation; i.e., additional industry sales due to consumption out of income.

Given that we present economic contribution results of the production and processing sectors in isolation and combined (i.e., the value chain), careful interpretation of the results is necessary. In particular, part of the indirect effects shown for the soybean processing sector in isolation includes the direct and indirect effects generated at the farm level. In this way, as constructed, the direct effects are additive across individual value chain components; however, to avoid double counting, the indirect and induced effects are not.

Economic Contribution Results

The economic contribution of the soybean value chain on total industrial sales in Kenya was estimated to be $78.4 million in 2015 (Table 14). The $50.2 million of direct contributions (total gross output) support an additional $12.1 million and $16.1 million in indirect and induced industry sales, respectively, through non-soybean value chain firm industry linkages. The individual value chain industry contributions (i.e., for farm production and soybean processing) are also shown in Table 14. Because the yield contribution for maize from soybeans (i.e., N fixation) occurs that the farm level, we have included those contributions with the soybean

production contribution for an aggregate "Production" contribution. Here, $1,550,591 of direct output contributions produces another $1.3 and 1.0 million in indirect and induced contributions, respectively.

Table 14. Total Economic Contribution of the Soybean Value Chain in Kenya

Sector	Direct Effect	Indirect Effect	Induced Effect	Total Effect	Contribution Multiplier
Output ($)					
Production	1,550,591	1,300,193	952,707	3,803,491	2.453
Processing	48,619,325	13,323,313	16,020,262	77,962,899	1.604
Value Chain	**50,169,916**	**12,085,528**	**16,133,196**	**78,388,640**	**1.562**
Employee Compensation ($)					
Production	477,907	219,429	134,787	832,122	1.741
Processing	3,669,969	3,697,045	2,512,445	9,879,460	2.692
Value Chain	**4,147,876**	**3,297,772**	**2,531,070**	**9,976,719**	**2.405**
Total Value Added ($)					
Production	250,435	709,228	546,908	1,506,572	6.016
Processing	15,864,441	6,470,754	9,215,662	31,550,857	1.989
Value Chain	**16,114,876**	**6,339,698**	**9,279,691**	**31,734,265**	**1.969**
Employment (FTE Jobs)					
Production	371.5	105.1	46.3	523.0	1.408
Processing	1,351.2	1,168.5	518.8	3,038.5	2.249
Value Chain	**1,722.7**	**842.2**	**794.1**	**3,359.0**	**1.950**

Processing contributions are similarly interpreted. However, recall that whereas the direct contributions across industry segments are additive (i.e., for the direct effects, individual values sum to the value chain total direct effect), the same is not true for the indirect and induced impacts. For example, when looking at the soybean processing industry in isolation, a portion of the $13.3 and $16.0 million in indirect and induced output, respectively, includes backward-linkages to the soybean production industry through processor purchases of soybeans from domestic production (Table 14). Thus, when looking at the composite value chain, those indirect effects for processors are already accounted for in the direct effects for farming. Simply summing the individual indirect and induced impacts across the individual components would result in double counting.

The contribution output multiplier for the soybean value chain in Kenya (i.e., the sum of the direct, indirect, and induced effects divided by the direct effect) is 1.562, meaning that for every dollar generated in the soybean value chain (broadly speaking), $0.562 is generated in backward

linked (non-soybean) industries (Table 14). Decomposing the multiplier effect into its indirect and induced components, the indirect effect is 0.241 (from business-to-business activity) and the induced effect is 0.321 (from household income spending). Individual component contributions and multipliers vary based on the type of spending, to what industries, and to the degree that spending is local (within Kenya).

Total employment contributions are estimated at 3,359 full-time equivalent (FTE) jobs, 1,723 through direct employment, and an additional 1,636 through non-soybean indirect and induced industry effects (Table 14). As with industry output, the majority of indirect and induced jobs are generated by soybean processing. Indeed, the soybean processing industry has an employment multiplier that exceeds two, and well above soybean farming (1.4085). That said, part of soybean processing's employment multipliers includes that the linkage to domestic soybean production. Should a higher contribution of soybean purchases come from local sources, as opposed to imports, that multiplier would be even higher. In total, for every FTE job generated by the soybean value chain, another 0.950 jobs are supported in backward-linked non-soybean industry sectors.

Employee compensation contributions generally align with employment, but to the degree that compensation levels differ across industries. Here, total economic contributions amount to nearly $10.0 million in compensation and originating from $4.1 million in soybean industry labor payments (Table 14). Employee compensation multipliers are arguably a better measure of contributions than jobs, as they are associated with labor payments spent (or saved) by households. In any event, every dollar in employee compensation contributes to the generation of an additional $1.405 in backward-linked non-soybean industries. Notably, the compensation multiplier for processing is higher than that for soybean production given (1) the contribution from backward-linked soybean production (in the indirect effect) and (2) a much lower level of employee compensation per dollar of output of 0.075 relative to soybean production of 0.308 (reducing the relative direct effect).

Finally, consider total value added, equivalent to contributions to Gross Domestic Product (GDP). The entire soybean industry generates $16.1 million in direct total value added and expands to over $31.7 million when all backward linkages are considered. The overall multiplier is 1.969, which indicates that for every additional dollar of GDP generated in the soybean industry, $0.969 of GDP is generated elsewhere in the Kenyan economy. The multiplier effect is weighted slightly more towards induced (0.575) than indirect effects (0.394) relative to that exhibited for output, and consistent with relatively high returns to owners of capital exhibited for soybean processing that are transferred (a significant portion thereof) to households. The large multiplier for soybean production (i.e., 6.016) is largely an artifact of the negative return to factors other than labor and, for all practical purposes, even though correct, can be ignored. The total effect includes total value-added contributions from all industries for which backward linkages accrue (i.e., in the numerator), however, the direct effect is reduced due to the negative returns (i.e., in the denominator). A reasonable return to other factors in the long run would suggest a multiplier of around two.

Economic Contribution Impact of Selected Soybean Value Chain Outcomes (Objective 3)

Changes were made to the elements of the SAM to assess the impact of selected soybean value chain development outcomes, including increased domestic production, increased processing changes in transportation of domestic and imported soybeans, meal and oil, and increases in broiler production. As noted above, these assessments suggest the potential per-year impact on the economic contribution of the Kenyan SVC from investments to achieve these outcomes. The costs and feasibility of achieving these objectives are beyond the scope of this analysis but merit careful consideration in subsequent analyses. These scenarios were selected to highlight the impact of achievement of alternative SVC development outcomes of interest to potential pubic and private SVC investors.

Scenario Descriptions

***Scenario 1a:* 4X increase in farm production of soybeans in Kenya, assuming expanded output as sales to local processors, corresponding reduction of soybean imports and NO Maize acreage offsets.**

This scenario assumes expansion of soybean planting from 2,761 ha (reported by FAO for 2015) to 11,044, with average yields per ha unchanged. This would result in an increase in production from 2,603 MT to 10,412 MT, and a reduction in soybean imports equal to the amount of the production increase. The total quantity of soybeans processed in Kenya would be the same, so this scenario examines the impact of increased farm production of soybeans. In this case, no offset of decreased maize plantings is included in the analysis although in principle this could be important (and is thus assessed in scenario 1b). There is increased transportation of Kenya-produced soybeans and reduced transportation of imported soybeans.

The specific changes to the SAM calculations for this scenario are:

- Increase farm soybean output $1,507,000 to $6,028,000 (Change = $4,521,000). Sales to soybean processors = $5,886,158 (Change = $4,521,000), Sales to export = $141,842 (Change = $0)
- Farm production function coefficients unchanged, but for a minor change on *c_tran* since exports and transport of them do not change, while everything else is scaled by 4.
- Reduce soybean imports by soybean processors by same amount of expanded farm sales to soybean processors (Total soybean processor output unchanged).
    - Account for changes in transport cost rates by type (transport of local soybeans = $0.06 per $1 of soybeans, transport of imported soybeans = $0.11 per $1 of soybean).
    - Current *c_tran* for processing = $2,437,989 ($82,200 local soybeans to processing, $747,474 soybean imports to processing, $94,105 soybean oil imports to processing, and $1,514,211 soybean meal imports to processing)
    - New *c_tran* for proc = 2,206,586 ($353,169 local SB to Proc, $243,848 soybean imports to processing, $94,105 soybean oil imports to processing, and $1,514,211 soybean meal imports to processing)

Scenario 1b: **4X increase in farm production of soybeans in Kenya, assuming expanded output as sales to local processors, corresponding reduction of soybean imports and <u>WITH Maize acreage offsets</u>.**

This scenario is identical to the one above except that includes a reduction in maize output as a consequence of expanding soybean plantings. For this scenario, we assumed that each additional acre of soybeans planted would require a reduction in maize planting, and thus an offsetting effect of the value of maize production. Consistent with our previous analysis, we assumed that maize planted after the soybean crop would have increased yields, so only 90% of the maize yield was considered as an offset. We used the maize yields reported by farmer focus groups for the short rains crop or the long rains crop without fertilizer (360 lbs / acre) given that these are the most likely point for substitution given their lower opportunity cost in terms of maize yield foregone. The maize price was assumed to be 27.8 KSh/kg ($0.31 USD/kg) based on the average of 2500 KSh/90 lbs ($28 USD/90 lbs) across selling times reported by the farmer focus groups. This results in a maize value offset of just under $1 million (but an increase in the value of farm production of soybeans of $4.5 million).

The specific changes to the SAM calculations for this scenario are:

- Increase farm soybean output $1,507,000 to $6,028,000 (Change = $4,521,000). Sales to soybean processors = $5,886,158 (Change = $4,521,000), Sales to export = $141,842 (Change = $0)
- Farm production function coefficients unchanged, but for a minor change on *c_tran* since exports and transport of them do not change, while everything else is scaled by 4.
- Reduce soybean imports by soybean processors by same amount of expanded farm sales to soybean processors (Total soybean processor output unchanged).
    - Account for changes in transport cost rates by type (transport of local soybeans = $0.06 per $1 of soybeans, transport of imported soybeans = $0.11 per $1 of soybean).
    - Current *c_tran* for processing = $2,437,989 ($82,200 local soybeans to processing, $747,474 soybean imports to processing, $94,105 soybean oil imports to processing, and $1,514,211 soybean meal imports to processing)
    - New *c_tran* for proc = 2,206,586 ($353,169 local soybean to Proc, $243,848 soybean imports to processing, $94,105 soybean oil imports to processing, and $1,514,211 soybean meal imports to processing)
- Reduce maize output value by $965,000. Still retain maize yield boost from soybean production but less the negative acreage shock of maize. No change to production function coefficient for maize.

Scenario 2: Reduce soybean oil imports to zero, the difference made up from expanded local soybean production

Kenya imported significant quantities of soybeans, soybean oil and soybean meal in 2015 relative to domestic production and processing volumes. This scenario assesses the impact of

increased domestic production of soybeans to substitute for imports of soybean oil and soybean meal. It thus complements the scenarios 1a and 1b, which examine the impact of substituting local production of soybeans for imported soybeans. Kenya imported 1,192 MT of soybean oil in 2015, and this is assumed in this scenario to be reduced to 0 and the oil replaced by additional production and processing of soybeans in Kenya. Thus, there would be additional soybean production (2.4 times 2015 production amount), additional soybean processing (production of oil and meal), additional transportation from the farm to processing, and reduced transportation of imports of oil and soybean meal. This scenario also reduces the amount of imported soybean meal by the yield of meal assumed per unit of additional soybeans processed.

The specific changes to the SAM calculations for this scenario are:

- Reduce soybean oil imports to zero. $126,519 to $0, 1192 MT to 0 MT
- Based on 60 lbs of soybean yields 11 lbs soybean oil and 47 lbs soybean meal, this implies purchasing 6,502 MT of soybean more from local producers (to make up for the soybean oil gap); i.e., increase soybean production output and sales to processors by $3,686,634
- Assume no maize acreage offset, comparable with Scenario 1a.
- The extra soybean procured locally also means less imported soybean meal, by 5093 MT or less $2,358,059
- Leave (whole) soybean imports unchanged.
- Assume labor requirements and costs in plant are unchanged with change in product source allocations of soybean, soybean meal, and soybean oil.
- Account for changes in transport cost rates by type and volume:
    - Transport of local soybean = $0.06/$1 soybean, transport of imported soybean = $0.11/$1 soybean, transport of imported soybean oil= $0.74/$1 soybean oil, transport of imported soybean meal = $0.14/$1 soybean meal.
    - Current *c_tran* for proc = $2,437,989 ($82,200 local soybean to processing, $747,474 soybean imp to processing, $94,105 soybean oil imports to processing, and $1,514,211 soybean meal imp to processing)
    - New *c_tran* for processing = 2,206,586 ($304,183 local soybean to processing, $747,474 soybean imp to processing, $0 soybean oil imports to processing, and $1,192,657 soybean meal imports to processing)

Scenario 3: 4X increase in local soybean production leading to more meal and oil and increased quantity demanded for livestock production

As noted in Table 3, a principal use of soybean meal in Kenya is for animal feed. This scenario assumes that increased domestic production of soybeans leads to additional processing of oil and meal, which facilitates the use of soybean meal in the production of broiler chickens (a key animal product using soybean meal). There is no reduction in soybean, soybean oil or soybean meal imports, so this scenario represents a net increase in each of the major activities associated with the SVC and the use of its outputs. Under this scenario, soybean production

increases 7,809 MT, with an increase in soybean meal of 6,247 MT (equal to about one-quarter of soybean meal imports in 2015). This soybean meal is assumed integrated into feed at 36% based on Mitchell (no date)[8] and assumes a feed conversion ratio of 2.7 for broiler meat based on information for Kenya (https://www.farmlinkkenya.com/broiler-farming-in-kenya/). The total increase in broiler production is 6,508 MT, with a value of 400 KSh/kg ($4.44 USD/kg) based on reports from the local media[9]. This additional production is assumed to be consumed at current prices.

It is important to note that we have not assessed the cost of feasibility of this (or the other) scenarios, but this scenario also implies that broiler production is currently limited by the availability of soybean meal, an effect for which there is quite limited evidence. Limited access to soybean meal was not mentioned as a factor in discussions with any SVC stakeholders, and the large amount of soybean meal imports suggests that supply chains for this input are reasonably well-developed. We also assume that domestic and imported meal have similar prices, so there is no cost savings to the use of domestic versus imported meal. Thus, this scenario is best interpreted as suggesting the potential economic impact of coordinated development activities designed to increase both soybean and livestock production in Kenya[10].

The specific changes to the SAM calculations for this scenario are:

- Increase farm soybean output $1,507,000 to $6,028,000 (Change = $4,521,000). Sales to soybean processors = $5,886,158 (Change = $4,521,000), Sales to export = $141,842 (Change = $0).
- No acreage offsets to maize, as in Scenario 1a.
- Farm production function coefficients are unchanged, but for minor change on *c_tran* since exports and transport of them do not change, while everything else is scaled by 4 as in Scenario 1a.
- Assumes soybean, soybean meal, and soybean oil imports by soybean processors are not substituted for increase in local soybean production, so soybean processor output increases:
    - Given a fixed production function, if total soybean purchases increase by soybean processed, all other inputs (including soybean meal/soybean oil imports) must increase proportionally to satisfy increase in soybean processing output.

[8] This presentation notes that inclusion of soybean meal in broiler diets above 35% could result in issues with poultry litter, but this higher value of 36% is selected because it is a value used in starter rations and results in a conservative estimate of the increase in feed production and broiler meat production.

[9] "The Coast farm that churns out 31,000 broilers", *Daily Nation*, September 8 2018. https://www.nation.co.ke/business/seedsofgold/The-Coast-farm-that-churns-out-31-000-broilers/2301238-4749106-359knxz/index.html.

[10] There is no reason to expect that increasing soybean meal availability in Kenya alone will increase *demand* for poultry products. However, if additional availability decreases meal prices and poultry production costs (effects not accounted for in our analysis), there could be an increase in the *quantity demanded* of broiler meat.

  - Given that $0.166 of soybean are required per $1 of output by soybean processors (regardless of source), soybean processor output expands by $27,234,940 (4521000/0.166) to $75,854,265.
- Broiler producers purchase all of the added soybean meal produced by soybean processors from the higher purchases of local soybean and expand production.
  - At assumed prices ($567/MT), $4,521,000 of more soybeans equates to 7,809 MT
  - Based on 60 lbs of soybean yields 11 lbs soybean oiland 47 lbs soybean meal, 6,247 MT of soybean meal are produced from expanded farm soybean production.
  - The associated increase in broiler production output is $15,657,000
  - There is not a separate broiler industry in the SAM, but a livestock industry that includes poultry, beef, goat, and other livestock commodities (excluding dairy).
  - Production function for livestock industry does not change.
- In the combined soybean value chain TEC computation, to avoid double counting:
  - Include only soybean exports from soybean farm production as the rest of the soybeans produced are already accounted for by purchases by soybean processors.
  - Since the extra soybean meal is still accounted for in the expanded livestock production, reduce soybean processor output by the value of the extra soybean meal, or $-2,891,898
- Expanded livestock production is included in direct effects, as was done with maize.

The large market share for palm oil among edible oil in Kenya suggests that there may be substantive potential for substitution of soybean oil for palm oil in food applications[11]. Despite this potential, we did not examine the economic contribution impact for scenarios substituting domestic soybean production and soybean oil processing for palm oil for two principal reasons. First, the substitutability of soybean oil for other oils in food applications can be complex and merits additional detailed study to assess the potential (personal communication, John Jansen, Vice President, Oil Strategy, United Soybean Board). This is related to a second justification, the difficulty of determining the volumes of soybean oil that might appropriately be substituted for palm—and their implications. Given the large market share for palm oil, complete substitution appears unrealistic in the foreseeable future. Soybean acreage in Kenya would need to increase from about 7,500 acres in 2015 to more than 5 million acres to replace palm oil imports. This increase would require more detailed assessment of what land uses would be decreased to allow for this large increase in soybean production. This type of analysis would more appropriately employ dynamic modeling methods (given the time required to ramp up soybean production) and, moreover, is likely to be inconsistent with the current structure of the (agricultural) economy upon which the 2014 SAM is based. Further assessment of the potential for substitution of soybean oil for other edible oils in Kenya is merited but is beyond the scope of our analysis.

[11] Substitution of soybean oil for other oils—especially palm—is also an issue of interest to the US soy industry.

Scenario Results

Each of the Scenarios increases the value of the economic contribution of the SVC, employee compensation, total value added and FTE employment compared to the Baseline scenario for the economic contribution reported to address Objective 2 of this report (Table 15). The largest percentage increases are for employment, ranging from 37% (for Scenario 2) to 143% (for Scenario 3). Consistent with increased employment, payments to employees (Employment Compensation) also increased by 20% to 135%.

The scenarios that substitute Kenya-produced soybeans for imported beans, or Kenya-processed soybean oil and meal for imported meal have effects on the total economic contribution of the SVC of a similar order of magnitude, increasing the contribution by $8.5 to $10.8 million per year including direct, indirect and induced effects. Total employment for these scenarios increased by about 1,250 to 1,500 FTE positions (Table 15).

Not surprisingly, the impact of a coordinated increase in production, processing and broiler meat production has substantively larger effects than increasing production and processing activities alone (Table 15). This occurs in part because Scenarios 1a, 1b and 2 assume offsets to other sources of soybeans (i.e., substituting domestic production for imports) and Scenario 3 assumes a net increase in demand for soybean products—with no offsets. Scenario 3 also accounts within the SAM effects for an entire additional sector of the Kenyan economy (livestock production) not included in other scenarios. Thus, it is not surprising that the effects of this scenario are between 3 (for FTEs) and 19 times (for value-added) the magnitude of Scenarios 1a, 1b and 2. Total value output (direct, indirect and induced) would increase by nearly $85 million, with more than 4,800 additional FTE positions. As noted above, the results of this scenario should tempered with knowledge of the underlying assumption of a successful coordinated strategy that makes investments in soybean production, processing and animal production (at costs that allow for the quantity demanded to increase).

Table 15. Economic Contribution Analysis of Selected Soybean Value Chain Development Outcomes

Scenario Outcome	Baseline	Scenario 1a	Scenario 1b	Scenario 2	Scenario 3
Economic Contribution Outcomes					
Output, $000	78,389	89,215	87,559	86,818	163,231
Employee Compensation, $000	9,977	12,476	12,282	11,956	23,412
Total Value Added, $000	31,734	36,212	35,195	33,947	74,381
Employment, FTE jobs	3,375	4,910	4,824	4,620	8,197
Change from Baseline					
Output, $000		10,826	9,170	8,429	84,842
Employee Compensation, $000		2,499	2,305	1,979	13,435
Total Value Added, $000		4,478	3,461	2,213	42,647
Employment, FTE jobs		1,535	1,449	1,245	4,822
% Change from Baseline					
Output, $000		13.8%	11.7%	10.8%	108.2%
Employee Compensation, $000		25.0%	23.1%	19.8%	134.7%
Total Value Added, $000		14.1%	10.9%	7.0%	134.4%
Employment, FTE jobs		45.5%	42.9%	36.9%	142.9%

NOTE: All values report the combined direct, indirect and induced effects. Disaggregated results by sector (production or processing) and by type of effect are shown in detail in Appendix 4.

NOTE: Scenario 1a increases soybean production by 4X, substituting for soybean imports, without an offsetting decrease in maize acres. Scenario 1b increases soybean production by 4X, substituting for soybean imports, but includes an offsetting decrease in maize acres. Scenario 2 increased soybean production sufficiently to eliminate soybean oil imports (2.4X), with no offsetting decrease in maize acres. Scenario 3 increases soybean production, processing of soybean and production of broiler chickens with soybean meal.

The results of these scenarios suggest that the annual economic contribution of the SVC can be increased by $8 million to $11 million assuming successful investments that promote additional production and processing of soybeans, soybean oil and meal that replace imports. Larger impacts on the economic contribution can be obtained with successful investments that included soybean production and processing but also animal feeding operations. These results suggest a sort of "best case" return to future investments in the SVC of Kenya, because a) they do not account for the investment costs and b) they assume that the investments will be both feasible and rapidly successful. Thus, these scenario analyses provide benchmarks, order-of-magnitude estimates of the potential economic contribution impacts of SVC investments that can be complemented with additional analyses of the costs, feasibility and likelihood of success of expanding soybean production and processing in Kenya.

Feasibility, Generalizability and Study Limitations (Objective 4)

This effort indicates that an assessment of the economic contribution of SVC in a lower-income country setting is feasible and provides relevant information for development organizations. However, it is worth noting the conditions under which this type of research is likely to result in more accurate and informative conclusions.

Information Needs

There are multiple information needs for an assessment of the economic contribution of the SVC of a country. First, it is necessary to have ***access to a recent I-O table or SAM*** that can be disaggregated to represent the specific contribution of the SVC. We were fortunate to have access to a relatively recent SAM developed for Kenya. Although it has substantive limitations (discussed below) the EORA project has I-O tables for 2015 for 37 countries in sub-Saharan Africa (Appendix 5), including most of the major soybean producers. Other sources of I-O matrix information or SAM are also available (e.g., https://www.exiobase.eu) but may require additional resources for access.

Another requirement is to be able to develop a ***detailed descriptive profile of the SVC***, preferably with data sufficient to map the quantities of soybean and soybean products moving in different channels and uses. This is necessary to allow more accurate quantification of the linkages between SVC and other parts of the country's economy. In the case of Kenya, it was not possible to fully quantify the alternative pathways based on available published sources (despite the usefulness of studies such as Tinsley, 2009; Collombet, 2013; and Jackson, 2016) and interviews with SVC stakeholder organizations. Information that exists for this characterization are often approximate, anecdotal and(or) somewhat dated.

Finally, ***detailed information on the input use and costs of each of the stakeholders in the SVC is needed*** to accurately assess the linkages between the SVC and other segments of the economy. At the farm level, this information can generally be collected with surveys or FGD (if not already available from previous work), although determination of the value component within the country for imported farm-inputs will often be approximate. This project benefited

from the experience of Agrics staff with farmer groups and production practices in a key production area. This expertise seems essential for the successful implementation of future farm-level data collection efforts. The detailed scripts for the FGD (Appendix 3) provide a template that could be implemented in other farm-level data collection efforts, although these might a) need to be modified to reflect production systems other than those based on maize production and b) might be streamlined for greater focus on soybean inputs.

Data on transportation from farm to processing has been feasible to collect from SVC stakeholders (especially processors) as the information is not a source of proprietary advantage—there appear to be common transportation rates from multiple small transportation companies for all companies based on our interviews with soybean processors and traders. That said, some of the transportation information in our study was based on multiples of a specific transportation movement (from farms to processing in central Kenya) and thus are approximations to what may be a more complex underlying reality. Information about distribution costs is not readily available but must be approximated with information about the nature of the distribution systems used by soybean processing companies—descriptive information of this sort was not considered too sensitive to share.

The most challenging information to obtain was for processing costs and the number of employees engaged in soybean processing and marketing. As noted previously, no company was willing to share detailed production or cost information from their operations, although three companies were willing to share approximate markup information over the price that they paid for soybeans. Although this ensures that the approximate magnitude of the overall contribution of processing is correct, it implies that the individual components of the costs needed to be approximated based on information from processing operations in the US (with adjustments for likely volumes and only mechanical oil extraction). Although unlikely to have a marked effect on the estimate of the overall contribution of the SVC, more detailed information on processing costs—which would likely require the development of a close working relationship with major processing companies—would provide greater accuracy.

Limitations and Recommendations for Future Work

This study has two key limitations, which likely do not affect the overall accuracy of the estimated economic contribution of the SVC but which may be addressed in future studies. First, many of the input use and cost values are approximations based on simple rules of thumb provided by a limited number of SVC stakeholders (such as the markup values over soybean purchase prices for processing costs). Although these rules of thumb were provided independently by the interviewed companies (i.e., without prompting based on information from other interviewees), they were broadly consistent for the markup values and for inbound transportation costs. This provides a degree of confidence that the order-of-magnitude values are appropriate. Second, because the latest SAM information is for 2014, there is a degree of mismatch between resource use for which data was collected in 2019 (and, in some cases, unit costs) and the data upon which the linkages between the SVC and the rest of the Kenyan economy were based. This was addressed by calculating unit values for input requirements and

then using 2015 production volume values to provide greater consistency with SAM data. This latter is challenging to address given that for consistency one would need to collect SVC information in coordination with (with advance knowledge of) the release of updated I-O matrix information, although a smaller time gap between data collection and the year represented by the I-O matrix would likely improve outcomes—if that year is reasonably representative.

Industry contribution analyses serve multiple purposes, both private and public in perspective. However, the strength of these analyses derives directly from the quality of data used to assemble the underlying I-O models and(or) SAMs. Nearly all such efforts start with a National Table of Accounts and then customized to more local levels given availability of data. In addition, all models must consider the level of aggregation in commodities, industries, households, and other institutions that the data will support.

As in cases where specific industries are of interest (like soybeans), they are often represented within more very much more aggregated industries (like agriculture) in national-level IO/SAM models. In our case specifically, the soybean commodity was included with an oilseed and pulses aggregate, while the soybean industry was included in a crop production aggregated. Aggregation issues across commodities and industries are likely to be more prevalent in low-income (as opposed to high-income) countries. This becomes even more acute when considering national SAMs where, in addition to industry activities, households, enterprises, and government institutions are added, as well as transfers among institutions, investments, savings, and taxes (of all kinds) must be considered.

Our research approach initiated with the IO tables available form EORA (worldmrio.com), which includes over 50 country IO tables and linkages among them. Although the EORA representation was useful, several issues arose that precluded its eventual use. First, both the commodity and industry row sums and column sums do not match as they should. For some industries and commodities the discrepancy was minor, but for others quite large. Further, as an IO-only table, flows among all industries, factors, and institutions do not exist, thus requiring the researcher to add them with limited or no knowledge. We were fortunate that a full Kenyan SAM had recently been developed and available for research purposes. Can EORA be used for future country analyses? Yes, but with more limited multiplier effects and/or with additional elements required by the research team to balance the IO. Certainly, indirect effects can be readily computed from existing EORA data tables, and limited induced effects. To the degree that that is sufficient for the research objectives, it is a resource available for future use.

Given the above, recommendations for future efforts are:

- Explore whether subscription I-O databases and(or) SAM are available for relevant countries that could provide access to more recently updated information, particularly if the goal is to replicate a study similar to this one in multiple countries of sub-Saharan Africa. If these data are or could be made available through existing software platforms (such as IMPLAN), this would greatly facilitate the feasibility of the analysis;

- Devote more project effort (in the early phases) to the cultivation of working relationships with soybean processing companies to enhance the degree to which they are willing to share potentially sensitive data on costs and input use;
- Given that the farm sector will typically comprise a relatively small share of the economic contribution of SVC (although smallholder farmers may be a highly relevant stakeholder group for development purposes), a smaller effort on farm-level data collection may be appropriate for future studies.
- Future studies might best focus on those countries with a larger volume of domestic soybean production moving through the SVC, particularly those that are net exporters (given that Kenya is a major net importer). This would allow relevant comparisons to be made between Kenya and countries with a larger SVC production component.
- Studies of the change in economic contribution through achievement of SVC development initiatives to increase soybean production and processing can be complemented with additional analyses of the costs, feasibility and likelihood of success of the necessary investments to achieve substantive increases. This can include an assessment of the ability of domestic soybean oil to substitute for the predominant edible oil consumed in Kenya, palm oil.

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Appendix 1. Detailed Flowcharts of Kenya SVC Components and Processes

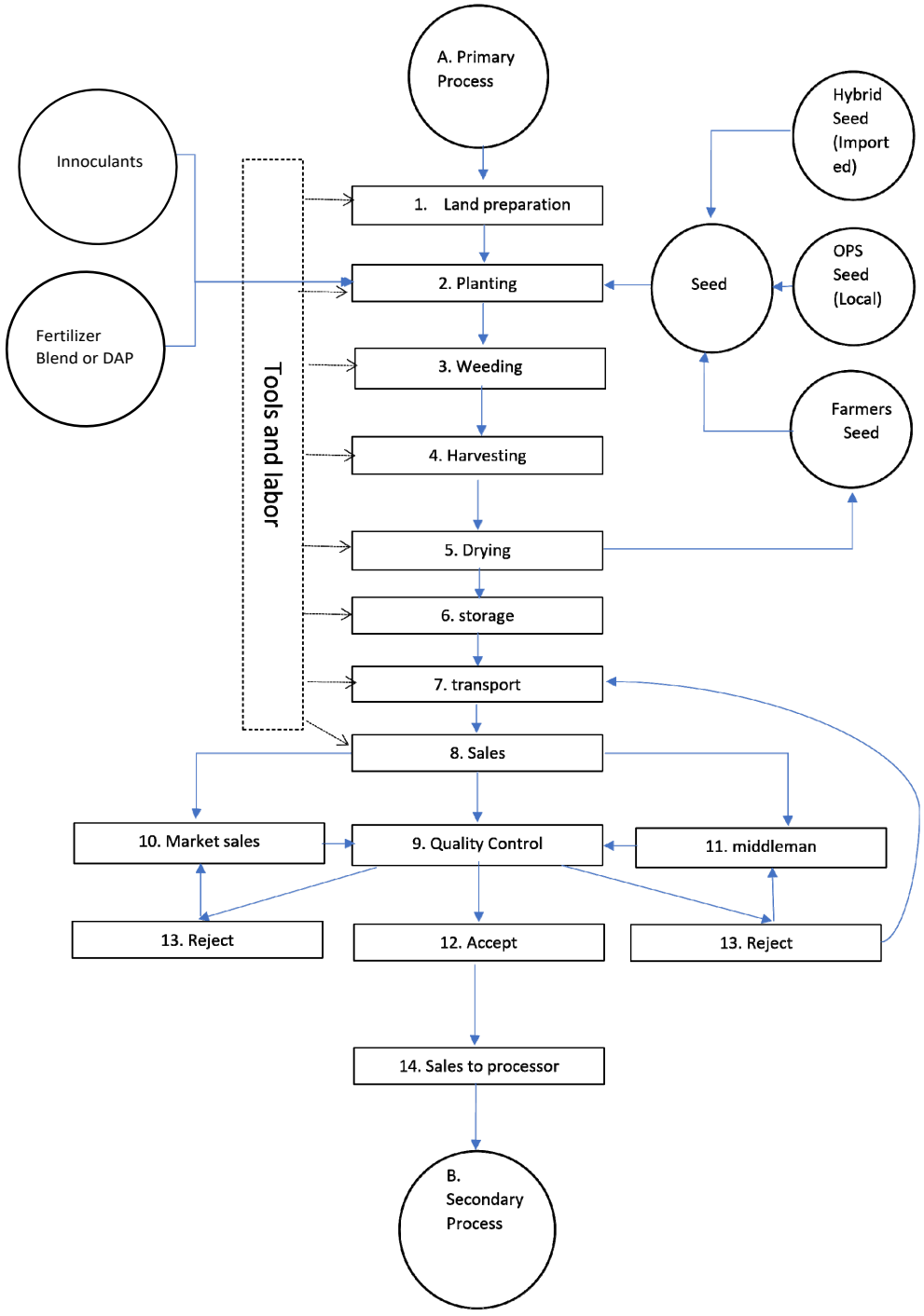


Figure A1. Detailed Generic Flowchart of Soybean Production and Sales, Kenya

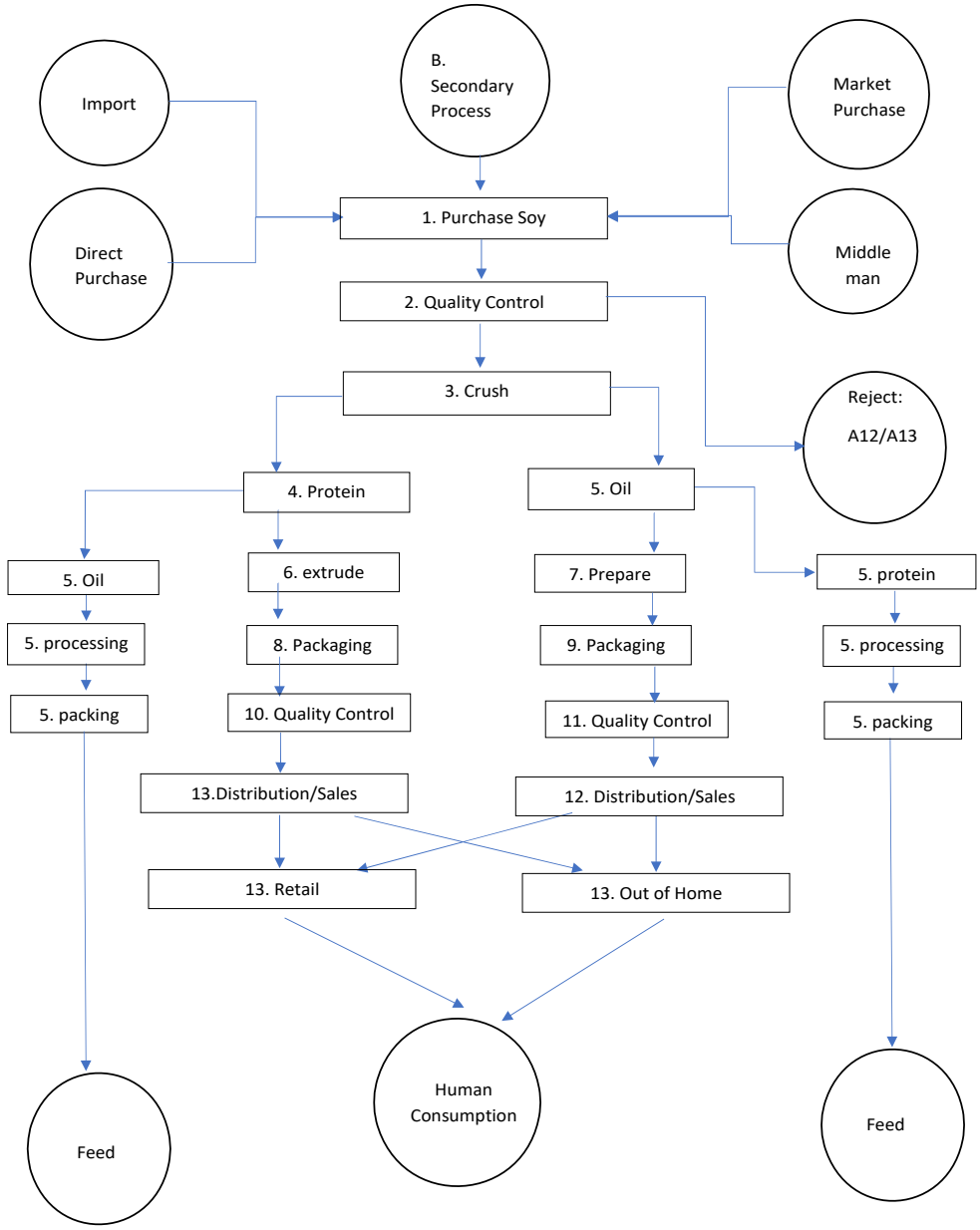


Figure A2. Detailed Generic Flowchart of Soybean Sourcing and Processing to Meal and Oil for Human and Animal Consumption, Kenya

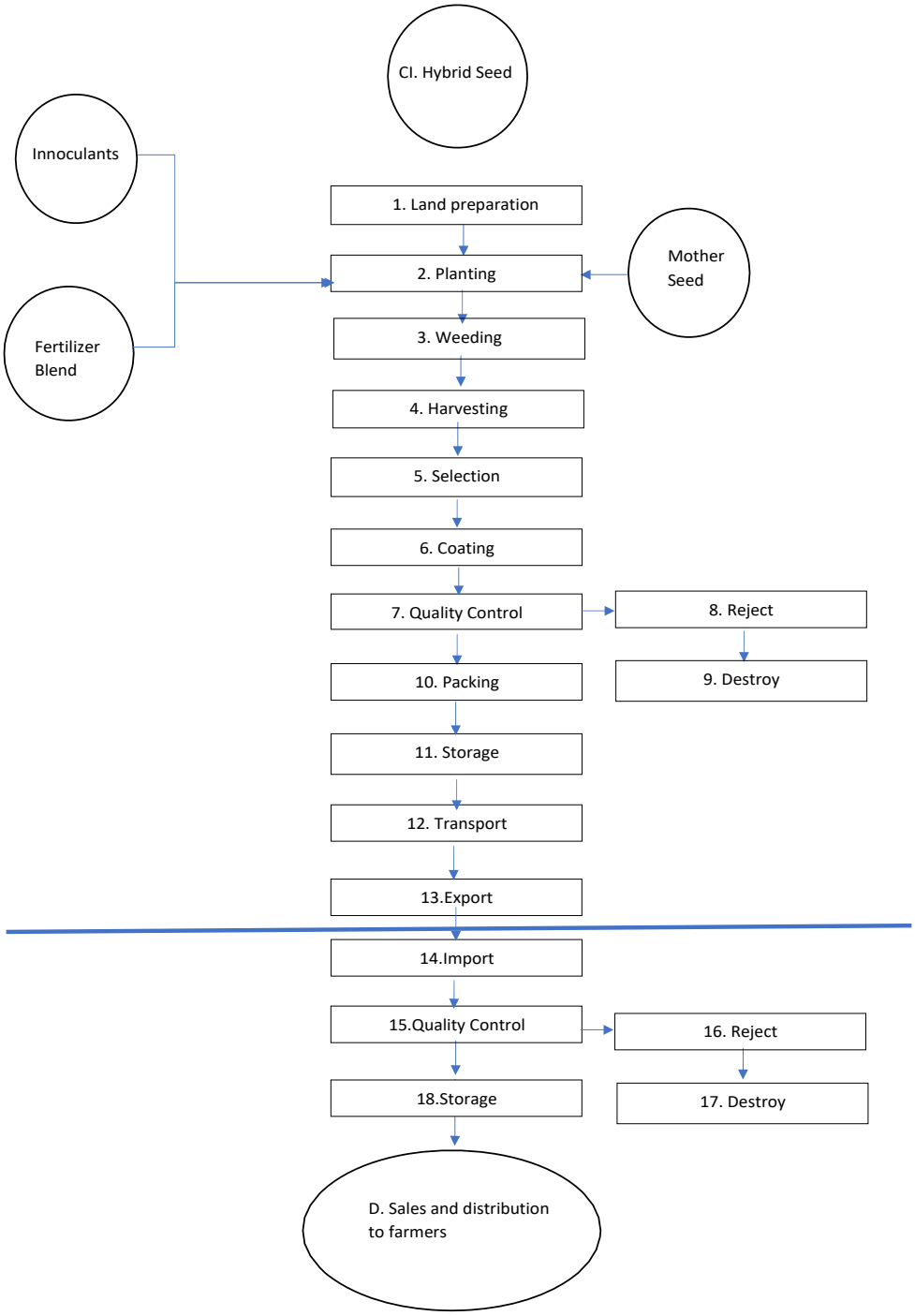


Figure A3. Detailed Generic Flowchart of Hybrid Seed Production and Marketing, Kenya

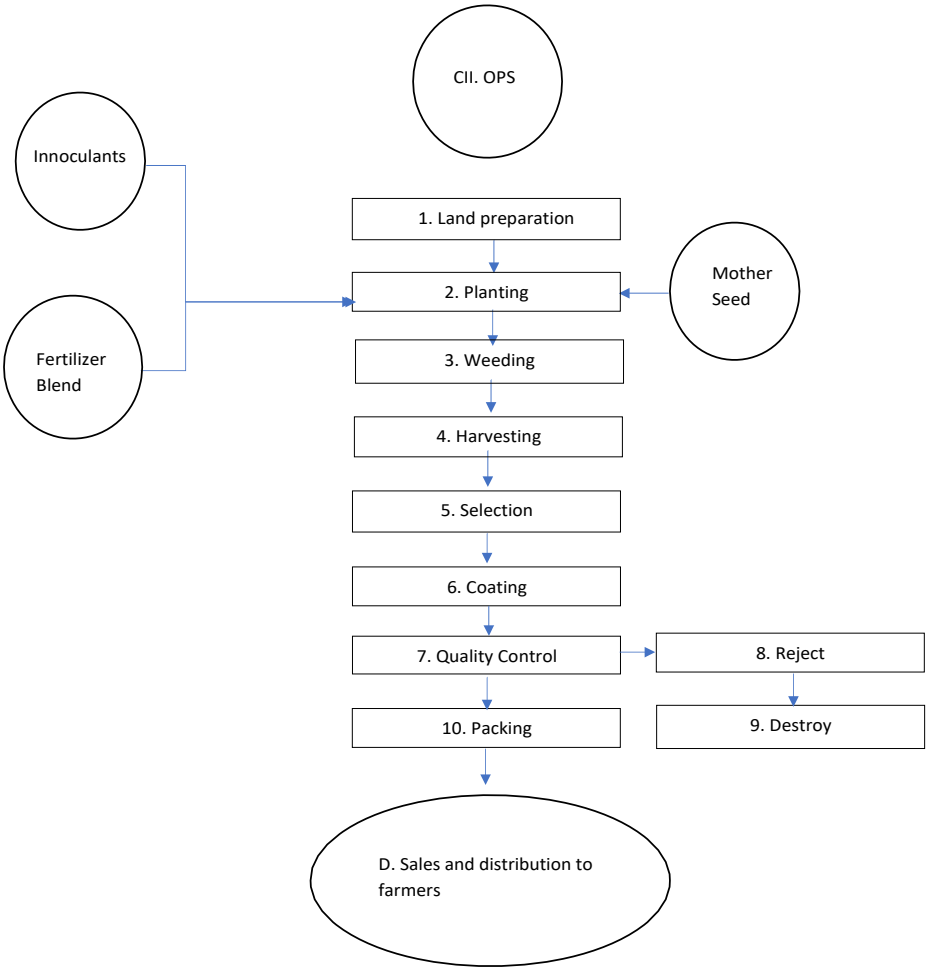


Figure A4. Detailed Generic Flowchart of OPS Seed Production and Marketing, Kenya

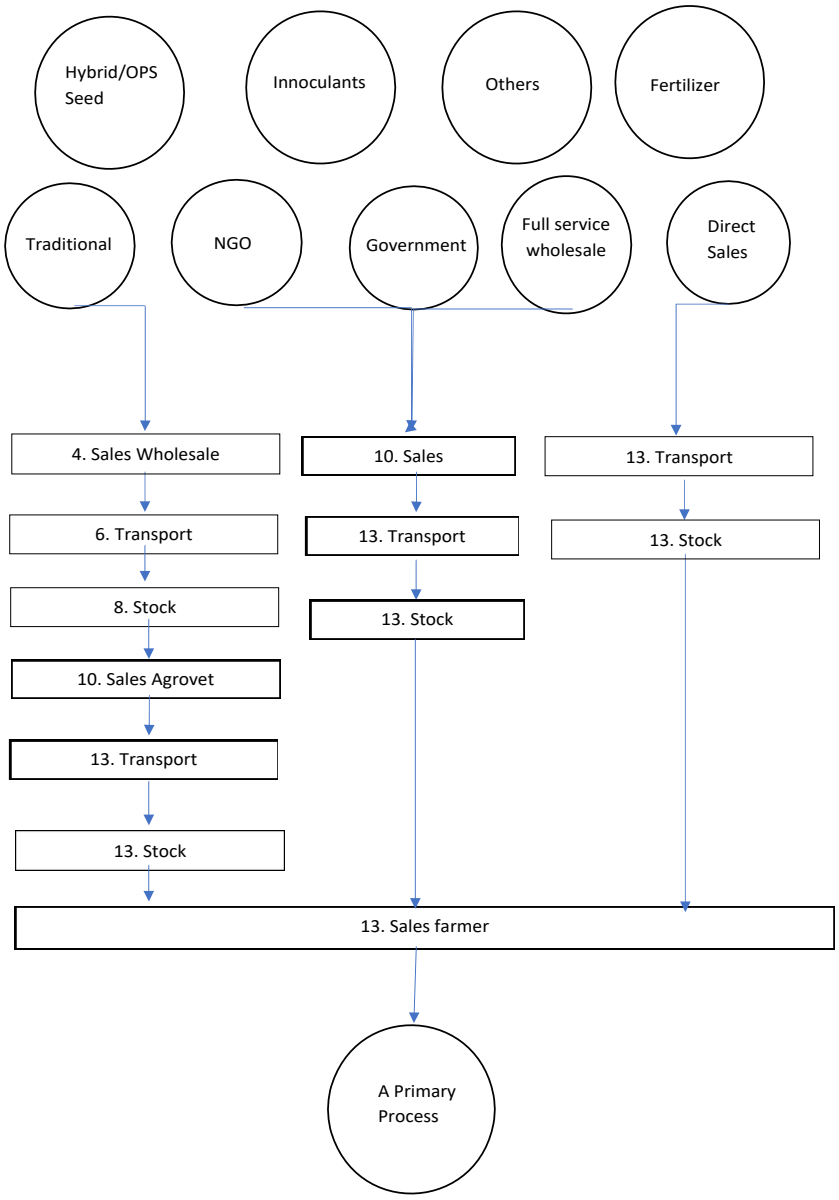


Figure A5. Detailed Generic Flowchart of Input Supply for the Soybean Production Primary Process, Kenya

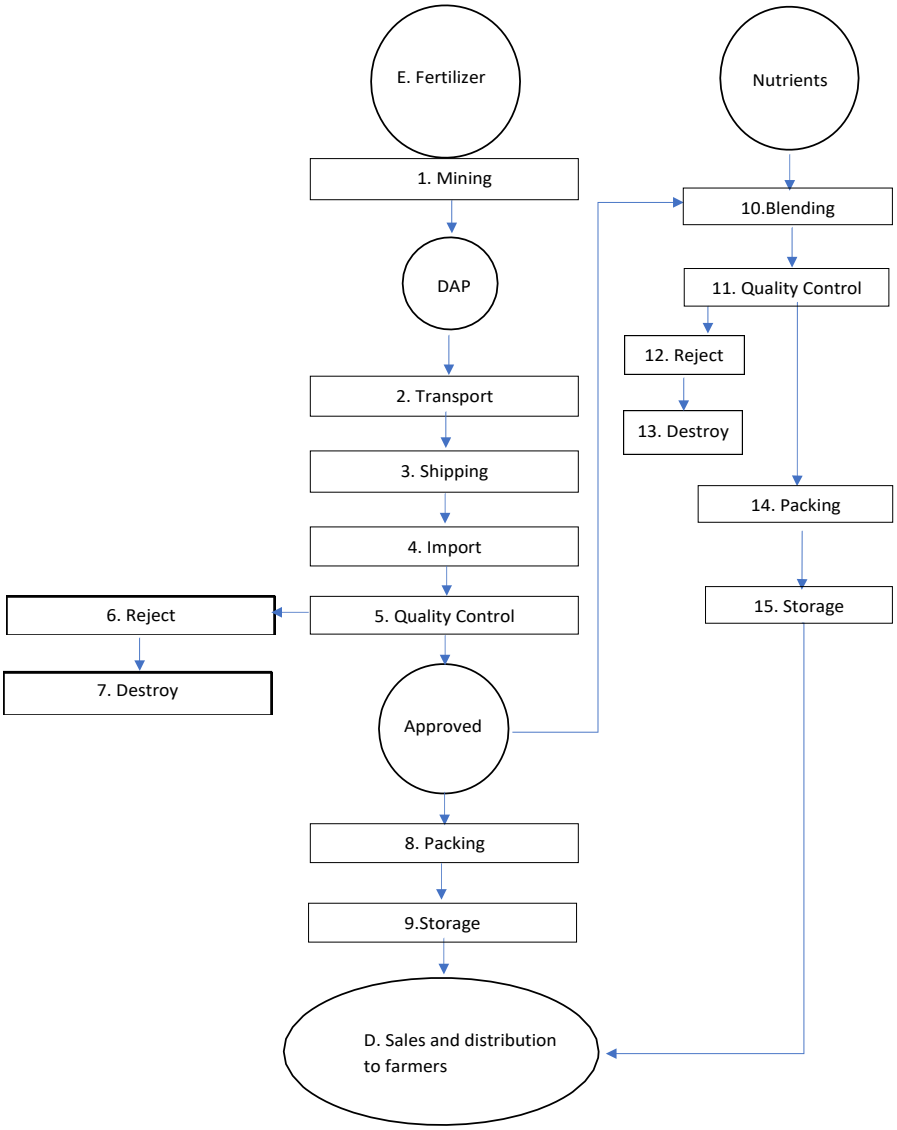


Figure A6. Detailed Generic Flowchart of Fertilizer Production and Marketing, Kenya

Appendix 2: Description of Basic Input-Output Methods[12]

Basics of Input-Output Modeling

We present a simple non-technical discussion of the formulation of input-output (IO) modeling in this section. An example of similar descriptive treatments would be Shaffer, Deller and Marcouiller (2004). An example of a more advanced discussion of input-output would be Miernyk (1965), and Miller and Blair (1985). As a descriptive tool, IO analysis represents a method for expressing the economy as a series of accounting transactions within and between the producing and consuming sectors. As an analytical tool, IO analysis expresses the economy as an interaction between the supply and demand for commodities. Given these interpretations, the IO model may be used to assess the impacts of alternative scenarios on the region's economy.

Transactions Table

A central concept of IO modeling is the interrelationship between the producing sectors of the region (e.g., manufacturing firms), the consuming sectors (e.g., households) and the rest of the world (i.e., regional imports and exports). The simplest way to express this interaction is through a regional transactions table (Table A1). The transactions table shows the flow of all goods and services produced (or purchased) by sectors in the region. The key to understanding this table is realizing that one firm's purchases are another firm's sales and that producing more of one output requires the production or purchase of more of the inputs needed to produce that product.

Table A1: Illustrative Transaction Table

	Purchasing Sectors (Buyers/Demand)			Final Demand		
Processing Sectors (Sellers/Supply)	**Agr**	**Mfg**	**Serv**	**HH (labor)**	**Exports**	**Output**
Agr	10	6	2	20	12	50
Mfg	4	4	3	24	14	49
Serv	6	2	1	34	10	53
HH (labor)	16	25	38	1	52	132
Imports	14	12	9	53	0	88
Inputs	50	49	53	132	88	372

The transactions table may be read from two perspectives: reading down a column gives the purchases by the sector named at the top of the column from each of the sectors named at the left. Reading across a row gives the sales of the sector named at the left of the row to those named at the top. In the illustrative transaction table for a fictitious regional economy (Table 1), reading down the first column shows that the agricultural firms buy $10 worth of their inputs from other agricultural firms. The sector also buys $4 worth of inputs from manufacturing firms and $6 worth from the service industry. Note that agricultural firms also made purchases from

[12] This section is taken verbatim from Deller et al. (2018).

non-processing sectors of the economy, such as the household sector ($16) and imports from other regions ($14). Purchases from the household sector represent value added, or income to people in the form of wages and investment returns. In this example, agricultural firms purchased a total of $50 worth of inputs.

Reading across the first row shows that agriculture sold $10 worth of its output to agriculture, $6 worth to manufacturing, $2 worth to the service sector. The remaining $32 worth of agricultural output was sold to households or exported out of the region. In this case $20 worth of agricultural output was sold to households within the region and the remaining $12 was sold to firms or households outside the region. In the terminology of IO modeling, $18 (=$10+$6+$2) worth of agricultural output was sold for intermediate consumption, and the remaining $32 (=$20+$12) worth was sold to final demand. Note that the transactions table is balanced: total agricultural output (the sum of the row) is exactly equal to agricultural purchases (the sum of the column). In an economic sense, total outlays (column sum, $50) equal total income (row sum, $50), or supply exactly equals supply. This is true for each sector.

The transactions table is important because it provides a comprehensive picture of the region's economy. Not only does it show the total output of each sector, but it also shows the interdependencies between sectors. It also indicates the sectors from which the region's residents earn income as well as the degree of openness of the region through imports and exports. In this example, households' total income, or value added for the region is $132 (note total household income equals total household expenditure), and total regional imports is $88 (note regional imports equals regional exports). More open economies will have a larger percentage of total expenditures devoted to imports. As discussed below, the “openness” of the economy has a direct and important impact on the size of economic multipliers. Specifically, more open economies have a greater share of purchases, both intermediate and final consumption purchases, taking the form of imports. As new dollars are introduced (injected from exports) into the economy they leave the economy more rapidly through leakages (imports).

Direct Requirements Table

Important production relationships in the regional economy can be further examined if the patterns of expenditures made by a sector are stated in terms of proportions. This means that the proportions of all inputs needed to produce one dollar of output in a given sector can be used to identify linear production relationships. This is accomplished by dividing the dollar value of inputs purchased from each sector by total expenditures. Or, each transaction in a column is divided by the column sum. The resulting table is called the direct requirements table (Table A2).

The direct requirements table, as opposed to the transactions table, can only be read down each column. Each cell represents the dollar amount of inputs required from the industry named at the left to produce one dollar's worth of output from the sector named at the top. Each column essentially represents a `production recipe' for a dollar's worth of output. Given

this latter interpretation, the upper part of the table (above households) is often referred to as the matrix of technical coefficients. In this example, for every dollar of sales by the agricultural sector, 20 cents worth of additional output from itself, 8 cents of output from manufacturing, 12 cents of output from services, and 32 cents from households will be required.

In the example region, an additional dollar of output by the agricultural sector requires firms in agriculture to purchase a total of 40 cents from other firms located in the region. If a product or service required in the production process is not available from within the region, the product must be imported. In the agricultural sector, 28 cents worth of inputs are imported for each dollar of output. It is important to note that in IO analysis, this production formula, or technology (the column of direct requirement coefficients), is assumed to be constant and the same for all establishments within a sector. This assumption holds regardless of input prices or production levels.

Table A2: Illustrative Direct Requirements Table

	Purchasing Sectors (Buyers/Demand)		
Processing Sectors (Sellers/Supply)	**Agr**	**Mfg**	**Serv**
Agr	**0.20**	**0.12**	**0.04**
Mfg	**0.08**	**0.08**	**0.06**
Serv	**0.12**	**0.04**	**0.02**
HH (labor)	**0.32**	**0.51**	**0.72**
Imports	**0.28**	**0.24**	**0.02**
Inputs	**1.00**	**1.00**	**1.00**

Assuming the direct requirements table also represents spending patterns necessary for additional production, the effects of a change in final demand of the output on the other of sectors can be predicted. For example, assume that export demand for the region's agricultural products increases by $100,000. From Table 2, it can be seen that any new final demand for agriculture will require purchases from the other sectors in the economy. The amounts shown in the first column are multiplied by the change in final demand to give the following figures: $20,000 from agriculture, $8,000 from manufacturing, and $12,000 from services. These are called the direct effects and, in this example, they amount to a total impact on the economy of $140,000 (the initial change [$100,000] plus the total direct effects [$40,000]). For many studies of economic impact the direct and initial effects are treated as the same although there are subtle differences.

The strength of input-output modeling is that it does not stop at this point, but also measures the indirect effects of an increase in agricultural exports. In this example, the agricultural sector increased purchases of manufactured goods by $8,000. To supply agriculture's new need for manufacturing products, the manufacturing sector must increase production. To accomplish this, manufacturing firms must purchase additional inputs from the other regional sectors.

Continuing our $100,000 increase in export demand for a region’s agricultural products, for every dollar increase in output, manufacturing must purchase an additional 12 cents of

agricultural goods ($8,000 x .12 = $960), 8 cents from itself ($8,000 x .08 = $640), and 4 cents from the service sector ($8,000 x .04 = $320). Thus, the impact on the economy from an increase in agricultural exports will be more than the $140,000 identified previously. The total impact will be $140,000 plus the indirect effect on manufacturing totaling $1,920 ($960 + $640 + $320), or $141,920. A similar process examining the service sector increases the total impact yet again by $1,440 ([$12,000 x .04] + [$12,000 x .06] + [$12,000 x .02] = $1,440).

The cycle does not stop, however, after only two rounds of impacts. To supply the manufacturing sectors with the newly required inputs, agriculture must increase output again, leading to an increase in manufacturing and service sector outputs. This process continues until the additional increases drop to an insignificant amount. The total impact on the regional economy, then, is the sum of a series of direct and indirect impacts. Fortunately, the sum of these direct and indirect effects can be more efficiently calculated by mathematical methods. The methodology was developed by the Noble-winning economist Wassily Leontief and is easily accomplished using computerized models.

Total Requirements Table

Typically, the result of the direct and indirect effects is presented as a total requirements table, or the Leontief inverse table (Table A3). Each cell in Table 3 indicates the dollar value of output from the sector named at the left that will be required in total (i.e., direct plus indirect) for a one dollar increase in final demand for the output from the sector named at the top of the column. For example, the element in the first row of the first column indicates the total dollar increase in output of agricultural production that results from a $1 increase in final demand for agricultural products is $1.28. Here the agricultural multiplier is 1.28: for every dollar of direct agricultural sales there will be an additional 28 cents of economic activity as measured by industry sales.

Table A3: Illustrative Total Requirements Table

	Purchasing Sectors (Buyers/Demand)		
Processing Sectors (Sellers/Supply)	**Agr**	**Mfg**	**Serv**
Agr	**1.28**	**0.17**	**0.06**
Mfg	**0.12**	**1.11**	**0.07**
Serv	**0.16**	**0.07**	**1.03**
Inputs	**1.56**	**1.35**	**1.16**

An additional interpretation of the transactions table, as well as the direct requirements and total requirements tables, is the measure of economic linkages within the economy. For example, the element in the second row of the first column indicates the total increase in manufacturing output due to a dollar increase in the demand for agricultural products is 12 cents. This allows the analyst to not only estimate the total economic impact but also provide insights into which sectors will be impacted and to what level.

Highly linked regional economies tend to be more self-sufficient in production and rely less on outside sources for inputs. More open economies, however, are often faced with the requirement of importing production inputs into the region. The degree of openness can be obtained from the direct requirements table (Table 2) by reading across the imports row. The higher these proportions are, the more open the economy. As imports increase, the values of the direct requirement coefficients must, by definition, decline. It follows then that the values making up the total requirements table, or the multipliers, will be smaller. In other words, more open economies have smaller multipliers due to larger imports. The degree of linkage can be obtained by analyzing the values of the off- diagonal elements (those elements in the table with a value of less than one) in the total requirements table. Generally, larger values indicate a tightly linked economy, whereas smaller values indicate a looser or more open economy.

Input-Output Multipliers

Basics of Input-Output Multipliers

Through the discussion of the total requirements table, the notion of external changes in final demand rippling throughout the economy was introduced. The total requirements table can be used to compute the total impact a change in final demand for one sector will have on the entire economy. Specifically, the sum of each column shows the total increase in regional output resulting from a $1 increase in final demand for the column heading sector. Retaining the agricultural example, an increase of $1 in the demand for agricultural output will yield a total increase in regional output equal to $1.56 (Table 3). This figure represents the initial dollar increase plus 56 cents in direct and indirect effects. The column totals are often referred to as output multipliers.

The use of these multipliers for policy analysis can prove insightful. These multipliers can be used in preliminary policy analysis to estimate the economic impact of alternative policies or changes in the local economy. In addition, the multipliers can be used to identify the degree of structural interdependence between each sector and the rest of the economy. For example, in the illustrative region, a change in the agriculture sector would influence the local economy to the greatest extent, while changes in the service sector would produce the smallest change. The output multiplier described here is perhaps the simplest input-output multiplier available. The construction of the transactions table and its associated direct and total requirements tables creates a set of multipliers ranging from output to employment multipliers. Input-output analysis specifies this economic change, most commonly, as a change in final demand for some product. Economists sometimes might refer to this as the "exogenous shock" applied to the system. Simply stated, this is the manner in which we attempt to introduce an economic change.

The complete set includes:

Type	Definition
1. Output Multiplier	The output multiplier for industry *i* measures the sum of direct and indirect requirements from all sectors needed to deliver one additional dollar unit of output of *i* to final demand.
2. Income Multiplier	The income multiplier measures the total change in income throughout the economy from a dollar unit change in final demand for any given sector.
3. Employment Multiplier	The employment multiplier measures the total change in employment due to a one unit change in the employed labor force of a particular sector.

The income multiplier represents a change in total income (employee compensation plus proprietary income plus other property income plus indirect business taxes) for every dollar change in income for any given sector. The employment multiplier represents the total change in employment resulting from the change in employment in any given sector. Thus, we have three ways that we can describe the change in final demand.

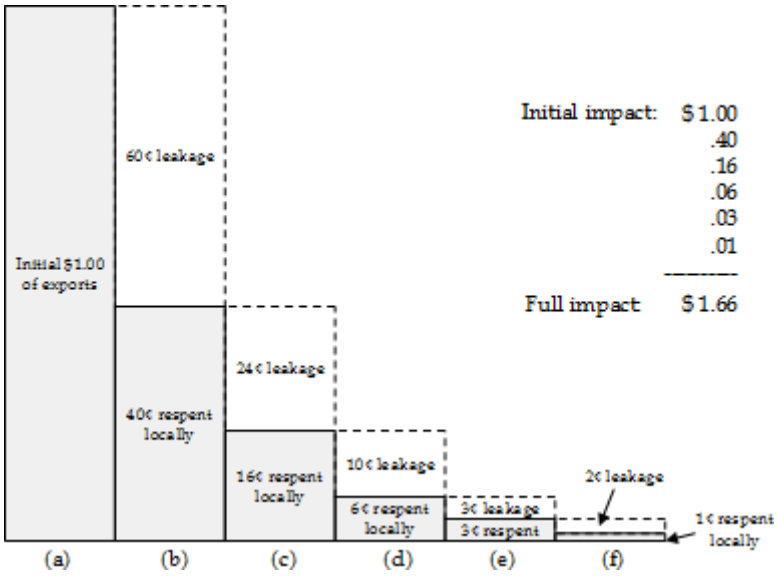
Consider, for example, a dairy farm that has $1 million in sales (industry output), pays labor $100,000 inclusive of wages, salaries and retained profits, and that employs three workers, including the farm proprietor. Suppose that demand for milk produced at these farm increases 10 percent, or $100,000 dollars. We could use the traditional output multiplier to determine what the total impact on output would be. Alternatively, to produce this additional output the farmer may find that they need to hire a part-time worker. We could use the employment multiplier to examine the impact of this new hire on total employment in the economy. In addition, the income paid to labor will increase by some amount and we can use the income multiplier to see what the total impact of this additional income will have on the larger economy.

How are these income and employment multipliers derived if the IO model only looks at the flow of industry expenditures (output)? In the strictest sense, the IO does not understand changes in employment or income, only changes in final demand (sales or output). To do this we use the fact that the IO model is a "fixed proportion" representation of the underlying production technologies. This is most clear by reexamining the direct requirements table (Table 2). For every dollar of output (sales) inputs are purchased in a fixed proportion according to the production technology described by the direct requirements table. For every dollar of output there is a fixed proportion of employment required as well as income paid. In our simple dairy farm example, for every dollar of output there are .000003 (= 1,000,000 ÷ 3) jobs and $.10 (=

1,000,000 ÷ 100,000) in income. We can use these fixed proportions to convert changes in output (sales) into changes in employment and income.

Graphically, we can illustrate the round-by-round relationships modeled using input-output analysis. This is found in Figure 1. The direct effect of change is shown in the far left-hand side of the figure (the first bar (a)). For simplification, the direct effect of a $1.00 change in the level of exports, the indirect effects will spill over into other sectors and create an additional 66 cents of activity. In this example, the simple output multiplier is 1.66. A variety of multipliers can be calculated using input-output analysis.

While multipliers may be used to assess the impact of changes on the economy, it is important to note that such a practice leads to limited impact information. A more complete analysis is not based on a single multiplier, but rather, on the complete total requirements table.



Initial, Indirect and Induced Effects

The input-output model and resulting multipliers described up to this point presents only part of the story. In this construction of the total requirements table (Table 3) and the resulting multipliers, the production technology does not include labor. In the terminology of IO modeling, this is an "open" model. In this case, the multiplier captures only the initial effect (initial change in final demand or the initial shock) and the impact of industry to industry sales. This latter effect is called the indirect effect and results in a Type I multiplier. A more complete picture would include labor in the total requirements table. In the terminology of IO modeling, the model should be "closed" with respect to labor. If this is done, we have a different type of multiplier, specifically a Type II multiplier, which is composed of the initial and indirect effects as well as what is called the induced effects.

The Type II multiplier is a more comprehensive measure of economic impact because it captures industry to industry transactions (indirect) as well as the impact of labor spending income in the economy (induced effect). In the terminology of IO analysis, an "open" model where the induced effect is not captured, any labor or proprietor income that may be gained (positive shock) or lost (negative shock) is assumed to be lost to the economy. In our simple dairy farm example, any additional income (wages, salaries and profits) derived from the change in output (sales) is pocketed by labor and is not re-spent in the economy. This clearly is not the case: any additional income resulting from more labor being hired (or fired) will be spent in the economy thus generating an additional round of impacts. This second round of impacts is referred to as the induced impact.

Insights can be gained by comparing and contrasting the indirect and induced effects. For example, industries that are more labor intensive will tend to have larger induced impacts relative to indirect. In addition, industries that tend to pay higher wages and salaries will also tend to have larger induced effects. By decomposing the Type II multiplier into its induced and indirect effects, one can gain a better understanding of the industry under examination and its relationship to the larger economy.

Appendix 3. Report on Farm-Level Data Collected through Focus Group Discussions Conducted by Agrics Field Staff and Farmers During May 2019

Background

This appendix provides the results of five focus group discussions executed in West Kenya with funding support from the Soybean Innovation Lab (SIL), a USAID-funded project that promotes innovations and research to support the development of soybean production and marketing in lower-income countries. This provides information about the farm input requirements and cost structures within that chain. This component of the project was executed by Agrics staff with the collaboration of Charles Nicholson from Cornell University as the direct contractor with SIL.

Agrics is a company operating in western Kenya that sells hybrid seeds and fertilizer to around 20,000 farmers on credit including training on Good Agricultural Practice. Their farmer customers generally cultivate between 0.25 and 5 acres of land in western Kenya. The inputs are provided as close to farmers' homes as possible in a package including fertilizer, seed and training and support on good agricultural practices. Although the majority of Agrics' sales are for maize production, Agrics also has been selling packages of soybean seed in combination with fertilizer to its farmers on a smaller scale. Agrics also purchases and markets soybeans from some of its farmers, providing linkages to the post-farm value chain. Thus, Agrics is well-positioned in terms of its direct knowledge of relevant soybean production and marketing systems, internal records, and the contacts of its field staff to assist with the acquisition of data required for the analyses under this project.

The principal contributions of Agrics to the achievement of project objectives are to facilitate the collection of needed farm-level data inputs through a series of farmer focus group discussions (FGD), facilitate access to other necessary information about input requirements and costs for post-farm marketing and as well as the flow of value through the chain and the value additions through different steps in the chain. This appendix primarily describes the process and results from the farmer FGD.

Objectives of the Focus Group Discussions

The main objective of the Focus Group Discussions (FGD) was to obtain data on the value additions from the farmers perspective within the soy value chain. In addition, the process also generated insights regarding the challenges that farmers face and the trade-offs they make with regards to the planting of soy versus other crops.

Execution

The FGD were undertaken using a semi-structured interview process that was designed with input from Charles Nicholson, Cornell collaborator Todd Schmit, and Agrics staff (Guustaaf van de Mheen and Peter Matyoko). The semi-structured interviews were implemented in an iterative manner, with assessment after each of the two days' meetings with farmers. This was preceded by initial testing of the interview questions with Agrics' regional field staff.

Interviewing Agrics' field staff first allowed assessment of the adequacy of the overall approach and the specific questions, and was appropriate because the field staff are farmers themselves, are well-versed with the agricultural landscape in western Kenya, and are able to express their opinions and share knowledge around the focal topics for the FGD. The field staff interviews indicated that the process and specific questions were generally appropriate, with a few minor refinements to the interview guide resulting from the process. [The interview guide is given in Appendix 1.] After the initial evaluation process with Agrics' field staff, FGD were conducted with four farmer groups, primarily representing farmers doing business with Agrics, in regions where the farming of Soya is more common in Western Kenya.

Set up of the Focus Group Discussions

The selection criteria for the groups were:

- Locations where there has been growth of soybean production in the recent past. One FGD was done in Butere, one in Mumias and two in Nambale, which are in western Kenya near the city of Kisumu and the border with Uganda. (See map below, Figure A3.1)
- Farmer participants in the FGD grew soybeans, maize or both crops.
- Farmer participants purchased inputs from Agrics during the long rainy season of 2019. These farmers were selectedto participate in the FGD's for logistical reasons, but also to assure a certain level and commitment of farmers that participated (due to their relationship with Agrics).

Agrics farmers were selected for the FGD to assure acquisition of the needed information within time and budget limits, while building on Agrics' experience and relationships with participants able to respond to the interview questions based on their knowledge and experience. The use of only Agrics farmers, though, also limited the outcome of the FGD's because of the limited offering of the company's products to the farmers. For example, the soybean packages, pricing and seed varieties were the same for all farmers who purchased then from Agrics. This also resulted in farmers providing relatively similar answers, given the common information and training received from Agrics.

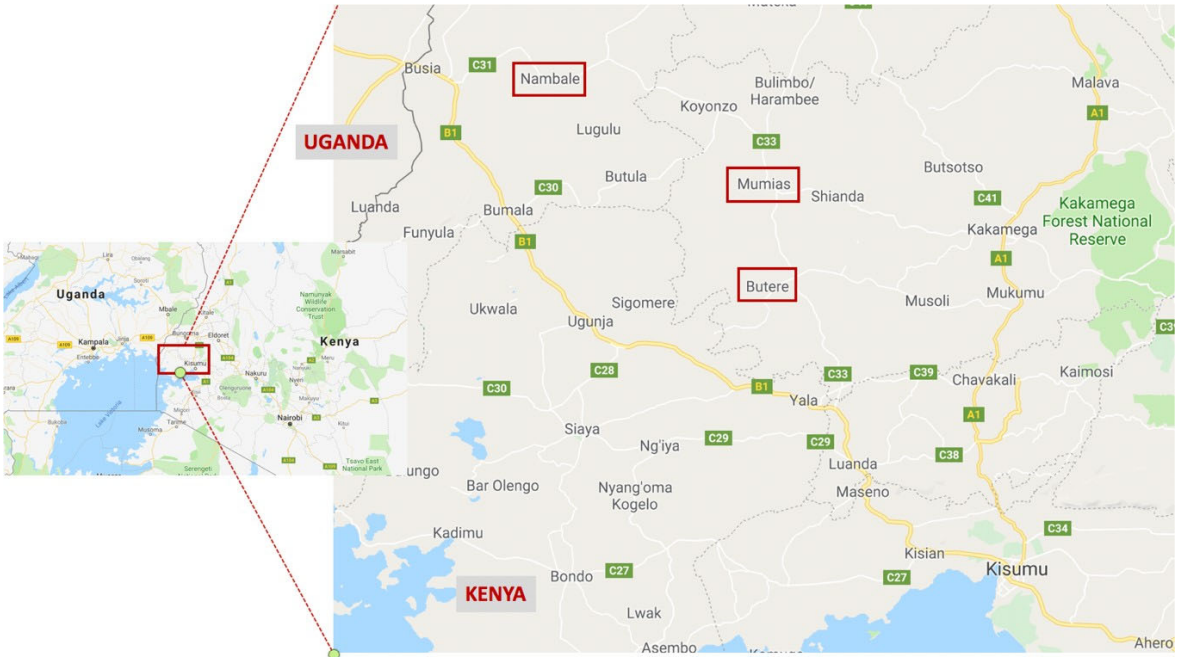


Figure A3.1. Locations of the Four Farmer Focus Group Discussions Conducted by Agrics

Results

Basic descriptive characteristics provided by the focus groups are:

- Total land ownership per farm: 1.5 to 2.0 acres
- Land farmed: 1 acre in long rains; 0.5 to 0.75 in short rains
- Land in soybean production: 0 to 0.25 in long rains; 0.5 in short rains
- Maize is the main crop during the long rains, many other crops are planted
- All focus groups mentioned soybeans as a crop grown by farmers in their area
- Most agricultural activities (e.g., for both maize and soybean production) are done by hand (i.e., without mechanization) although land preparation often uses hired teams of oxen and labor
- Soybean yields during the long rains were 540 kg/acre (1.5 90-kg bags for 0.25 acres)
- Soybean yields during the short rains ranged from 270 kg/acre to 450 kg/acre (based on acres planted and the number of 90-kg bags harvested)
- Soybean prices were reported from 45 KSh/kg (via middlemen) ($.48 USD/kg) to 70-80 KSh/kg ($0.74 - $0.84 USD/kg) (if sold directly to the market). These are based on prices for a local 2-kg unit (the *gologolo*).
- Given reported (and seasonal) prices for maize and soybeans, we calculated that revenue per acre can be higher for soybeans than for maize (36,000 KSh/acre ($379 USD/acre) versus 33,660 KSh/acre ($354 USD/acre); costs per acre may also be lower.
- Key purchased inputs are seeds, fertilizer, agricultural chemicals, labor, storage bags, storage services, transportation services and mobile credit (see detailed discussion below). Basic hand tools are either owned or rented—mechanized production is uncommon
- Rented assets can be spraying equipment, land, wheelbarrows, storage and transport.

- Parts of the soybean plant other than the beans have value as an animal feed, a soil amendment (green manure), as a fuel (burned), and the ash from burned soybean plants is used as a cooking ingredient (like baking soda, used in cooking dried beans)
- The cost per hour for hired labor generally ranges between 200-300 KSh per hour ($2.11 - $3.16 USD/hour), although payment for land preparation can be higher (350 or 400 KSh per hour ($3.68 - $4.21 USD/hour).
- Most hired labor hired for in planting and drying. Weeding and land preparation are the next most common tasks for which labor is hired.
- Farmers reported use of standard DAP and CAN fertilizers and hybrid seed for their soybean plantings. This contrasts with the sales by Agrics of NPK only as plant dressing.

Assumptions and Elements Used for Economic Valuation

To derive from the information received from the Focus Group Discussions to input for the Input-Output analysis, we used information and knowledge from various sources. This includes several substantiated assumptions.

For the share of value added from activities occurring in Kenya, basic information from the Agrics' cost and selling price analysis used. The information of Agrics comprises of data stretching over 3 years and in various key products including fertilizer, seed and assets (both low cost like: storage bags and chemicals and high added value like solar products and cooking stoves). This provides an assessment regarding the margins made from importer to farmers supports assumptions for the value addition in the chain, both inside and outside Kenya. Further, for some inputs references were obtained for direct import or world prices, which can be used to provide an estimate of landed cost.

Table A3.1. Assumptions Used for Value Added Within Kenya

Product type	High-Volume (low margin) Inputs	High-Value Inputs	High-Value Assets	Low-Value Assets
Products	DAP, CAN, NPK	Seeds, inoculants, chemical, other supporting inputs	Solar, stoves	Storage bags, gum boots, *jembe* (hoe)
Imported/local	imported	Mostly local	Imported	Imported
Estimated added value between importer/producer and reseller*	10%	40%	40%	20%
Estimated added value between reseller(s) and farmer*	35%	35%	40%	40%

*This is margin over selling price of the previous actor in the chain.

A comparable calculation can be made for differences between farmer price and the landed cost for a processor. Because Kenya is a large net importer of soybeans, soybean meal and soy oil, these products are sourced from other regional locations (Uganda, Ethiopia, Tanzania and Malawi), In part because these imports are the higher volume sourced, the purchase price for producers is set around 50-60 KSh per kg ($0.53 - $0.63 USD/kg) delivered[13] Nairobi. This implies a price of approximately 40-50 KSh per kg ($0.42 - $0.53 USD/kg) for farmers at their local market.

For inputs such as *jembe* (hoe), gummy boots and spraying equipment, the main challenge is to allocate the appropriate proportion of their total cost to soybean production, given that they are also used for other crops For this allocation we assumed that the proportion was sum of the total acreage used for soybeans both in short rains and long rains divided by the sum of total acreage used in both long and short rains[14]. This indicates that an estimated 40% of use of these assets can be allocated to soybean production for the farmers in the FGD's. For the other assets yield is used for allocation to soybean and other crops. These inputs are primarily related to yield. Here the yield of soy is compared to that of the main staple crop, maize, and to alternatives. The allocation of asset use for soybean estimated on this basis was 14.2%.

For bicycle, motorcycle and mobile phone it is assumed that they are also used for non -arming activities (and in fact non-farm use are assumed to be their principal use). We assume that their use in farming is about 20% of total use, and the allocation to soybean is about one-tenth of that, or 2.8%.

We assume that all labor reported hired for soybean production is a) local and b) allocated only to soybean tasks only. At the same time we recognize that labor-sharing (rather than hired labor paid cash) is a common practice in soybean production areas, i.e., where farmers work the land in groups or with family and help each other.

Selected insights derived from FGD information

Although not directly related to the task of determining the value of the economic contribution of the soybean value chain, data collected in the farmer FGD allows us to estimate the comparative returns to soybean and maize production (Table 2). Although often maize is perceived as a more desirable (and perhaps more profitable crop), our analysis indicates that soybean production has a larger gross margin per acre. This suggests the potential for additional expansion of soybean production in western Kenya, which can thus contribute to an overall increase in the economic contribution of the soy value chain.

[13] Delivered Duty Paid (DDP) basis, which means that the seller assumes all of the responsibility, risk, and costs associated with transporting goods until the buyer receives or transfers them at the destination port. This agreement includes paying for shipping costs, export and import duties, insurance, and any other expenses incurred during shipping to an agreed-upon location in the buyer's country.

[14] The proportion of land planted in soybeans during long rains was 9% (of an average of 0.85 total acres planted) and 63% (of an average of 0.80 total acres planted) during the short rains. Overall, for both seasons, soybeans accounted for 36% of total cropped acres of maize and soybeans.

Table 2. Revenues, Purchased Input Costs and Gross Margins for Soybeans and Maize Based on Information from Farmer Focus Groups

Category	Soybean	Maize
Revenue[a]	19,980	15,360
	($210 USD)	($162 USD)
Yield, kg/acre	540	1,536
Price, KSh/kg	74	20
Input Cost[b]	3,417	4,213
	$36 USD	$44 USD
Gross margin	16,563	11,147
	$376 USD	$117 USD
% gross margin	82.9%	72.6%

Note: Assumes average reported yields, selling prices and input costs for production during the long rains and a harvested area of 0.5 acres

[a] Assumes that all yield is sold, rather than retained for household consumption. This is thus an estimate of "potential revenue" or "full revenue".

[b] Includes purchased inputs other than labor.

Discussion

The foregoing results provide insights relevant for the input-ouput cost at the farm level, derived through the Farmer FGD. There are notable similarities between the responses obtained for the different FG, which was to some extent contrary to our initial expectations about a higher degree of differentiation. We believe that some of the underlying reasons for the similarity of responses are:

- All FG farmers are Agrics farmers who act and work in groups. This means that their inputs, its cost and access to market as well as practices are more likely to be comparable, and many reported costs are aligned with Agrics' selling prices;.
- Farmers come from the same region or location and farmer group. This means that circumstances are often comparable.
- Farmers are selected because they are soybean farmers. This implies the potential for similar farmer characteristics, and with regards to information they have and share among each other.
- In addition, there may have been bias and (unintended) steering towards answers by the facilitator and his support staff, who work for Agrics and is therefore highly familiar with the recommended practices for soybean production.

Concluding Remarks

In conclusion, these four FGD provide reasonably viable and verifiable outcomes with insights about input requirements, costs and from the perspective of the farmer. Thus, they provide one source of information to triangulate with other sources for the input-output analysis.

Key takeaways are:

- There are indications that Revenue and Profit are potentially higher than the main crop Maize.
- Labor is a major component of the cost structure of production of any crop including Soy, for which it amounts to about 79% over revenue, which is consistent with the findings of Goldsmith (2019)
- Input Cost and assets are and estimated 18,6% of total revenue with a value of 7,450 KSh per acre ($78 USD/acre).
- Further analysis can be developed based on the insight of labor, cost, profitability of Soy and potential against Maize.
- The analysis done on the data is using several assumptions and as such, though interesting insights can only be used for further analysis and questioning within other research.
- It is good to note that if the cost of land (opportunity cost by leasing out) and cost for rental cost are included, which is not always used, the farmer is at a net loss. It can be assumed though that the farmer will not value its own labor and its own land as cost on his side.

Appendix 3 [Part II] Farmer Focus Group Interview Guide

A. General Consent Process and Guidelines

1. Welcome
   Introduce yourself and the note taker and send the Sign-In Sheet with a few quick demographic questions (age, gender, and cadre) around to the group while you are introducing the focus group.
   Review the following:
   - Who we are and what we're trying to do
   Good day, We have invited your as Agrics to participate in this discussion on behalf of an American organization that is focusing on the improvement of Soy growth and use called Soy Innovation Lab. This discussion is about the cost to grow soy and use of soy in your area. The information will be used to analyse the the cost and revenue you can make out of soy in Kenya. We asked you to participate because you have shown interest in the past or we believe you have the ability to give us valuable information about the soy or other elements of growing crops in West Kenya.
   - What will be done with this information
   - Why we asked you to participate

Once again, thank you for agreeing to participate. We are very interested to hear your valuable opinion on how the economic contribution of the Soy Value Chain in Kenya as a first example of this type of analysis and to identify a generalizable approach that can be applied in Kenya and even in other countries.

- *The purpose of this study is to describe the current structure, status and key stakeholders of the Kenya SVC from input supply to production, processing and distribution to end users of soy products;*
- *Assess the economic contribution of the Kenya SVC;*
- *Assess the feasibility of a generalizable approach for 1) and 2) to facilitate comparative analysis of SVC in other countries of sub-Saharan Africa.*

2. Explanation of the process
   Ask the group if anyone has participated in a focus group before. Explain that focus groups are being used more nowadays in research.

About focus groups

- We learn from you (positive and negative)
- Not trying to reach an absolute truth or come to full agreement, we're gathering information
- No virtue in long lists: we're looking for priorities
- In this project, we are doing focus group discussions. The reason for using this tool is that we can get more in-depth information from a smaller group of people in focus groups.

- This allows us to understand the context behind the answers given in the written survey and helps us explore topics in more detail than we can do in a written survey.
- Focus group will last about one and a half hours

3. Ground Rules
   Ask the group to suggest some ground rules. After they brainstorm some, make sure the following are on the list.
   - Everyone should participate.
   - Participant must also have grown Soy or Must be knowledgeable about other farmers in the area
   - Must be willing and able to appreciate the questions being asked and create a genuine discussion
   - Looking at the composition of the group, in the sense that we want to rule out familial relationships and people to dominant or too shy.
   - The facilitator will make sure that any information gathered will only be reported back to Agrics or SIL in general terms and the name of people in this group will not be used in the report. This means that people can speak freely about what they think and feel without any consequences from Agrics.
   - Stay with the group and please don't have side conversations
   - Turn off cell phones if possible

4. Ask the group if there are any questions before we get started, and address those questions.
5. Make sure to give people time to think before answering the questions and don't move too quickly. Use the probes to make sure that all issues are addressed, but move on when you feel you are starting to hear repetitive information.

B. DISCUSSION BEGINS

1) Land size

1. What is average size of land ownership in the area?
2. How much land do most farmers have in use during long rain?
3. How much land do most farmers have in use during short rain?

2) Land Use

Guideline: Split up long rain and short rain and then after we received the information from the Focus Group Discussion we will combine them together. However if it is clear that short rain is predominantly Soy while long rain is predominantly maize then it might be good to zoom in on the short rains first.

1. What are the crops that are mostly grown in the area?
2. What is the size of land for sugarcane per average farmer?
3. What is the size of land for maize per average farmer?
4. What is the size of land for Soy per average farmer?

3) Hired labor

Guideline: To get a proper reference on how labour is used and what the labor cost are per stage it is advisable to do the most dominant crop in the area first. Farmers can use this as a reference point. For West Kenya it is therefore advisable to do maize first, and then check where soy is different.

S/n	Step	Number of help	Number of days	family	Part of group supporting each other	Given goods? Which ones How much?	Given other trades?/what?	Given money? How much
1	During land preparation							
2	During planting							
3	During weeding							
4	During topdressing							
5	During harvesting							
6	Post-harvest handling							

4) Yield per crop

Guideline: At this point the questions change in principle from question per season to questions per acre. It is good to keep in mind and check what the farmers is referring to, is it yield per harvest, per year? Is the yield different in the short and long rain? The estimates are per average size, for which the answer was given in theme one average plot size.

So if the size of the farmer will be xxx acre…

1. What would a typical farmer, farming soy yield in terms of Soy?
2. What would a typical farmer yield in terms of Maize?
3. What would a typical farmer yield in terms of Other Crops?

5) Sales

Note; with sales we are moving to sales per year, so no longer per season

On Soy:

1. What is the quantity a soy farmer is selling every year?
2. What are the options for soy farmers to sell their Soy to?
3. Did you sell your soy through Agrics?
4. What would be a reason to sell to Agrics?
5. What would be a reason to sell to the market?
6. What would be a reason to sell to a middleman?
7. What would be the average price a farmer receives when they sold soy to the market?
8. What would be the average price a farmer receives when they sold through the middleman?
9. What can other parts of the soy plant be used for?
10. What is the unit of measurement of rest product of soy?
11.

On Maize:

1. What is the price farmers receive at long rain harvest last year?
2. What is the price farmers receive at the end of the year last year?
3. What is the price farmers receive for maize in January?
4. What is the price farmers receive for maize in March?
5. What can other parts of the maize be used for?
6. What is the unit of measurement of rest product of maize?

On other crops:

At this question the other crops are defined higher up in the questions, meaning the other crops will filled in according to the answers given earlier. This can be several crops. The months will depend on the time of harvest, typical 1. During or right after harvest, 2. 2-3 months after harvest, 3. During planting and 4. 2-3 months after planting. It will give an indication of fluctuation of yield prices over the year

1. What is the price farmers receive at long rain harvest last year for [OTHER CROP]?
2. What is the price farmers receive at the end of the year last year for [OTHER CROP]?
3. What is the price farmers receive for [OTHER CROP] in January?
4. What is the price farmers receive for [OTHER CROP] in March?

6) Other revenue source of the plant

1. Are you able to sell other parts of the plant like Stover as fodder or other use?
2. Is it possible to use other parts of the soy plant?
3. What can it be used for?
4. Is it used as soil amendment?

5. Is it used as ANIMAL feed?
6. If a farmer would sell it to the market or to another farmer, how much would they get per bag?
7. What other products would a farmer use for [SOIL AMMENDMENT, ANIMAL FEED, GRAZED, OTHER USE]? What would they pay?

7) Other income

1. What are typical other sources of income that farmer household have in this area?
2. How much other income would a farmer household make per month depending on the source?

8) Current Asset Ownership

1. What equipment do farmers use for farming? Some examples include:

S/n	Asset	Bought last 3 years?	How often bought?	What is current price?	Made in Kenya	Used for soybean crop?	Produced in Kenya?
1	A jembe, hoe						
2	Gummy boots						
3	Spraying pump						
4	Wheelbarrow						
5	Storage						
6	Bike						
7	Carts						
8	Pikipiki						
9	Mobile phone						
10							

2. Are they used for soy production?
3. In the past three years, have farmers in your area bought equipment, tools or clothing used for farming activities? Relate as needed to the "average" farm size from earlier.

9) Non-Current Assets Ownership

1. What buildings or structures do farmers use for farming? Some examples include:

S/n	Asset	Bought last 3 years?	How often bought?	What is current price?	Made in Kenya	Used for soybean crop?	Produced in Kenya?
1	Storage for grain						
2	Storage for equipment						
3	Other						
4	Other						

2. Are they used for soy production?
3. In the past three years, have farmers bought materials to build or paid someone to build a structure used for farming activities?
4. Have farmers purchased more land in the last three years?
5. If so, on average, how much?
6. What would be a general price per acre?

10) Hired equipment

Was the equipment indicated below hired/rented for farming during the past Rented in past two cropping seasons?					
S/n	Equipment	Price (unit, such KSh/hr)	Used for soybean crop?	Price (unit, such KSh/hr)-If different from the previous price	Other Kind of payments made
1	A jembe, hoe				
2	Gummy boots				
3	Spraying pump				
4	Lease of land (per acre)				
5	Wheelbarrow				
6	Storage				
7	Bike				
8	Carts				
9	Pikipiki				
10					

11) Input purchase

Relate as needed to the "average" farm size from earlier.

During the past two cropping seasons (long rains + short rains) did farmers generally purchase any of the following inputs for crop production?

Input	Amount	Price per unit	Seller (Agrics, Agrovet, etc.)	Made in Kenya	Amount used for soybean crop
Fertilizers					
Chemicals					
Seeds/plants					
Packaging					
Bags?					
Fuel or oil					
Maintenance or repair					
Land rent/lease				*Assumed to be Kenyan*	
Bank charges (interest)					
Insurance					
Mobile credit					
Services*					
Crop					

Packing					
Storage					
Transport					
Other?					

From the above, want to be able to put the seller into a category: manufacturer, wholesaler/distributor, retailer (local shop). Additional lines can be used for specific types of inputs, like different fertilizers.

'*' means purchased from another company

Appendix 4. Detailed Results for Development Contribution Analyses Based on the Economic Contribution Analysis

Table A4.1a. Economic Contribution Results for Scenario with 4X Soybean Production, Reduced Soybean Imports, and No Maize Production Offset

Sector	Direct Effect	Indirect Effect	Induced Effect	Total Effect	Contribution Multiplier
Output ($ 000)					
Production	6,202	5,147	3,851	15,200	2.45
Processing	48,619	21,209	18,737	88,565	1.82
Value Chain	54,822	15,465	18,928	89,215	1.63
Employee Compensation ($ 000)					
Production	1,912	1,076	607	3,595	1.88
Processing	3,670	5,744	2,938	12,353	3.37
Value Chain	5,582	3,923	2,972	12,476	2.24
Total Value Added ($ 000)					
Production	1,040	2,804	2,211	6,055	5.82
Processing	16,096	9,015	10,779	35,890	2.23
Value Chain	17,136	8,190	10,885	36,212	2.11
Employment (FTE Jobs)					
Production	1,487	419	191	2,096	1.41
Processing	1,351	2,565	930	4,845	3.59
Value Chain	2,838	1,134	939	4,910	1.73

Table A4.1b. Change in Economic Contribution for Scenario with 4X Soybean Production, Reduced Soybean Imports, and No Maize Production Offset

Sector	Direct Effect	Indirect Effect	Induced Effect	Total Effect	Contribution Multiplier
Output ($ 000)					
Production	4,651	3,847	2,898	11,397	0.00
Processing	0	7,886	2,717	10,602	0.22
Value Chain	4,655	3,379	2,795	**10,826**	0.07
Employee Compensation ($ 000)					
Production	1,434	801	457	2,692	-0.01
Processing	0	2,047	426	2,474	0.68
Value Chain	1,434	625	441	**2,499**	-0.17
Total Value Added ($ 000)					
Production	790	2,095	1,664	4,548	-0.20
Processing	232	2,544	1,563	4,339	0.24
Value Chain	1,021	1,850	1,605	**4,478**	0.14
Employment (FTE Jobs)					
Production	1,115	314	144	1,572	0.00
Processing	0	1,389	135	1,523	1.13
Value Chain	1,115	283	139	**1,535**	-0.23

Table A4.2a. Economic Contribution Results for Scenario with 4X Soybean Production, Reduced Soybean Imports, With Maize Production Offset

Sector	Direct Effect	Indirect Effect	Induced Effect	Total Effect	Contribution Multiplier
Output ($ 000)					
Production	6,202	4,061	3,282	13,545	2.18
Processing	48,619	21,209	18,737	88,565	1.82
Value Chain	54,822	14,379	18,359	87,559	1.6
Employee Compensation ($ 000)					
Production	1,912	992	498	3,401	1.78
Processing	3,670	5,744	2,938	12,353	3.37
Value Chain	5,582	3,838	2,862	12,282	2.2
Total Value Added ($ 000)					
Production	1,040	2,094	1,904	5,039	4.84
Processing	16,096	9,015	10,779	35,890	2.23
Value Chain	17,136	7,481	10,578	35,195	2.05
Employment (FTE Jobs)					
Production	1,487	360	164	2,010	1.35
Processing	1,351	2,565	930	4,845	3.59
Value Chain	2,838	1,075	912	4,824	1.7

Table A4.2b. Change in Economic Contribution for Scenario with 4X Soybean Production, Reduced Soybean Imports, With Maize Production Offset

Sector	Direct Effect	Indirect Effect	Induced Effect	Total Effect	Contribution Multiplier
Output ($ 000)					
Production	4,651	2,761	2,329	9,742	-0.27
Processing	0	7,886	2,717	10,602	0.22
Value Chain	4,655	2,293	2,226	**9,170**	0.04
Employee Compensation ($ 000)					
Production	1,434	717	348	2,498	-0.11
Processing	0	2,047	426	2,474	0.68
Value Chain	1,434	540	331	**2,305**	-0.21
Total Value Added ($ 000)					
Production	790	1,385	1,357	3,532	-1.18
Processing	232	2,544	1,563	4,339	0.24
Value Chain	1,021	1,141	1,298	**3,461**	0.08
Employment (FTE Jobs)					
Production	1,115	255	117	1,486	-0.06
Processing	0	1,389	135	1,523	1.13
Value Chain	1,115	224	112	**1,449**	-0.26

Table A4.3a. Economic Contribution Results for Scenario with Increased Soybean Production, No Soybean Oil Imports, and No Maize Production Offset

Sector	Direct Effect	Indirect Effect	Induced Effect	Total Effect	Contribution Multiplier
Output ($ 000)					
Production	5,344	4,437	3,316	13,097	2.45
Processing	48,619	19,798	17,793	86,210	1.77
Value Chain	53,963	14,886	17,969	86,818	1.61
Employee Compensation ($ 000)					
Production	1,647	928	523	3,098	1.88
Processing	3,670	5,377	2,790	11,837	3.23
Value Chain	5,317	3,818	2,821	11,956	2.25
Total Value Added ($ 000)					
Production	895	2,418	1,904	5,216	5.83
Processing	14,856	8,558	10,236	33,650	2.27
Value Chain	15,751	7,862	10,335	33,947	2.16
Employment (FTE Jobs)					
Production	1,281	361	164	1,806	1.41
Processing	1,351	2,324	883	4,557	3.37
Value Chain	2,632	1,097	891	4,620	1.75

Table A4.3b. Change in Economic Contribution for Scenario with Increased Soybean Production, No Soybean Oil Imports, and No Maize Production Offset

Sector	Direct Effect	Indirect Effect	Induced Effect	Total Effect	Contribution Multiplier
Output ($ 000)					
Production	3,793	3,137	2,363	9,294	0.00
Processing	0	6,475	1,773	8,247	0.17
Value Chain	3,796	2,800	1,836	**8,429**	0.05
Employee Compensation ($ 000)					
Production	1,169	653	373	2,195	-0.01
Processing	0	1,680	278	1,958	0.54
Value Chain	1,169	520	290	**1,979**	-0.16
Total Value Added ($ 000)					
Production	645	1,709	1,357	3,709	-0.19
Processing	-1,008	2,087	1,020	2,099	0.28
Value Chain	-364	1,522	1,055	**2,213**	0.19
Employment (FTE Jobs)					
Production	909	256	117	1,282	0
Processing	0	1,148	88	1,235	0.91
Value Chain	909	246	91	**1,245**	-0.21

Table A4.4a. Economic Contribution Results for Scenario with Increased Soybean Production Resulting in Increased Broiler Production, No Impact on Imports of Soybeans, Meal or Oil, No Maize Production Offset

Sector	Direct Effect	Indirect Effect	Induced Effect	Total Effect	Contribution Multiplier
Output ($ 000)					
Production	21,859	8,432	23,299	53,591	2.45
Processing	75,854	27,245	27,210	130,308	1.72
Value Chain	97,713	19,949	45,569	163,231	1.67
Employee Compensation ($ 000)					
Production	5,133	1,418	3,648	10,199	1.99
Processing	5,726	7,446	4,268	17,440	3.05
Value Chain	10,859	5,412	7,141	23,412	2.16
Total Value Added ($ 000)					
Production	11,780	4,658	13,371	29,809	2.53
Processing	24,946	12,180	15,657	52,783	2.12
Value Chain	36,726	11,467	26,188	74,381	2.03
Employment (FTE Jobs)					
Production	2,288	597	1,154	4,039	1.77
Processing	2,108	2,974	1,350	6,432	3.05
Value Chain	4,396	1,542	2,259	8,197	1.87

Table A4.4b. Change in Economic Contribution Results for Scenario with Increased Soybean Production Resulting in Increased Broiler Production, No Impact on Imports of Soybeans, Meal or Oil, No Maize Production Offset

Sector	Direct Effect	Indirect Effect	Induced Effect	Total Effect	Contribution Multiplier
Output ($ 000)					
Production	20,308	7,132	22,346	49,788	0.00
Processing	27,235	13,922	11,190	52,345	-0.10
Value Chain	47,546	7,863	29,436	**84,842**	0.04
Employee Compensation ($ 000)					
Production	4,655	1,143	3,498	9,296	0.11
Processing	2,056	3,749	1,756	7,561	-0.32
Value Chain	6,711	2,114	4,610	**13,435**	-0.08
Total Value Added ($ 000)					
Production	11,530	3,949	12,824	28,302	-3.29
Processing	9,082	5,709	6,441	21,232	-0.11
Value Chain	20,611	5,127	16,908	**42,647**	-0.08
Employment (FTE Jobs)					
Production	1,916	492	1,107	3,515	0
Processing	757	1,798	555	3,110	-0.54
Value Chain	2,673	691	1,459	**4,822**	0.14

Appendix 5. Sub-Saharan African Countries for which EORA Input-Output Matrix Data are Available (https://worldmrio.com/countrywise/)

** indicates county with substantive soybean production in recent years*

Angola
Burkina Faso*
Cameroon*
Central African Republic
Chad
Congo
Cote D'Ivoire*
Democratic Republic of Congo*
Djibouti
Eritrea
Ethiopia*
Gabon*
Gambia
Ghana*
Guinea
Lesotho*
Liberia*
Madagascar*
Malawi*
Mali
Mauritania
Mozambique
Namibia
Niger
Nigeria*
Senegal*
Sierra Leone
Somalia
South Africa*
South Sudan
Sudan
Swaziland
Tanzania*
Togo
Uganda*
Zambia*
Zimbabwe*

Appendix 6. Domestic Supply and Import Shares of Edible Oils in Kenya Based on FAO Data, 2010 to 2017

Appendix Table 6.1 Domestic Supply and Percentage of Total for Edible Oils in Kenya, 2010 to 2013

Year	Coco-nut Oil	Cotton-seed Oil	Groundnut Oil	Maize Germ Oil	Other Oilcrop Oil	Olive Oil	Palm Oil	Palm Kernel Oil	Rape and Mustard Oil	Sesame seed Oil	Soybean Oil	Sunflower Oil	Total
2010	7,886	757	-15	18,588	14,835	544	574,928	9,489	18	-37	578	4,478	632,049
2011	1,944	1,762	0	18,401	20,656	706	201,543	933	78	-64	3,452	6,311	255,722
2012	4,131	1,024	0	18,401	21,043	706	232,739	933	78	0	2,452	6,292	287,799
2013	3,978	1,253	-27	19,765	19,221	370	604,740	9,761	70	-14	1,550	8,694	669,361
Percentage of Domestic Supply													
2010	1.2	0.1	0.0	2.9	2.3	0.1	91.0	1.5	0.0	0.0	0.1	0.7	100.0
2011	0.8	0.7	0.0	7.2	8.1	0.3	78.8	0.4	0.0	0.0	1.3	2.5	100.0
2012	1.4	0.4	0.0	6.4	7.3	0.2	80.9	0.3	0.0	0.0	0.9	2.2	100.0
2013	0.6	0.2	0.0	3.0	2.9	0.1	90.3	1.5	0.0	0.0	0.2	1.3	100.0

Both palm oil and palm kernel oil derive from **palm** trees, but there the similarity ends. **Palm oil** comes from the **palm** fruit, while **palm kernel oil** is extracted from the **palm** seed.
And while over 80 percent of the fat in **palm kernel oil** is saturated, only 50 percent of **palm oil** is, making it easier on arteries.

Appendix Table 6.2 Import Quantities and Percentage of Total for Edible Oils in Kenya, 2010 to 2013

Year	Coco-nut Oil	Cotton-seed Oil	Ground-nut Oil	Linseed Oil	Maize Oil	Palm Oil	Palm kernel Oil	Rape-seed Oil	Sesame Oil	Soy-bean Oil	Sun-flower Oil	Other Vege-table Oil	Total
2010	2,239	4	0	49	5,067	536,572	9,489	18	3	482	2,255	893	557,071
2011	104	240	0	21	5,067	165,702	1,001	78	55	4,422	3,867	6,580	187,137
2012	682	118	0	28	3,738	196,832	692	112	0	654	2,015	6,338	211,209
2013	296	0	2	29	6,048	593,882	9,765	81	7	2,256	6,335	6,270	624,971
2014	570	1	37	6	3,264	274,096	611	270	7	227	4,749	7,792	291,630
2015	282	2	32	22	3,484	320,686	1,000	95	8	1,143	3,822	6,983	337,559
2016	124	158	0	6	5,293	320,954	798	2,865	5	2,094	3,509	4,585	340,391
2017	376	121	0	55	4,466	768,380	9,830	5,112	7	2,636	7,800	24,149	822,932

Percentage of Total

2010	0.4	0.0	0.0	0.0	0.9	96.3	1.7	0.0	0.0	0.1	0.4	0.2	100.0
2011	0.1	0.1	0.0	0.0	2.7	88.5	0.5	0.0	0.0	2.4	2.1	3.5	100.0
2012	0.3	0.1	0.0	0.0	1.8	93.2	0.3	0.1	0.0	0.3	1.0	3.0	100.0
2013	0.0	0.0	0.0	0.0	1.0	95.0	1.6	0.0	0.0	0.4	1.0	1.0	100.0
2014	0.2	0.0	0.0	0.0	1.1	94.0	0.2	0.1	0.0	0.1	1.6	2.7	100.0
2015	0.1	0.0	0.0	0.0	1.0	95.0	0.3	0.0	0.0	0.3	1.1	2.1	100.0
2016	0.0	0.0	0.0	0.0	1.6	94.3	0.2	0.8	0.0	0.6	1.0	1.3	100.0
2017	0.0	0.0	0.0	0.0	0.5	93.4	1.2	0.6	0.0	0.3	0.9	2.9	100.0