Final report

Maize value chains in East Africa

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October 2016

When citing this paper, please use the title and the following reference number:
F-38202-RWA-1

DIRECTED BY

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The International Growth Centre sponsored the research for this report. It draws on primary information from field interviews carried out in Rwanda and Uganda in May and June, 2015, as well as secondary information sources. Errors of fact or interpretation remain the exclusive responsibility of the author(s). The opinions expressed or conclusions made in this study are not endorsed by the project sponsor. We welcome comments and suggestions. The lead author may be contacted at jack.daly@duke.edu.

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Acronyms

ABCD	Archer Daniels Midland, Bunge Group, Cargill, and Louis Dreyfus
ADM	Archer Daniels Midland
CAGR	Compound Annual Growth Rate
CIP	Crop Intensification Program
DSIP	Development Strategy and Investment Plan
DDG	Distillers' dry grains
DRC	Democratic Republic of Congo
EAC	East African Community
EAGC	Eastern Africa Grains Council
EAX	East African Commodity Exchange
ECX	Ethiopian Commodity Exchange
ENAS	Enterprise Nkubili Alfred & Sons
EU	European Union
FAO	Food and Agriculture Organization
GVC	Global Value Chains
MINAGRI	Ministry of Agriculture and Animal Services
MT	Metric tons
OPV	Open-pollinated varieties
RAB	Rwandan Agriculture Board
RGCC	Rwanda Grains and Cereal Corporation
R&D	Research & Development
SHS	Ugandan shillings
SPS	Sanitary and Phytosanitary standards
SSA	Sub-Saharan Africa
UIA	Uganda Investment Authority
UNCE	Uganda National Commodity Exchange
WRS	Warehouse Receipt Systems

Executive Summary

This report uses the Global Value Chain (GVC) framework to examine the maize industry in East African Community (EAC) countries, concentrating its analysis on Rwanda and Uganda. Agriculture is an important economic activity throughout the region, accounting for an estimated 83% of total employment (Joughin, 2014b). However, its export profile in countries such as Rwanda and Uganda is muted by high volumes of informal trade, with as much as 70-80% of maize accessed through channels where it is not taxed or regulated. Despite the difficulty in retrieving accurate data because of the size of the unregulated market, the clear trend in Rwanda and Uganda is toward increasing production and exports.

The Maize Global Value Chain

The maize value chain can be divided into five categories: inputs; production; aggregation; processing; and marketing and distribution. One of the world's three dominant crops along with rice and wheat, the global maize industry had revenues of US$219.5 billion in 2015 (Marketline, 2016). End uses depend on geographic location and food security considerations; however, animal feed and, increasingly, ethanol production are the focus in developed nations.

The interest in ethanol and animal feed helps shape the organization of the global industry. The largest grain traders are Archer Daniels Midland Co (ADM), Bunge Group, Cargill, and Louis Dreyfus. Collectively, these four companies manage an estimated 70-90% of globally traded grains (Murphy et al., 2012). All are critical to the world food trade, using an unmatched network of silos, ports, ships and farmer relationships to buy and sell grains to customers ranging from food groups to biofuel companies and animal feed corporations. Investments in new markets are often contingent on securing supplies of grain or accessing new markets for growth segments—ethanol, animal feed, or advanced food products such as glucose—for outputs.

The EAC in the Maize Value Chain

The EAC maize context is partially disconnected from global trends. This stems from maize's status as a staple food crop in East Africa, where it accounts for nearly half of the calories and protein consumed (Macauley, 2015). Kenya, in particular, is a voracious consumer. Unable to satisfy its demand with domestic supply, the country imported the second highest volume of maize in Sub-Saharan Africa behind Zimbabwe in the period from 2004 to 2013. Its processors serve as lead firms in the regional chain, exerting their power by demanding traders and other suppliers deliver high-quality maize that adheres to EAC or Kenyan standards. While maize is not as significant a component of the Ugandan diet—a cash crop instead of a food crop—the country enjoys resource advantages in upstream segments of the chain, allowing it to become a prominent regional producer and exporter of maize to Kenya and other markets.

In addition to Kenyan demand and Ugandan supply, a second significant characteristic that shapes the EAC maize market is the prominence of maize flour exports. Depending on the year, Africa generally accounts for 1.5 to 3.5% of global exports of maize; by comparison, the value of the continent's exports of maize flour represented 20% of worldwide trade in 2013. Much of the maize flour emanates from more technologically advanced processing nations to countries that do not have extensive milling infrastructure.

Both Uganda and Rwanda have sizeable market share in maize flour exports. Consumers in the EAC are sensitive to price considerations, which mean that transportation costs can impair competitiveness. As a result, trade of maize flour is concentrated in countries in close geographic proximity. Uganda exports its surplus maize flour to the Democratic Republic of Congo (DRC) and South Sudan, while Rwanda, which is a relatively minor player in the regional market and not reliant on Kenyan consumers, exports low quality flour to the DRC and Burundi.

The differences in the trading profiles between Uganda and Rwanda hint at contrasts in the organization and the structure of their value chains. While "formal" aggregators, including mills and large traders, compete with "informal" traders in the sourcing of raw material in both countries, Uganda's industry has a higher number of larger-scale actors. Smallholder farming systems characterize the production systems in each; however, cooperatives are larger in Rwanda compared to Uganda, with thousands of farmers instead of hundreds. In the downstream segments of the chain, Rwanda has only one large mill and a small number of formal traders; Uganda, on the other hand, has a higher number, including roughly five large and several medium-sized mills.

These characteristics lead to strengths and weaknesses that can be both generalized and localized. The advantages include:

- **Widespread maize farming with recent increases in production and export volumes.** While there are conflicting estimates about maize production and exports in the EAC as well as concerns about data reliability, the clear trend line is for increasing production and export volumes in both Rwanda and Uganda. Rwanda's production volume increased from 88,000 MT in 2004 to 667,000 in 2013; Uganda's jumped from 1.3 million to 2.7 million MT in the same period. The gains have helped Uganda solidify its place as one of Africa's three largest exporters of both maize and maize flour.

- **Favorable growing conditions.** Maize production is widespread in both countries. Uganda, in particular, has been the target for upstream investments in the chain, with foreign companies such as Afgri Limited (South Africa) and Amatheon-Agri (Germany) expanding their presence in the country.

- **Government attention to the sector.** Both the Rwandan and Ugandan governments have included maize as part of broader pushes to spark agricultural development. In Rwanda, the CIP provides subsidies to farmers for key inputs such as seed, fertilizer, and insecticide. In Uganda, the *Development Strategy and Investment Plan (DSIP)* developed by the Ministry of Agriculture, Animal Industry & Fisheries in 2010 included maize as a priority crop.

There are a diverse array of challenges and barriers to upgrading at different segments of the chain. However, three fundamental constraints impede the development of the sector. These include: (1) The lack of cash and finance for farmers; (2) the lack of commercial scale; and (3) the lack of communication of market signals and standards. Together, these shortcomings lead to the prevalence of low-quality maize, which has the effect of driving actors to the informal market

since: (1) Smaller-scale informal traders do not differentiate for quality and provide immediate sources of cash; and (2) formal aggregators demand higher-quality maize.

There are other obstacles to more competitive maize industries. These include the following:

- **High levels of segregation within private sector.** There are few examples of integrated companies in Rwanda and Uganda. Minimex, Rwanda's largest maize processor, is an exception, with aggregation and storage capabilities as well as links to the Bralirwa brewery to purchase its maize grits. Most companies in Uganda have a narrow focus save for a few outliers. Segregation within the private sector reduces communication of market signals throughout the chain while also perpetuating the misalignment of incentives.

- **Failure to implement government programs.** While the Ugandan government included maize as part of development initiatives, it has not implemented *DSIP* at a broad level. Previous studies report that there does not appear to be institutional support to adopt the DSIP, with government officials concerned that full implementation and increased autonomy for the sector may undermine the interests of entrenched, elite stakeholders (Joughin, 2014a).

- **Low compliance capacity with regional maize standards.** While there is harmonization of maize standards at the EAC level, there is uneven adherence to these requirements at the country level. The failure to comply with these guidelines is the result of one of three factors: (1) Consumers' unawareness of the benefits of food safety; (2) consumers' sensitivity to higher prices; and (3) inability of national governments to publicize, test, or enforce the standards at all stages of value chain.

Despite the entrenched challenges, there are opportunities to upgrade Uganda's and Rwanda's maize value chains to enhance efficiency and boost exports. Consistent with the dynamics of the regional value chain described earlier—Uganda as an important supplier for the vibrant Kenyan market; Rwanda as a supplier of maize flour for neighboring countries—the two countries can concentrate future efforts on different segments of the chain. Stakeholders in Uganda should focus on upstream portions, where process upgrades can address shortages of critical inputs, poor storage conditions, inadequate warehouse capacity, and misaligned motivations of key actors. Given its fertility and its potential to generate large volumes of maize, Uganda can simultaneously work toward two goals: (1) Boosting exports further through increased commercial farming to generate favorable economies of scale; and (2) supporting the continued employment of the 2.5-3 million farmers by providing education on the importance of standards. Broadly, the country should work toward increasing volumes of EAC-certified maize to Kenyan processors, who act as lead firms in the chain and require adherence to quality protocols.

Rwanda would benefit from some of these same upgrades, especially in the aggregation or trading segment of the chain. However, as an importer of maize from Uganda and an exporter of maize flour to the DRC and Burundi, it also can focus on downstream elements such as marketing and distribution. This would facilitate the upgrading of the industry by potentially boosting demand for its largest export products while also providing nutritional benefits for its citizens.

Table E-1 presents a summary of the upgrading trajectories available to Rwanda and Uganda as well as specific recommendations that will aid their establishment.

Table E-1: Upgrading Trajectories and Policy Recommendations

Potential Upgrading Trajectory	Key Benefits	Capacities Required of Individual Firms	Challenges	Specific Recommendations (Level of Actors to Lead Efforts)
Process upgrading in Uganda to increase maize quality	• Increase maize quality • Positions country to gain better access to regional markets (Kenya) • Drive actors from informal to formal chain	• Technical expertise • Access to inputs/storage facilities • Access to finance • Access to market information	• Counterfeit or low-quality inputs • Lack of liquidity • Small land size comprises economies of scale • Poor storage conditions • Lack of coordination/ information-sharing between actors	**Seeds** • Easier access to Kenyan seed market (national) • Enhance and simplify institutional environment (EAC) • Investigate causes for seed market failures in Uganda (national) **Scale** • Provide clarity with land ownership (national) • Recruit FDI from regional firms (national) **Aggregation** • Training and education of key actors (national, EAC) • Encourage financial institutions to support warehouse projects and increase capacity (national, EAC) • Collaborate with regional institutions (EAC, national)
Process upgrading in Uganda to ensure adherence to EAC standards	• Increase exports to Kenya • Increase economic security for smallholders • Drive actors from informal to formal chain	• Access to market information and EAC standards • Technical expertise • Access to storage	• Knowledge of standards among producers and aggregators • Warehouse and storage conditions • Certification capacity • Weak institutional and legal frameworks	• Increase certification capacity through education programs, improving maize quality, and expanding testing facilities at border (EAC, national) • Evaluate appropriate legal frameworks and engage in conversations with stakeholders (National)
Product and process upgrading in Uganda and Rwanda to increase quality and diversity of outputs	• Access new markets • Strengthen downstream linkages	• Access to higher quality inputs • Investments in expensive equipment	• Low quality maize • High demand of maize for traditional outputs • Cost sensitivity of consumers • Outdated or insufficient technology	• Initiate studies of livestock industries (national) • Encourage communication between participants in livestock and maize GVCs (national, EAC)
Functional upgrading in Rwanda and Uganda to increase demand for higher-value products	• Increased health and nutritional benefits • Possible increase of volume and value of exports	• Access to markets • Access to technology	• Cost sensitivity of consumers • Lack of awareness of benefits of higher-value maize flour products	• Introduce mandatory flour fortification in Rwanda (national) • Create public relations campaign in that highlights health benefits of fortified flour (national) • Conduct market studies for regional markets (national) • Collect better data (EAC, national)

Source: Authors.

1. Introduction

Governments in Rwanda and Uganda have targeted maize as a priority sector due to the industry's potential to enhance GDP, expand exports, and promote food security. Agriculture in the region traditionally has been an important source of employment, providing as many as 83% of jobs (Joughin, 2014b), but in the last decade, the maize industry in the EAC has experienced rapid growth, substantial upgrading of capabilities, and the expansion of cross-border trade.[1]

Despite the fact that substantial volumes of informal maize trade obscures the full scope of the industry, Rwanda's and Uganda's gains can be detected from official production and export data (see Table 1). With the government's *Crop Intensification Program* (CIP) providing access to subsidized inputs such as seed and fertilizer, Rwanda's maize production jumped from 88,000 metric tons (MT) in 2004 to 667,000 in 2013. Exports have followed a similar trend, with trade in maize flour showing particular vibrancy. In Uganda, moves toward increasing commercialization have seen both production and exports more than double in the same period.

Table 1: Production and Exports Within Uganda and Rwanda's Maize Industry, 2004-2013

	2004	2006	2009	2011	2013
Production					
Rwanda					
Area Planted (Hectares, '000)	115	113	147	223	292
Production Quantity (MT, '000)	88	96	286	525	667
Uganda					
Area Planted (Hectares, '000)	710	819	942	1,063	1,101
Production Quantity (MT, '000)	1,300	1,258	2,354	2,551	2,748
Export Profile					
Rwanda					
Maize Export Value (US$, millions)	0	0.1	0	0.1	2
Maize Flour Export Value (US$, millions)	0	0	0	0.8	6
Total (US$, millions)	**0**	**0.1**	**.09**	**1**	**9**
Uganda					
Maize Export Value (US$, millions)	10	15	16	17	26
Maize Flour Export Value (US$, millions)	6	7	12	9	15
Total (US$, millions)	**17**	**23**	**28**	**26**	**42**

Sources: Uganda Bureau of Statistics, 2015; FAOSTAT. FAO based on item codes 58 and 5922. Retrieved on July 15, 2016.

The contours of a regional value chain have emerged as Uganda and Rwanda have made productivity gains. With large areas of fertile land, Uganda has been the source of FDI in farming and trading segments of the chain, helping it to become the third-largest exporter of maize in Africa (FAOSTAT). As the country has increased its production, Kenya—the largest consumer of maize in the EAC and one of the principal importers in Africa—has become its most significant trading partner. Rwanda also imports Ugandan maize for its domestic industry, but the country is its own node in the regional chain, with its processors exporting low-quality maize flour to neighboring Burundi and the Democratic Republic of Congo (DRC).

[1] The EAC is an intergovernmental organization designed to strengthen links between five partner states: Burundi, Kenya, Rwanda, Tanzania, and Uganda.

Future interventions can focus on driving efficiencies in the segments of the chain where each country has advantages. Despite productivity gains, the Ugandan maize sector is still characterized by substandard maize. There are a variety of upstream constraints; however, the underlying issues that comprise the quality of the maize and drive actors to the informal market are: 1. Lack of liquidity; 2. Lack of scale; 3. Lack of communication of market signals and standards. Although the CIP program has helped Rwanda make improvements in the upstream portions of its chain, like Uganda, it is also characterized by challenges in aggregation segments. Additionally, with its recent expansion in maize flour exports, there may be opportunity for Rwanda to enhance its marketing and distribution.

In collaboration with the International Growth Centre (IGC), this report attempts to gain better understanding of the role of East African firms play within regional value chains and the opportunities and constraints that firms face in participating and upgrading their positions. The GVC analysis is particularly useful to inform policy makers as it examines the full range of activities that firms and workers perform to bring a product from conception to production and end use. By assessing the labor inputs, technologies, standards, regulation, products, processes, and geography that define the sector, it offers insight that will allow domestic and regional stakeholders to understand the factors that have allowed similar countries both to enter and improve their position in the chain.

The first section of the report concentrates on the global industry by first mapping the value chain before proceeding to an analysis of the prominent firms in the industry. It concludes by analyzing global trade and production data. The second section examines the EAC maize value chain, focusing primarily on Uganda and Rwanda. After outlining the industry characteristics in both countries, it identifies important recent regional trends. The final section then examines both opportunities and key constraints that limit the upgrading potential before suggesting policy interventions to address these obstacles.

1.1. Research Questions

In partnership with the IGC, Duke CGGC identified the following three clusters of research questions to guide its analysis of the maize industry in the EAC:

- How does the maize value chain differ in each country? What are the different products? How do end markets differ?

- Who are the relevant actors at the national and regional levels? How do lead firms govern the chain? How is production and trade coordinated across EAC countries?

- What are specific strategies private actors can use to upgrade? What are the most important barriers to upgrading? What are the key barriers to regional integration? What are specific strategies the government can implement to help Rwanda and Uganda upgrade the capabilities of actors in the maize GVC?

1.2. Methodology

Broadly speaking, the GVC methodology is a systems-based and actor-centric approach that combines broad analyses of global industry structures and trends with detailed mapping of national industries and local economic clusters based on existing economic statistics. Data is then supplemented by interviews with international lead firms and intermediaries, domestic suppliers, and institutional stakeholders. As the primary actors within value chains, firms are of central importance in the GVC methodology—GVC analysis seeks to determine what makes firms productive in the context of dispersed supply chains, how private-sector governance and public policies influence firm performance, and what factors and strategies allow firms to move into higher-value segments of the chain.

GVC analysis involves identifying the input-output structure, geographic scope, and lead firm dynamics (i.e., "governance") of a particular value chain in order to understand how materials, financial resources, and information flow between firms and other stakeholders in the chain. Once a value chain is mapped in terms of the activities and firm location, comparative benchmarking is undertaken in order to assess the position of a specific firm, cluster or country relative to competitors. This also helps identify potential trajectories for expanding exports and moving into higher-value-added positions in the chain (i.e., "upgrading").

Because of the constraints associated with export and production data in Rwanda and Uganda, Duke CGGC focused its research efforts on literature reviews and in-depth interviews with industry stakeholders, supplementing when possible with FAO and UNCOMTRADE figures. Field research was conducted by Andrew Guinn on trips to Kampala and Kigali in May and June, 2015. Together with phone or Skype interviews, Duke CGGC spoke with approximately 15-20 officials with direct ties to the maize industry in the region, including government officials and private sector actors in various segments of the chain.

1.3. Limitations

In the course of pursuing these objectives, this study focused primarily on maize value chains in Rwanda and Uganda. Where appropriate, Kenya was incorporated into the analysis in order to provide additional context and insight; however, the overwhelming concern was Rwanda and Uganda. There were at least two reasons for the limiting the study to these countries: 1. Charting the complete universe of actors and businesses in all five EAC countries risked being too expansive; 2. IGC counseled Duke CGGC on focusing on the countries where it had a strong presence (Rwanda and Uganda).

2. The Maize Global Value Chain

As one of the world's three dominant cereal crops, the global maize industry had revenues of US$219.5 billion in 2015 (Marketline, 2016). Worldwide production has increased steadily over the last decade, with total volume jumping from 728 million tons in 2004 to a little more than 1 billion tons in 2013 (FAOSTAT).[2] Although the value of the sector has plateaued in recent years because of a slowdown in demand from China, it still posted a Compound Annual Growth Rate

[2] All production and trade data cited in this report is based on FAO statistics unless otherwise specified.

(CAGR) of 2.5% in the period from 2011-2015. This exceeded wheat and was comparable to rice and barley (see Table 2).

Table 2: Global Cereal Crops by Industry Segmentation, 2011-2015

Segment	(US$, billions)					CAGR	% Share				
	2011	2012	2013	2014	2015		2011	2012	2013	2014	2015
Maize	199.1	222.9	238.7	225.6	219.5	2.5%	31.6%	32.4%	32.6%	31.4%	30.9%
Other Cereal Crops											
Rice	259.7	286.3	302.4	305	287.6	2.6%	41.3%	41.6%	41.3%	42.4%	40.5%
Wheat	148.6	154.4	164.2	165.2	152.1	0.6%	23.6%	22.4%	22.5%	23.0%	21.4%
Barley	21.7	24.9	26.0	23.0	23.8	2.4%	3.4%	3.6%	3.6%	3.2%	3.4%
Other	0	0	0	0	27.6	—	0	0	0	0	3.9%
TOTAL	**629.1**	**688.5**	**731.3**	**718.8**	**710.6**	**3.1%**	**100%**	**100%**	**100%**	**100%**	**100%**

Source: Marketline, 2016.

Maize has different production and trading patterns, as well as end uses, depending on geographic regions. The United States is the largest single producer and exporter of the crop, although only 12% is used for human consumption, with the remainder being split between animal feed and ethanol fuel production (Ranum, 2014). The volume of maize used in ethanol production in the US increased by 100 million tons per year in the decade from 2000-10, which helped facilitate dramatic increases in the trade of animal feed—exports of distillers' dry grains (DDG), which is a co-product of ethanol production and a valuable feed for chicken and other livestock, jumped from roughly 500,000 tons in 1996 to 9 million tons in 2010 (Wallington et al., 2012).

Demand in other regions is more directly tied to maize's status as a staple food crop. Africa, in particular, is notable for its human consumption; of the 22 countries in the world where maize accounts for the highest daily intake, 16 are African (Ranum, 2014). There is further variance within the continent, with maize accounting for nearly half of the calories and protein consumed in East Africa compared to 20% of calories and protein consumed in West Africa (Macauley, 2015). Table A-1 in the Appendix lists the African countries with the highest daily maize consumption—Lesotho, Malawi, and Zambia are the continent's highest, followed by Zimbabwe, South Africa, and Kenya.

2.1 Mapping the Maize Value Chain

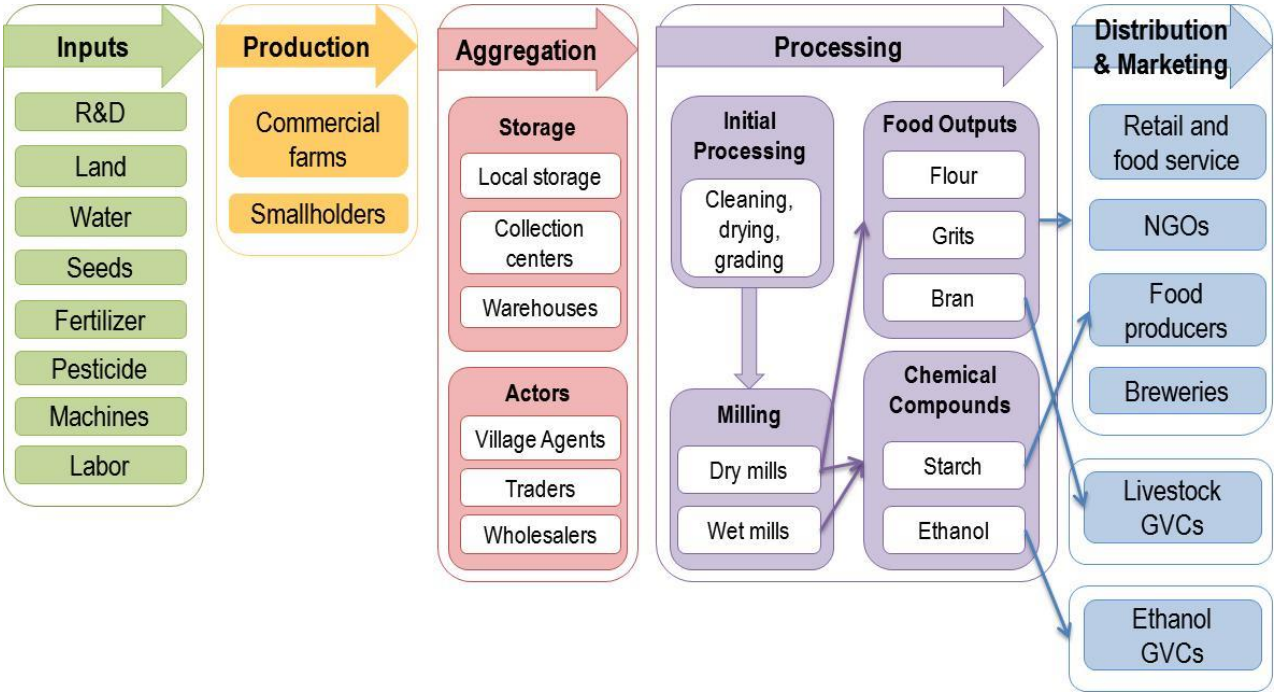
The main actors in the maize value chain are input providers, farmers, traders/aggregators, processors (mills) and downstream participants in activities such as retail, food manufacturing, brewing, and animal production. The primary actors, along with their position in the value chain, are identified in Figure 1 below. The section that follows offers short descriptions of key actors in the chain.[3]

INPUTS: The most important inputs in agricultural value chains are typically land, seeds, fertilizers, agrochemicals (herbicides, fungicides and pesticides), farm equipment, and water and irrigation equipment. Maize is no different. Other services in the pre-production phase include

[3] The descriptions of individual segment of the maize value chain are adapted in part from Bamber et al. (2014).

extension services, market information, credit, and certifications for production in niche organic or other high-value markets. Poorly developed inputs markets inhibit the use of fertilizers, drought and disease resistant seeds, and increased mechanization, contributing to low productivity, which is an important problem in many countries across Africa (AGRA, 2013). In general, input supply is typically provided by private sector firms in response to demand from producers in most countries around the world; however, poor access to credit and information together with substandard infrastructure can weaken this demand, and as a result, it is not uncommon for the public sector or international development agencies to offer inputs through a variety of free or subsidized programs, albeit with varying degrees of success (AGRA, 2013; Banful, 2011; Morris et al., 2007).

Figure 1: The Maize Global Value Chain



Source: Authors.

Research & Development (R&D) plays an important role in the chain. For the production stage, research tends to focus on how to increase productivity, improve seed varieties, adapt existing varieties to local conditions, and improve disease and drought resiliency of crops. Research requirements also extend to other segments, including extending shelf life of products through processing technologies such as drying maize or fortifying maize flour. New technologies and techniques introduced as a result of this research can drive upgrading and help countries to open up new markets. In many developing countries, R&D in the production stage of the chain is carried out by government funded research centers, while ongoing research regarding shelf life and food processing often takes place either within private firms or universities. Ideally, R&D institutions must be closely linked with other value chain actors to ensure effective and efficient use of resources to support chain development (Hall et al., 2002).

PRODUCTION: Geographic, environmental, social and political characteristics are important contextual drivers of competitiveness in production. Soil types, rainfall or access to water, temperature variations, as well as land ownership structures significantly affect maize cultivation. For the global industry, cereal crops tend to have lower margins at the production level and success often depends on economies of scale; competitive production of these crops is thus often concentrated in large scale, modern production operations with heavy mechanization and low labor engagement (Murphey et al., 2012).

AGGREGATION: This segment of the chain is more prominent in markets that do not rely on large-scale modern production. In many developing countries, the major aggregators are producer cooperatives, small- and medium-sized traders, or processors that have vertically integrated into this stage of the chain (da Silva et al., 2009). In informal maize value chains, aggregation occurs through multiple layers of small traders, who sell to small-scale processors or exporters. In both formal and informal chains, some degree of aggregation occurs to achieve economies of scale. Village agents are the traders who generally work most closely with farmers.

PROCESSING: Cereal products must be processed before being incorporated into a range of end products. Initial tasks include cleaning, drying, and grading. There are two primary milling techniques that follow for maize: dry milling and wet milling. Both processes break down maize into a range of outputs; however, there are also costs and benefits for each. Dry milling, which describes the grinding of the entire kernel in hammer or rolling mills, is less capital intensive and yields a greater array of inexpensive food outputs, including flour. While the maize in wet milling is separated from its nutritional content and therefore not used for direct human consumption,[4] the process produces an increased range of chemical by-products (Peña-Rosas et al., 2014; Gwirtz & Garcia-Casal, 2014; OHSA, 2014). While dry mills are more common globally because of the dietary benefits and lower investment costs,[5] major companies have recently constructed wet mills in emerging nations to produce a range of food additives.[6]

Overall, the major actors present at this stage include local or household actors, small and medium-sized enterprises, and industrial-scale processors (Gwirtz & Garcia-Casal, 2014; da Silva et al., 2009). The skill and technologies incorporated in these stages can differ considerably according to the scale of operations and access to capital of key actors (UNIDO, 2004, 2009). Different production processes can be used to either extend shelf life or add nutritional content. For example, de-germination enhances preservation and allows maize products to be traded longer distances, while nixtamalization and fortification can increase iron content (Peña-Rosas et al., 2014; Gwirtz & Garcia-Casal, 2014). Most of these processing techniques are employed at the industrial level.

MARKETING AND DISTRIBUTION: Maize's end uses can be divided into three primary categories: (1) Human consumption; (2) ethanol for fuel; and (3) animal feed. Prominent outputs of the milling segment that are destined for human consumption are categorized by particle size and include flour, grits, meal, bran and kernels. All can be used for a variety of staple products,

[4] In wet milling, maize is soaked in water and sulfur dioxide, which helps separate the kernel into individual chemical components, such as starch, protein, oil, and fiber.
[5] Of the roughly 220 maize processing facilities in the US that produce ethanol, 90% are dry mills (RFA, 2016).
[6] Cargill opened a US$100 million wet mill in India in 2016 that will generate glucose and other outputs that can be used as sweeteners in both the local market as well as Southeast Asia and Africa (Cargill, 2016a).

including bread, porridges, tortillas, arepas, cornbread, and couscous. Grits or flour are common inputs for breweries. Other food products include corn oil, corn starch and sweeteners among the final products.

The market for ethanol developed rapidly in the last decade, especially in established economies. Table 3 provides a breakdown of the three major categories in the US in the time period from 1980-2013. Ethanol's share has surged to the point it has tied animal feed as the largest final use for maize. Globally, the largest share of maize production is used as animal feed; the US, European Union (EU), China, and Brazil account for 70% of the consumption of maize as a food source for animals (Abassian, 2007). Animal feed can be generated from the by-products of ethanol production, although in some locations, bran that is removed from the maize in the early stages of processing is used as food for livestock (Heuze et al., 2015).

Table 3: Domestic Maize Use in the United States, 1980-2013

Corn Use	Billions of bushels					% Share				
	1980	**1990**	**2000**	**2010**	**2013**	**1980**	**1990**	**2000**	**2010**	**2013**
Animal Feed	4.16	4.75	5.73	4.79	5.00	83.3%	76.0%	74.3%	43.4%	43.6%
Food	0.81	1.08	1.15	1.25	1.46	16.2%	17.3%	14.9%	11.3%	12.7%
Ethanol	0.02	0.42	0.83	5.00	5.00	0.4%	6.7%	10.8%	45.3%	43.6%
TOTAL	**4.99**	**6.25**	**7.71**	**11.04**	**11.46**	**100%**	**100%**	**100%**	**100%**	**100%**

Source: Ranum, 2014.

Marketing and distribution systems consist of channels that control access of products to the final consumers. For products destined for human consumption, these include supermarkets, kiosks and wholesale markets as well as food service operations such as hotels and restaurants. Marketing channels differ somewhat according to geographic end-markets. These geographic end-markets can be local, regional or global in scope and exhibit differing patterns of market control. For example, in leading US and EU markets, supermarket chains such as Walmart, Tescos and Sainsbury control a significant share of the market (Gereffi, Fernandez-Stark, & Psilos, 2011), while in some developing countries, a large portion of agricultural products are still sold on informal markets, including in East Africa (Dihel, 2011). Dominant supermarkets typically require adherence to wide ranges of quality and safety standards in order to become an approved supplier, while smaller chains or informal markets tend to have lower standards and be more easily accessible for less sophisticated production operations (Kaplinsky, 2010).

SUPPORTING SERVICES: Logistics and transportation fulfill key supporting functions, while government regulatory bodies are required to approve the sanitary and phytosanitary (SPS) conditions of outbound products and to ensure food safety and contain the spread of plant and animal diseases domestically. Post-harvest losses as a result of inadequate transportation and storage can account for as much as 30% of production in developing countries, undermining improvements in productivity and reducing incentives for producers to invest in the adoption of new techniques (Fernandez-Stark, 2013). Transportation alternatives often vary depending on the value-to-weight ratio of the product. High-value, low-weight products, such as French beans or blueberries are appropriate fits for air transportation. Cereal products are typically bulk commodities that require large storage facilities and must generally be shipped in large vehicles or by sea.

2.2 Global Organization of Industry

A limited number of firms manage maize that is traded internationally. The largest grain traders, often called the ABCDs, are Archer Daniels Midland Co (ADM), Bunge Group, Cargill, and Louis Dreyfus (see Table 4). Collectively, the ABCDs manage an estimated 70-90% of globally traded grains (Murphy et al., 2012). The ABCDs are critical to the world food trade, using an unmatched network of silos, ports, ships and farmer relationships to buy and sell grains to customers ranging from food groups such as Nestle to biofuel companies and animal feed corporations across the globe. They are active in a variety of grains, including maize, soybean, and wheat.

Table 4: Lead Firms in the Maize GVC[7]

Company	Ownership	Country of Origin	Revenue (US$, billions)	Company Operations Segments	Geography of Operations (African offices)
Archer Daniels Midland (ADM)	Public	USA	$81.2 (2014)	— Oilseed processing — Maize processing — Agriculture services — Finance	75 nations (3 in Africa)
Bunge Limited	Public	Amsterdam (now in US)	$57.83 (2014)	— Agribusiness — Sugar and bioenergy — Food and ingredients — Fertilizer	40 nations (3 in Africa)
Cargill	Private	USA	$120.4 (2015)	— Origination and processing — Food ingredients and applications — Agriculture services — Risk management — Finance	67 countries (11 in Africa)
Louis Dreyfus Company	Private	France	$64.7 (2014)	— Proteins — Tropicals — Other products	100 nations (15 in Africa)

Source: Adapted from Ahmed et al., 2013 and Ahmed, Hamrick & Gereffi, 2014.

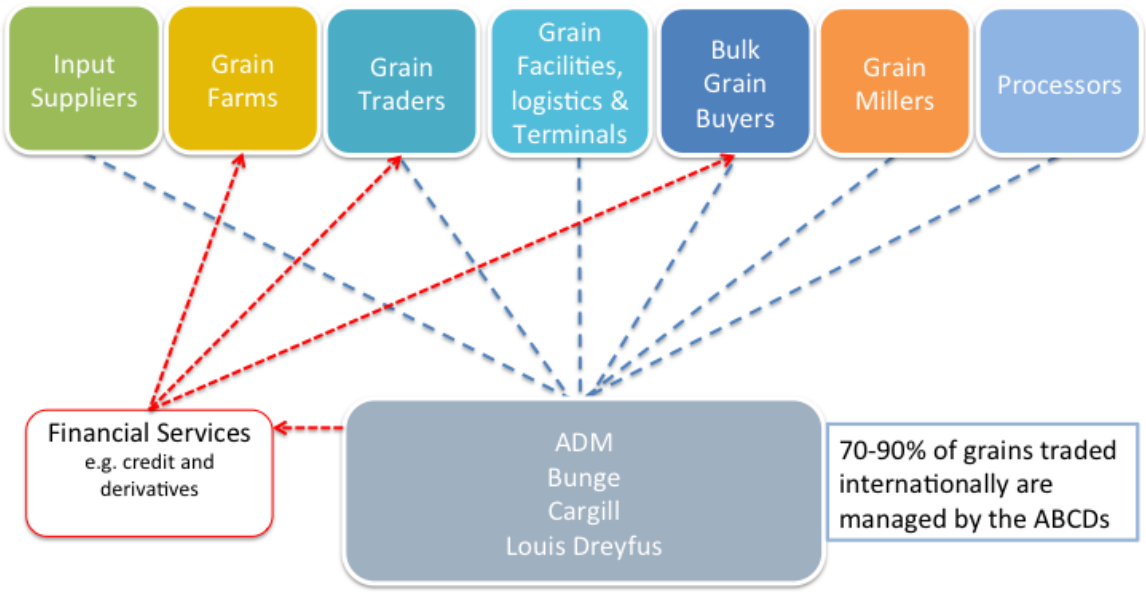
Global traders, particularly the ABCDs, drive the flow of maize through the chain and are involved in almost all segments, from agricultural inputs such as fertilizers and agrochemicals, to downstream activities, including milling, biofuels, and manufacturing. Their size and market diversification allows them to exploit economies of scale in information gathering, data analysis, technology, storage, transportation, and risk management. Furthermore, strategic investments in upstream and downstream segments of the chain, particularly in financial services, are of increasing importance (see Figure 2 below).

The ABCDs see ethanol production, particularly maize-based ethanol, as a high-growth segment of the chain. Citing the growth of US demand for ethanol due to its status as a competitive octane blender, many of the large grain traders invest heavily in biofuels. Ethanol revenue is closely tied

[7] In addition to the global traders, a set of powerful global actors in inputs is also present in the maize global value chain firms, such as Monsanto; provide the seeds needed for maize production. Monsanto is a major player in seed technology and agriculture productivity, but not in the production and processing of maize.

to harvest amounts, and fluctuations in production yields can have impacts on ethanol revenue. Maize-based ethanol production remains concentrated in the US and South America. Cargill has three large ethanol plants in the US, located in Iowa and Nebraska. It is also active in Brazilian ethanol, where factories blend maize and sugar-based ethanol (Cargill, 2016b; Lane, 2015).

Figure 2: Maize Lead Firms Capabilities and Activities



Source: Adapted from Ahmed, Hamrick & Gereffi, 2015.

Despite the growing interest in ethanol production, most lead firm activities in Africa focus on maize for animal feed and human consumption. All of the ABCDs have operations in Africa, with Cargill and ADM playing the largest role. The ABCDs' individual profile within Africa is summarized below.

- **Archer Daniel Midland:** ADM is a global leader in maize and operates in three African countries: Egypt, Morocco, and South Africa. While focusing on the North Africa region and South Africa, ADM is a major importer of maize to the continent (ADM, 2016).

- **Bunge:** Bunge has four offices in Africa, two in Egypt, and one in Kenya and South Africa. The company expects that Sub-Saharan Africa (SSA) presents many opportunities for growth in agricultural production, exports, and domestic consumption (Bunge, 2016).

- **Cargill:** Cargill, the leading global cereals company as measured by 2014 revenue, first entered the continent 25 years ago and is now active in at least 11 African nations: Algeria, Côte d'Ivoire, Egypt, Ghana, Kenya, Morocco, Mozambique, Nigeria, South Africa, Zambia, and Zimbabwe. At least six of these countries have grain operations: Egypt, Kenya, Mozambique, South Africa, Zambia, and Zimbabwe. Cargill performs a variety of activities along the value chain, including providing inputs to commercial farms and smallholders, processing, distributing grains to consumers and end users. It is also expanding its reach in the region through acquisitions and expansions. For example,

Cargill acquired Lesiolo Grain Handlers Limited (LGHL), a bulk grain handling company based in the Nakuru region of Kenya, in 2014 (see Box 1). In 2013, Cargill opened a grain and oilseed processing facility in Mozambique.

- **Louis Dreyfus Company:** Louis Dreyfus Company operates in 15 countries in Africa: Angola, Burkina Faso, Cameroon, Côte d'Ivoire, Egypt, Ghana, Kenya, Madagascar, Mali, Nigeria, Senegal, South Africa, Tanzania, Uganda, and Zambia. The company divides its African activities into six separate platforms: grains & oilseeds; rice; coffee; cotton; fertilizers and inputs; and metals. Within the maize value chain, Louis Dreyfus focuses on marketing and distribution in Africa, citing its importance as an import and consumption market (LDC, 2016).

Box 1: Cargill in Kenya and India

Despite their African activity, ABCD firms have only limited activities in East Africa, concentrating on upstream segments such as aggregation. This is largely because of the maize's place in the region as a staple crop, while ABCD firms are interested in ethanol, animal, and industrial food products. Cargill's recent forays into Kenya and India are emblematic of the company's approach.

In Kenya, Cargill has roughly 300 employees at locations in Mombasa, Nairobi and Nakuru. It primarily acts as a grain trader in the country, although animal feed is an emerging focus. The company expanded its animal feed operations in 2015, using its 2014 acquisition of LGHL, a Kenyan grain trading company, to provide inputs for products that are sold in Kenya.

The company also has significant investments in India that service the African market. The company opened a US$100 million wet milling facility in Karnataka in 2016 that has the capacity to mill 800 tons of maize each day. Outputs include glucose and other similar products that can used as thickeners or sweeteners. Consumers are primarily located in India, although the company said the mill will also serve the African market.

Source: Cargill, 2016a; Cargill, 2015.

2.3 Trade in Maize GVCs

The US, China, and Brazil are consistently the three largest producers of maize, with the three countries accounting for roughly 64% of worldwide production in 2013. The US has seen its production volumes quantities fluctuate in recent years, with a severe drought in 2012 reducing capacity (Adonizio et al., 2012). Africa nations consistently generate between 6-8% of the world's output of maize, with South Africa, Nigeria and Egypt generally ranking as the continent's largest three producers. Table A-2 in the Appendix lists both the leading global and African producers of maize from 2004 to 2013.

The majority of global maize production does not reach the export market in unprocessed form. From 2004 to 2013, the share of worldwide production that was traded internationally vacillated between 11-13% (FAOSTAT). The relatively high domestic use can be attributed to maize's prominence in local human and animal diets. While the majority of maize is consumed domestically, exports increased at a higher rate than production in the period from 2004 to 2013

(50% for exports, 40% for production), and worldwide exports swelled by almost 200% over the same stretch. The increased premium being paid for maize is partially the result of higher demand associated with elevated ethanol production and animal feed consumption (Marketline, 2016; Ranum, 2014).

Table 5: Top 5 Global and African Exporters of Maize, 2004-2013

Country	Export Value (US$, millions)					World or African Share (%)				
	2004	2006	2009	2011	2013	2004	2006	2009	2011	2013
WORLD	**11,690**	**13,258**	**19,871**	**33,786**	**34,946**					
US	6,137	7,297	9,087	13,982	6,882	52.5%	55.0%	45.7%	41.4%	19.7%
Brazil	597	481	1,302	2,716	6,307	5.1%	3.6%	6.6%	8.0%	18.0%
Argentina	1,193	1,263	1,612	4,518	5,848	10.2%	9.5%	8.1%	13.4%	16.7%
Ukraine	—	—	1,012	1,982	3,833	—	—	5.1%	5.9%	11.0%
France	1,456	1,314	1,847	2,539	2,612	12.5%	9.9%	9.3%	7.5%	7.5%
Hungary	—	—	—	—	—	—	—	—	—	—
China	324	412	—	—	—	2.8%	3.1%	—	—	—
AFRICA	**203**	**285**	**546**	**1,175**	**1,005**	**1.7%**	**2.2%**	**2.8%**	**3.5%**	**2.9%**
South Africa	112	143	453	813	767	55.2%	50.3%	83.0%	69.3%	76.3%
Zambia	41	13	21	188	154	20.6%	4.7%	4.0%	17.0%	15.4%
Uganda	10	15	16	17	26	5.1%	5.6%	3.0%	1.5%	2.7%
Morocco	—	—	—	—	10	—	—	—	—	1.1%
Tanzania	8	—	—	—	8	4.0%	—	—	—	0.9%
Malawi	—	6	—	84	—	—	2.2%	—	7.2%	—
DR Congo	—	—	28	16	—	—	—	5.2%	1.4%	—
Mozambique	—	88	—	—	—	—	31.1%	—	—	—
Tunisia	12	—	—	—	—	6.0%	—	—	—	—
Egypt	—		8	—	—	—	—	1.5%	—	—

Source: FAOSTAT based on FAO item code 5922. (—) indicates country was not in the top 5 in the given year. Retrieved on August 15, 2016.

Of the top producers of maize, the US, Brazil and Argentina also export the crop in significant volume, while China's output is aimed mostly for the domestic market (see Table 5). In all locations, exports are susceptible to substantial swings based on local conditions. The drought the US experienced in 2012 caused the country's share of global exports to plunge from 41% in 2011 to roughly 20% in 2013. While Brazil benefitted from the US contraction in 2013, increasing its share of worldwide exports from 8% to 18%, dry conditions in Brazil in more recent years have contributed to a 38% fall in exports amidst the country's smallest production output in five years (USDA, 2016). Africa's share of global exports has fluctuated between 1.2-3.5% in the period from 2004 to 2013, with South Africa ranking as the largest exporting country by a significant margin.

Two East Asian countries that do not have significant domestic industries—Japan and South Korea—rank as the largest destinations for maize (see Table 6). Japan has historically preferred higher-quality maize, using the grain as animal feed, although that has changed in more recent years as the country has boosted its starch and ethanol production (Ranum, 2014). South Korea, on the other hand, prefers lower-quality grains and substitutes wheat for maize to hedge against price volatility. Other countries such as the US and Mexico turn to the export market to supplement gaps in local production, especially in cases of drought or other events that constrain local supply. Similarly, Egypt's imports of maize have increased substantially in the years since

the political upheaval associated with the Arab Spring. The Maghreb region is Africa's largest importer of maize, with Algeria, Morocco, Tunisia, and Libya consistently joining Egypt as the most significant markets for the crop. In SSA, Zimbabwe and Kenya were the largest aggregated importers of maize in the period from 2004 to 2013.

Table 6: Top 5 Global and African Importers of Maize, 2004-2013

Country	Import Value (US$, millions)					World or African Share (%)				
	2004	2006	2009	2011	2013	2004	2006	2009	2011	2013
WORLD	14,654	15,646	32,026	36,340	39,074					
Japan	2,931	2,586	5,602	5,347	4,753	20.0%	16.5%	17.5%	14.7%	12.2%
Korea	1,431	1,264	2,819	2,248	2,676	9.8%	8.1%	8.8%	6.2%	6.8%
Mexico	745	1,138	2,391	2,989	2,053	5.1%	7.3%	7.5%	8.2%	5.3%
Egypt	—	—	—	2,179	1,984	—	—	—	6.0%	5.1%
US	—	—	—	—	1,693	—	—	—	—	4.3%
Spain	528	712	1,629	1,567	—	3.6%	4.6%	5.1%	4.3%	—
Taiwan	817	756	1,152	—	—	5.6%	4.8%	3.6%	—	—
AFRICA	**1,564**	**1,954**	**2,881**	**4,603**	**4,391**	**10.7%**	**12.5%**	**12.5%**	**12.7%**	**11.2%**
Egypt	364	545	947	2,179	1,984	23.3%	27.9%	32.9%	47.4%	45.2%
Algeria	298	337	407	999	891	19.1%	17.3%	14.1%	21.7%	20.3%
Morocco	201	221	357	490	484	12.9%	11.3%	12.4%	10.7%	11.0%
Tunisia	120	—	126	266	234	7.7%	—	4.4%	5.8%	5.3%
Libya	—	—	—	—	180	—	—	—	—	4.1%
Zimbabwe	105	164	—	122	—	6.7%	8.4%	—	2.7%	—
Kenya	—	—	439	—	—	—	—	15.2%	—	—
South Africa	—	112	—	—	—	—	5.8%	—	—	—

Source: FAOSTAT based on FAO item code 5922. (—) indicates country was not in the top 5 in the given year. Retrieved on August 15, 2016.

3. The Maize Industry in East Africa

Whereas global demand is increasingly linked to ethanol production and animal feed, maize is a staple food crop throughout much of Africa. Maize is considered to be an important food source in countries where daily consumption exceeds 50 grams per person (Ranum, 2014). Twenty-seven African nations exceed that threshold, compared with 15 in the Americas, six in Europe and four in Southeast Asia (Ranum, 2014). The 10 countries with the highest maize consumption in the world include Lesotho (328 grams per person per day), Malawi (293), Zambia (243), Zimbabwe (241), South Africa (222), and Kenya (171) (Ranum, 2014).[8]

Maize in Africa is typically consumed either as green maize—young corn that is eaten shortly after harvest—or after processing in the form or maize flour or meal. Common final products include porridge or cakes. The emphasis on such outputs elevates the position of maize flour in many African countries' export baskets. Depending on the year, Africa generally accounts for between 1.5-3.5% of global exports of maize; by comparison, the value of the continent's exports of maize flour represented 20.1% of worldwide exports in 2013, and the value of the continent's maize flour exports increased by close to 400% in the period from 2004 to 2013. Table 7 provides further detail on the global trade of maize. South Africa was the second largest

[8] Table A-1 in the Appendix provides the complete list of countries that exceed the 50 grams per day threshold.

global exporter of maize flour in 2013, while EAC countries Uganda, Tanzania and Rwanda all had a significant market share within Africa. Much of the maize flour emanates from more advanced processing nations to countries that do not have mills.

Table 7: Top 5 Global and African Exporters of Maize Flour, 2004-2013

Country	Export Value (US$, millions)					World or African Share (%)				
	2004	2006	2009	2011	2013	2004	2006	2009	2011	2013
WORLD	**340**	**387**	**626**	**731**	**882**					
US	94	106	153	141	131	27.9%	27.5%	24.5%	19.4%	14.9%
South Africa	—	—	64	58	128	—	—	10.3%	8.0%	14.6%
France	57	56	77	88	92	17.0%	14.5%	12.4%	12.1%	10.5%
Italy	46	49	59	68	60	13.7%	12.9%	9.5%	9.4%	6.8%
Turkey	—	—	—	—	47	—	—	—	—	5.4%
Brazil	—	—	35	48	—	—	—	5.7%	6.7%	—
El Salvador	—	22	—	—	—	—	5.8%	—	—	—
Mexico	15	18	—	—	—	4.5%	4.9%	—	—	—
Germany	12	—	—	—	—	3.6%	—	—	—	—
AFRICA	**18**	**20**	**86**	**87**	**177**	**5.5%**	**5.3%**	**13.8%**	**12.0%**	**20.1%**
South Africa	6	10	64	58	128	34.1%	50.5%	74.6%	66.5%	72.5%
Uganda	***6***	***7***	***12***	***9***	***15***	***36.0%***	***38.5%***	***14.0%***	***10.4%***	***8.7%***
Tanzania	—	—	—	2	13	—	—	—	3.3%	7.5%
Rwanda	**—**	**—**	**—**	**—**	***6***	**—**	**—**	**—**	**—**	***3.8%***
Namibia	—	—	—	—	6	—	—	—	—	3.6%
Botswana	—	0.3	0.5	7	—	—	1.8%	0.6%	9.0%	—
Algeria	—	—	3	2	—	—	—	4.3%	4.0%	—
Zambia	3	—	3	—	—	20.2%	—	3.9%	—	—
Lesotho	0.2	0.4	—	—	—	1.1%	2.4%	—	—	—
Kenya	—	0.4	—	—	—	—	2.2%	—	—	—
Cote d'Ivoire	1	—	—	—	—	5.5%	—	—	—	—

Source: FAOSTAT based on FAO item code 58. (—) indicates country was not in the top 5 in the given year. Retrieved on August 15, 2016.

The significant regional dynamics found in the EAC can be detected in both the daily consumption and the maize flour export figures. Kenya is the largest regional market and was the second largest importer of maize in SSA behind Zimbabwe in the period from 2004 to 2013.[9] As the leading consumer, Kenyan processors and traders serve as lead firms in the chain. They govern over suppliers and upstream actors by demanding adherence to either Kenyan or EAC quality standards.

While maize is not as significant a component of the Ugandan diet, the country is a major regional producer and an exporter of maize and maize flour, sending much of its maize surplus to Kenya and its flour to the DRC. Overall, Uganda is Africa's third largest exporter of maize and second-leading exporter of maize flour (FAOSTAT). Finally, Rwanda is a relatively minor player in the regional market, importing maize from Uganda and primarily exporting low quality flour to the DRC and Burundi.

[9] Zimbabwe imported US$1.2 billion worth of maize from 2004-13 while Kenya imported US$922 million during the same stretch (FAOSTAT).

The differences in the trading profiles between Uganda and Rwanda hint at contrasts in the organization and the structure of the value chains. While "formal" aggregators, including mills and large traders, compete with "informal" traders in the sourcing of raw material in both countries, Uganda's industry has a higher number of larger-scale actors. Smallholder farming systems characterize the production systems in each; however, cooperatives are larger in Rwanda compared to Uganda, with thousands of farmers instead of hundreds. In the downstream segments of the chain, Rwanda has only one large mill and a small number of formal traders; Uganda has a higher number, including roughly five large and several medium-sized mills.

There are challenges that are both localized and widespread throughout the region. At a broad level, the three most prominent constraints in Uganda and Rwanda are: (1) The lack of cash and finance for farmers; (2) the lack of commercial scale; and (3) the lack of communication of market signals and standards.

Together, these shortcomings lead to the prevalence of low-quality maize, which has the effect of driving actors to the informal market since: (1) Smaller-scale informal traders do not differentiate for quality and provide immediate sources of cash; and (2) formal aggregators demand higher-quality maize. With farmers facing mixed incentives regarding product standards, informal trade remains stubbornly high—as much as 80% of regional exports, according to interviews conducted for this report.[10]

3.1 Uganda

Introduced in Uganda in the mid-19th century, maize is the third largest crop cultivated in the country as measured by production volume, trailing only plantains and cassava (Uganda Bureau of Statistics, 2015). The production system is dominated by peasant farmers, with 75% of the country's output grown on plots of land that are between 0.2-0.5 hectares (USAID, 2010; Joughin, 2012). With two separate growing seasons and vast stretches of fertile land, Uganda has some advantages over its regional peers in the production segment of the chain. Cultivation is dispersed throughout the country, although the eastern region accounts for the highest share of output. Processing in the formal sector is concentrated in Kampala.

While farming is widespread in Uganda, maize traditionally has not been a critical component of the national diet. Historically, plantains (*matooke),* cassava, and sweet potatoes have contributed the largest amount of calories to the country's aggregated food balance sheet. However, there are indications that appetites are shifting—Uganda's consumption of maize was 344 kilocalories per day per person in 2011, an increase from the 203 in 2007. This evolution has been attributed to urbanization—Kampala residents consume maize in greater volume—and increasing institutional use of the crop as well as higher prices of other staples (Dalipagic & Elepu, 2014; USAID, 2010). Nonetheless, daily consumption in Uganda still trails regional leader Kenya by a significant margin.

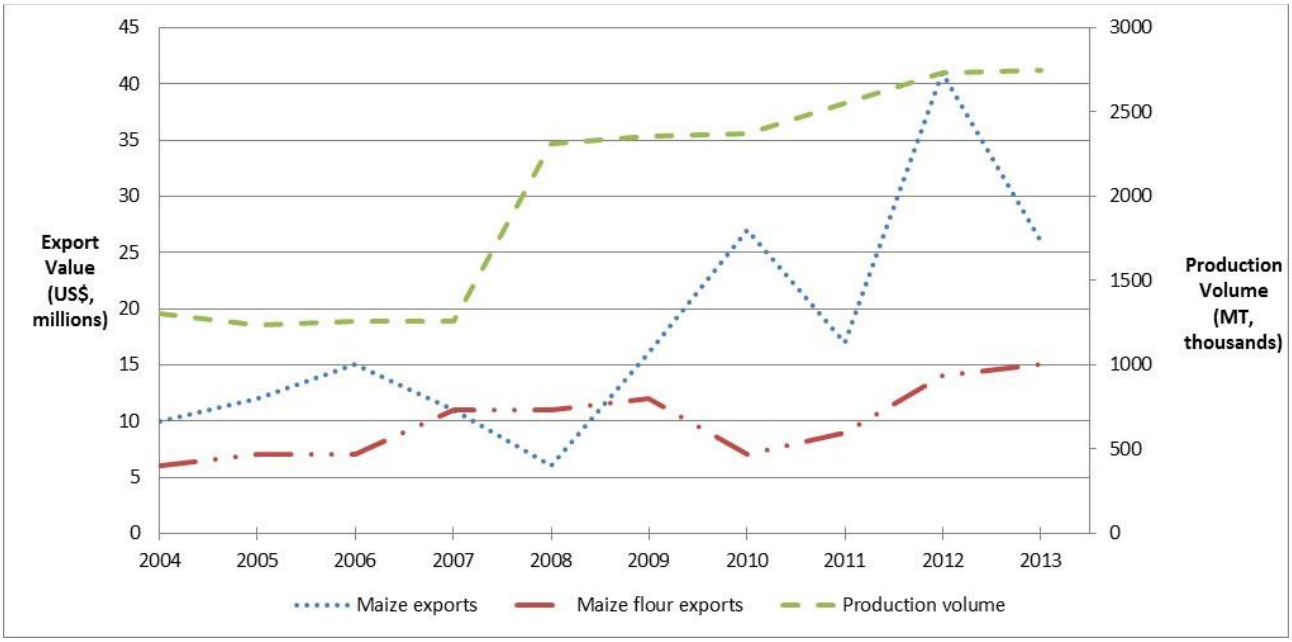
Instead, maize is a valuable cash crop. The magnitude of informal trade—stakeholders interviewed during this project estimated that 70-80% of maize that is bought and sold in Uganda

[10] The inability to pin down the precise number points to larger data questions, which complicates analysis. One official interviewed said maize data estimates are "diabolical" and that governments "do not have a clue" about accurate numbers.

is channeled through channels where it is not taxed or regulated—makes it difficult to estimate market size. The Uganda Bureau of Statistics reported that formal maize exports accounted for 1.9% of the country's total exports in 2014, which ranked 13th of all goods, but well behind the top tier of coffee (18.1%), petroleum (6.4%), fish and fish products (6%), animal/vegetable fats and oils (4.5%), and iron and steel (4.1%) (Uganda Bureau of Statistics, 2015).[11] Previous surveys have noted the size of the informal market and used multipliers of between 3-3.5 for formal trade data (Gates Foundation, 2014). This report uses FAO and UNCOMTRADE data while recognizing its limitations and supplementing with additional information when possible.

If official data underestimates the extent of maize trade, it nonetheless indicates the upward trajectory of production and exports. Production quantity more than doubled in the period from 2004-2013, while exports of both maize and maize flour increased 156% and 128%, respectively. Figure 3 below charts all three.[12] These trends have helped position Uganda as one of Africa's leading exporters—it had the third-highest export value of maize on the continent in 2013 and was the second-leading exporter of maize flour.

Figure 3: Uganda's Maize Production and Maize Exports, 2004-2013



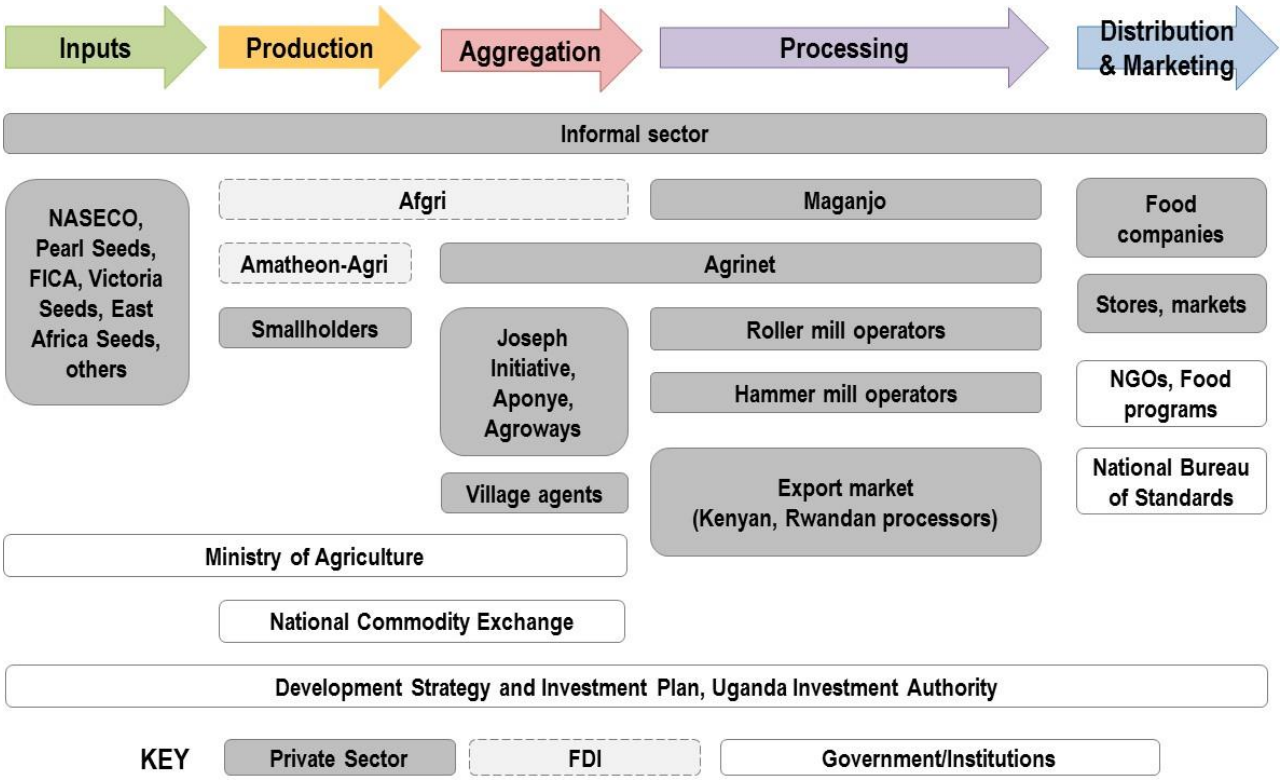
Source: FAOSTAT based on FAO item codes 58 and 5922. Retrieved on August 15, 2016.

Industry Organization

There are five primary segments of the maize value chain: inputs; production; aggregation; processing; and marketing and distribution. This sub-section of the report outlines the topography of the Ugandan industry in each. Figure 4 below provides an illustration of the chain.

[11] Table A-3 in the Appendix lists the top formal sector Ugandan exports from 2010-2014.
[12] The spike in maize exports in 2012 was the result of lower comparative prices associated with excess supply (Gates Foundation, 2014).

Figure 4: Major Actors in Maize Value Chain in Uganda



Source: Authors.

INPUTS: The availability of quality seeds is a prominent constraint in Uganda's maize industry, identified both in stakeholder interviews for this project and in previous studies such as Bold et al. (2015).[13] The informal market is the source for 85-90% of all seed used by farmers, with improved varieties accounting for only 5-15% of total seeds (Joughin, 2014a; Zorya et al., 2012). The informal market can be divided into three categories: 1. Farmers saving their own seeds; 2. Farmers trading seeds with neighbors; and 3. Farmers growing seed for sale or distribution through informal channels. The reliance on unregulated seed leads to a preponderance of counterfeit and low-quality seeds that are not drought, heat, or altitude resistant.

This environment persists even though the government opened up the seed sector to private investment in 2002. While seed imports from neighboring countries are restricted, there are between 20-25 companies operating in Uganda. Table 8 provides a list of the most prominent firms with maize portfolios. Maize seeds accounted for roughly 60% of all agricultural seed sales from registered companies in Uganda in 2011, but there is question about how many of the businesses are profitable. The failure of the formal sector to gain traction has been widely researched and attributed to three factors: 1. The inability of the agricultural ministry to effectively regulate companies selling fake seeds; 2. Donors focusing on narrow technical responses to challenges instead of comprehensive solutions; 3. A weak regulatory environment (Joughin, 2014b).

[13] Unless otherwise noted, the discussion about seeds contained in this sub-section is based on Joughin (2014a).

Table 8: Major Seed Companies in Uganda

Company	Maize Seeds	Notes
NASECO	— **OPV:** VP Max, Longe 5 — **Hybrid:** SSALonge, Longe 7H, 10H, Wanak	— Founded in 1996 — Believed to have No. 1 market share in Uganda for maize hybrid seeds
Pearl Seeds	— **OPV:** PH 5355, WE 2115, PH 5052, Longe 5 — **Hybrid:** Longe 7H, 11H, 4	— Distributors located in Kampala, Gayaza, Luwero, Mityana, Masaka — Provides extension services
FICA	— OPV and hybrids	— Founded in 2011 — Processing facility in Masindi — Seed production capacity of 5-6,000 tons
Victoria Seeds	— **OPV:** Longe 4 & 5 — **Hybrid:** Yara 41 & 42	— Founded in 2004 — Owner has received variety of entrepreneurship and gender empowerment awards — Also sells fertilizers and pesticides
East Africa Seeds Kampala	— **Hybrid:** KH 500 & 600, Ahadi, Hodari	— Parent company based in Kenya — Also sells farm tools and other inputs

Sources: Company websites; Gates Foundation, 2014; Joughin, 2014a.

Stakeholder interviews for this project indicated the sporadic use of fertilizers and insecticides was also a constraint, although not as significant as the ones related to counterfeit or low-quality seeds. Estimates suggest that only 5% of maize plantings receive the recommended dosage of fertilizer, with lack of financing or unfamiliarity with the benefits being the two most common reasons for the limited application of fertilizer (Gates Foundation, 2014). Insecticide and fungicide are used only rarely as well, although herbicide has had more success.

PRODUCTION: Smallholders dominate the production process. There are between 2.5-3 million farmers in Uganda, and three-quarters of maize is grown plots of less than 0.5 hectares (USAID, 2010; Joughin, 2012). Although the country's eastern region accounted for the highest share (47%) of the roughly 2.3 million tons harvested in 2009,[14] production is fairly dispersed, with the western (21%), central (19%), and northern (13%) regions all having significant outputs (13%) (Uganda Bureau of Statistics, 2015). Table 9 lists the 10 largest production districts by MT—Iganga in the east is the largest.

Table 9: Largest 10 Maize Production Districts in Uganda

District	Region	Production (MTs)	Share
Iganga	Eastern	303,262	13.1%
Mubende	Central	171,089	7.4%
Soroti	Eastern	137,657	5.9%
Kabarole	Western	91,318	3.9%
Masaka	Central	82,287	3.5%
Kamuli	Eastern	81,969	3.5%
Tororo	Eastern	75,763	3.2%
Bugiri	Eastern	63,603	2.7%
Masindi	Western	61,715	2.6%
Kibaale	Western	60,529	2.6%

Source: Uganda Bureau of Statistics, 2015.

[14] The most recent major agricultural census conducted in Uganda was in 2009.

The substandard quality of maize in Uganda is an issue.[15] While this is the result of obstacles at each segment of the value chain, two of the most prominent are associated with production. These include:

1. **Lack of farmer liquidity and access to finance**: Many of the challenges in the maize value chain stem from the fact many farmers have neither adequate savings nor access to finance. As a result, they do not have the ability to invest in improved inputs and are susceptible to selling to smaller-scale traders who provide immediate payment but do not differentiate or pay a premium for quality.

2. **Small size of farms:** With the majority of farmers having less than 0.5 hectares of land, it is difficult to generate economies of scale. As one interviewee noted, machinery such as combine harvesters are not effective for plots smaller than one hectare. While processors reported anecdotal evidence the situation is evolving, with higher numbers of farmers increasing land size to the 4-5-hectare range, a further move toward commercial-sized farms is needed—multiple actors said that 50 hectares was a more realistic target for generating economies of scale.

Related to the second constraint, there have been large recent investments by foreign companies attracted by the country's fertile regions north of Kampala. Amatheon-Agri, a German-listed company, contracted with 1,340 local farmers in 2013 to lease 400 hectares to grow rice and maize before increasing its holdings to 2,700 hectares in 2015 with future plans to expand to 3,300 (Reuters, 2015; Aglionby, 2016; Amatheon-Agri, 2015). In total, the company plans to spend more than US$115 million and work with close to 5,000 small farmers (Reuters, 2015).

AGGREGATION: Integration in the value chain is not widespread in Uganda, which facilitates a network of village agents, traders, and wholesalers to purchase maize from farmers and sell it to processors. The size of the network is vast—one prominent processor based in Kampala reported in interviews that maize often passes through at least four sets of traders before reaching the largest mills that are located in urban centers.[16] The largest companies include Afrgi, Joseph Initiative, Agrinet, Aponye, and Agroways. Prior studies have estimated the profit margins of the village agents at 5-10 Ugandan shillings (SHS) per kilogram (USAID, 2010). Urban traders may earn as much as SHS 60 per kg; however, they also face risks of losses as high as 20 per kg (USAID, 2010).

Major challenges in this segment of the chain are misaligned motivations and the lack of coordination and communication between downstream and upstream actors, which obscures market signals about the value of high-quality maize. With traders not reliably differentiating outputs, farmers have little incentive to invest in expensive inputs. The farmers' lack of liquidity sometimes makes them more willing to sell informal traders at lower prices, while traders'

[15] Said one official with a trading company: "Corn in Kenya is a different product. It's not product of the poor. Maize in Uganda is a product of the poor."

[16] As described by stakeholders, the process is as follows: A small-scale aggregator serves as the first link in the chain by purchasing a small number of bags from a handful of farmers (often 5-10). That individual most often sells the maize to someone with a truck, who then brings it to a storage facility. From there, someone else takes the bagged maize from the warehouse to a central source in Kampala, where it is then sold to processors.

inadequate quality differentiation impairs the processors who attempt to sell to Kenyan markets that demand premium maize.

Another significant constraint is the poor storage facilities that exacerbate the issue of post-harvest loss. Depending on the estimate, Ugandan farmers sacrifice between 22-30% of their maize crop to post-harvest loss (Kaminsky & Christiaensen, 2014; Gates Foundation, 2014). While that is less than the 32% global average on agricultural products (FAO, 2011), it still represents a higher share of the total production volume that is consumed in domestic or export markets (Gates Foundation, 2014).

Moisture content is a significant factor in post-harvest loss. EAC standards require that maize is dried to 13.5% in order to be exported, but interviews with stakeholders indicated that Ugandan maize is often harvested with moisture content of 20-25%. Poor drying and storage facilities ensure the kernels cannot reach that threshold and are susceptible to fungal infections and mildew.

PROCESSING: Dry mills are the dominant milling technology in Uganda and primarily yield three outputs: No. 1 maize flour; No. 2 maize flour; and maize bran. Each generates value-addition prospects for the mill. Table 10 below summarizes the three.

Table 10: Prominent Outputs of Ugandan Maize Mills

Category	Processors	Characteristics	Price	Customers
No. 1 flour	Medium and large-scale roller mills	— Refined flour with low nutritional value — Preferred in urban markets	— UGS 800-1100 per kg	— Food programs — Regional markets — Wholesalers — Retailers
No. 2 flour	Small-scale hammer mills	— "Whole grain" flour — Common in rural areas	— UGS 600-800 per kg	— Customers — Retailers
Animal feed	Medium-sized mills	— Produced from bran separated during hulling process	— UGS 100 per kg	— Livestock GVCs

Source: USAID, 2010.

No. 1 flour, which is more refined and consumed at higher volume within urban centers, is not as nutritious and often fortified with minerals (USAID, 2010; Gates Foundation, 2014). Large and medium-scale producers found primarily in Kampala produce it on roller mills (USAID, 2013). No. 1 flour is the more popular variety of flour—estimates indicate that 70-73 kgs are produced for every 100 kg of maize grain—and it fetches a higher market price, with mills selling it for between SHS 800-1100 per kg (USAID, 2010).

No. 2 maize flour resembles "whole grain" flour. Hammer mills in rural locations produce it instead of the roller mills that generate the No. 1 variety (USAID, 2010; USAID 2013). The margins are not as high as No. 1 flour, with prices ranging from SHS 600-800 per kg.

Before grinding maize to produce the No. 1 flour, medium and large-scale mills peel the hull to remove the bran. The separated bran is then sold to livestock farmers and companies as feed.[17] Millers sell maize bran for roughly SHS 100 per kg (USAID, 2010). Agrinet is one of the leading animal feed processors in the country.

Nationwide, there are three categories of millers based on size: large, medium, and small. There are an estimated 600 rural millers—roughly, 85% of the total population—that are small scale and generate primarily No. 2 flour (Gates Foundation, 2014; Joughin, 2012). These actors do not use modern technology, have little in the way of storage facilities, and produce less than 10 tons of flour per day. The medium-scale millers have larger capacity—50 tons per day—and focus on No. 1 flour. They are located in larger population centers, focus on an urban clientele and make a profit of UGS 87-383 per kg processed (USAID, 2010). Large-scale millers operate almost exclusively in Kampala, use roller mills and more modern technology, and sell to regional markets or food programs (Joughin, 2012, USAID, 2010, Gates Foundation, 2014). There are only a small handful of these companies active in Uganda, of which Maganjo is one of the more prominent examples.

MARKETING AND DISTRIBUTION: Maize grown in Uganda generally sees its lifecycle end in one of four ways: post-harvest loss (30%), the domestic industry (28%), the export market (22%), or on-the-farm consumption (18%) (Gates Foundation, 2014).[18] Within the domestic industry, an estimated 60% is processed into flour, 37% is turned into animal feed, and 3% is destined for breweries to use as an input to make beer (Gates Foundation, 2014). While ethanol production is increasingly the focus of the global maize industry, there was no evidence uncovered during field research that Ugandan maize was being used for fuel production in a meaningful way.

In interviews, large traders and processors focused on the export market reported the following four tiers of consumers, some of which are still based in Uganda.[19]

- **TIER ONE:** Large millers from Kenya that can be expected to account for 20-30% of total volume. These actors serve as lead firms in the formal chain, demanding that suppliers adhere to EAC or Kenyan quality standards. Some of these processors are public companies and pay close to a 30% premium. Examples include Unga Limited, Mombasa Maize Millers, Nairobi Flour Mills Ltd., TSS Grain Millers, Pembe Flour Mills, and others.

- **TIER TWO:** Institutional food programs such as the World Food Programme inside Uganda. These might represent 50% of volume for companies, but the margins are not as high as the Kenyan market.

- **TIER THREE:** Regional customers, mainly in Rwanda or South Sudan or perhaps smaller mills in Kenya. Depending on the company, this tier might represent 10-20% of

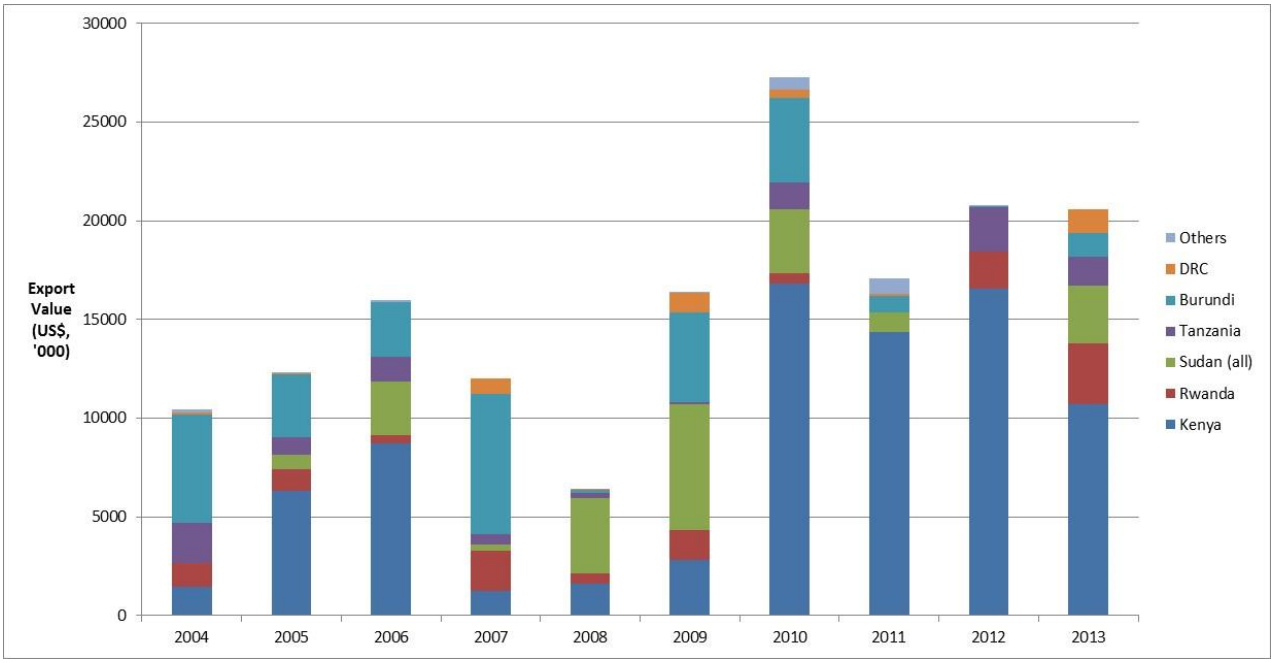
[17] This is an area where the Ugandan sector differs from the global maize industry, where animal feed is most often a co-product of ethanol production (See "Processing" in the Maize Value Chain section).
[18] Roughly 2% are saved for seeds (Gates Foundation, 2014).
[19] The information in this paragraph is based on interviews with prominent stakeholders conducted in Kampala in 2015.

total volume, although actors in Uganda report that demand for maize from Rwanda is expanding and represents a growth market.

- **TIER FOUR:** Less formal actors that do not demand quality grain. Depending on the business, this tier usually accounts for less than 5% of total volume.

The importance of each category can be detected in Uganda's export data. Kenya's share of official maize exports has grown steadily since 2009 (see Figure 5), and interviews with traders and processors indicated that informal trade between Uganda and Kenya is substantial and increasing. Tanzania and Sudan remain important markets most years, while Rwanda's share has jumped in recent years. With maize flour, Uganda's largest market is Sudan—North and South Sudan was consistently the destination for between 75-80% of the country's formal exports from 2004-2013, which averaged US$5.2 million in the period (FAOSTAT).

Figure 5: Export Markets for Ugandan Maize, 2004-2013



Source: FAOSTAT based on FAO item code 5922. Retrieved on August 15, 2016.

3.2 Rwanda

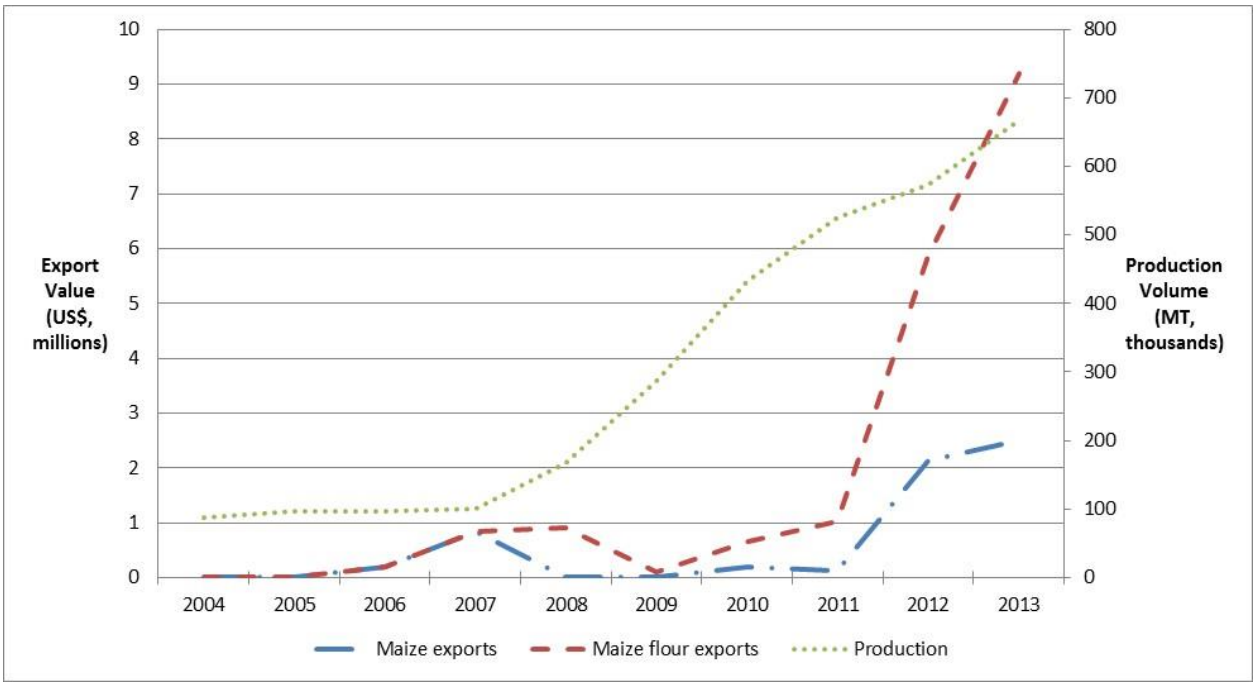
Although maize historically has not been a staple crop in Rwanda, ranking well behind plantains, potatoes, cassava, and sweet potatoes in daily consumption, it was included as part of the government's 2007 CIP because of its potential to enhance food security. That initiative, which includes efforts to improve the quality of and access to key inputs, has helped contribute to a substantial increase in yields and production volumes over the last decade.[20] The country generated 667,000 MT of maize in 2013, which was an increase of more than 650% from 2004.

[20] The CIP focuses on six priority crops (maize, wheat, rice, Irish potatoes, beans, and cassava) and also includes efforts by the government to consolidate land use, expand extension services, and improve market linkages.

As in Uganda, the maize industry in Rwanda is characterized by smallholder farmers and substantial volumes of informal trade. The country has roughly 300,000 households growing maize, and the average farm size is 0.6 hectares (Stone et al., 2011). Government data provides explicit estimates of the size of the informal export market—between 57-69% of the export value of maize from 2012-15, and between 45-90% of the value of maize flour in the same period (see Table A-4 in the Appendix). However, stakeholders reported in interviews that the volume of informal trade is likely still underreported.

Beyond these parallels, there are also prominent distinctions between the Ugandan and Rwandan maize industries. Whereas the top of the Ugandan industry is ultimately governed by Kenyan processors, Rwanda represents its own node in the regional chain. There are only a handful of mills and formal traders in the country, with the small size of the private sector being a defining characteristic. However, Rwanda exports processed maize—maize flour—in substantially higher volume than raw maize, which it affords its processors and traders a degree of power not necessarily enjoyed by Ugandan counterparts, who are dependent on Kenyan consumers. The bottom, meanwhile, features more expansive cooperative networks of farmers than Uganda. Although many of the constraints in upstream segments of the chain are similar, the CIP has also helped Rwanda gain some traction in distributing improved inputs—seed, fertilizer, and insecticide—to producers.

Figure 6: Rwanda's Maize Production and Maize Exports, 2004-2013



Source: FAOSTAT based on FAO item codes 58 and 5922. Retrieved on August 15, 2016.

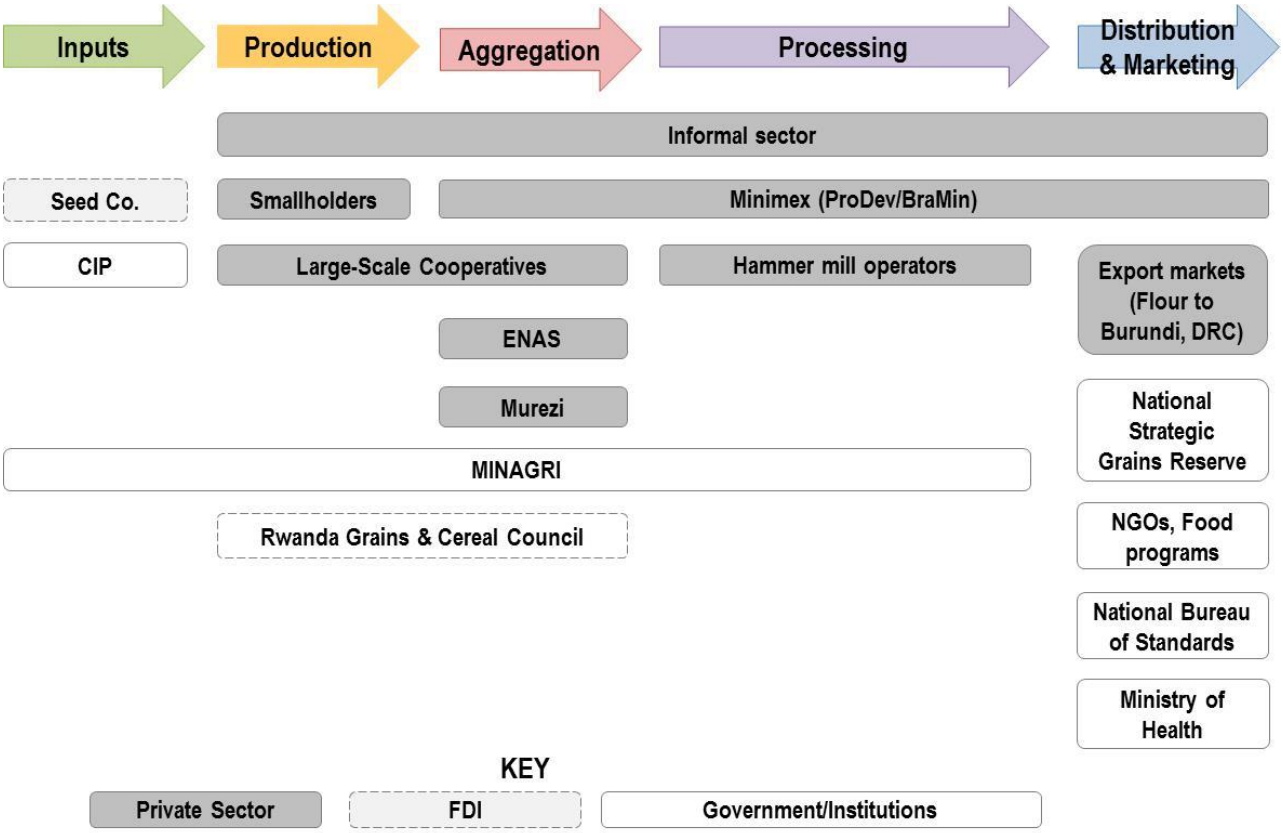
As far as trading patterns, Rwanda imports maize from Uganda and is an increasingly prominent market for aggregators and processors based there. Its most significant export is maize flour, the value of which has surged in recent years (see Figure 6). Rwanda was one of Africa's leading exporters of the product in 2013 (see Table 7), and maize flour has also become one of the country's 10 largest export products, accounting for 1.6% of total exports in 2014 (National

Institute of Statistics of Rwanda, 2015).[21] Much of the flour that Rwanda produces is of lower quality, but it finds a market in countries such as the DRC and Burundi, where there are insufficient processing facilities and where consumers are cost sensitive (USAID, 2013).

Industry Organization

There are five primary segments of the maize value chain: inputs; production; aggregation; processing; and marketing and distribution. This sub-section of the report outlines the characteristic of the Rwandan industry in each. Figure 7 below provides an illustration of the chain.[22]

Figure 7: Major Actors in Maize Value Chain in Rwanda



Source: Authors.

INPUTS: The CIP has boosted Rwanda's production of critical inputs such as fertilizer and seed, although the country still relies on imports of seed to satisfy demand. The Ministry of Agriculture (MINAGRI) and its implementation arm, the Rwandan Agricultural Board (RAB), control the market. Initially under CIP, the RAB bought seed from regional markets and

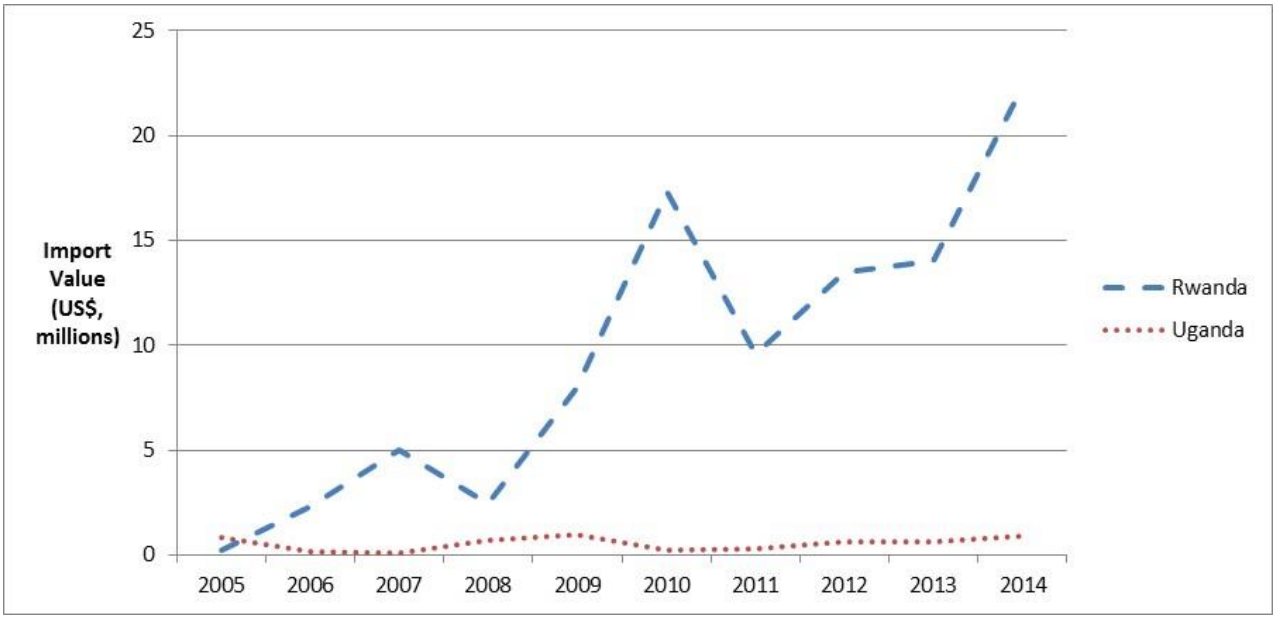
[21] Niobium, vanadium ores, tantalum and concentrates was Rwanda's largest export in 2014, accounting for 22.7% of the country's export basket (National Institute of Statistics of Rwanda, 2015). The other goods in the top 10 were tin ores and concentrates (15.8%), coffee (12.8%), tea (12.7%), tungsten ores (5.6%), wheat (3.6%), flat-rolled steel (2.1%), whole hides or skins (1.7%), gold (1.6%), and maize flour (1.6%).

[22] Shaded boxes indicate private sector actors, while clear boxes denote government or public sector stakeholders.

distributed them to farmers on a subsidized basis (Kelly & Mbizule, 2014).[23] More recently, MINAGRI has engaged the private sector with the hopes of reducing its subsidies, although the government still controls distribution (See "Recent Trends in Uganda and Rwanda"). As a result of CIP, the value of Rwanda's import of maize seeds has increased from approximately US$250,000 in 2005 to more than US$22 million in 2014 (see Figure 8), putting it among the top 15 imported goods in the country (National Institute of Statistics of Rwanda, 2015). Farmers' use of improve seed has also jumped from 3% to 40% (MINAGRI, 2012).

The dynamics are similar for fertilizer. The government provides subsidies of up to 50 percent of the purchase price and uses the relationships between prominent traders such as Enterprise Nkubili Alfred & Sons (ENAS) and large cooperatives to facilitate distribution to farmers (Kelly & Mbizule, 2014).[24] These efforts have contributed to an increase in average fertilizer use to increase from 8 kilogram per hectare to 23 under the CIP (MINAGRI, 2012).

Figure 8: Value of Imports of Maize Seed in Rwanda and Uganda, 2005-2014



Source: UNCOMTRADE. Based on commodity code 100510. Retrieved on August 31, 2016.

PRODUCTION: Smallholders dominate maize production in Rwanda, with an average farm size of 0.6 hectares. The crop is grown throughout the country, with distribution roughly split between the four rural provinces (USAID, 2013). The growing season lasts from September to February, with the bulk being harvested in December and January.

The large size of the cooperative networks that pool the outputs of thousands of farmers is an important feature of the production system. To support the National Policy on Promotion of Cooperatives, MINAGRI requires the government to purchase at least 40% of its grain for initiatives such as the National Strategic Grains Reserve from smallholder-based cooperatives.

[23] To be eligible, participants must agree to consolidate land holdings.
[24] MINAGRI also contracts with ENAS to perform extension services and distribute critical inputs such as fertilizer (Kelly & Mbizule, 2014).

Various government and aid agencies have worked directly with individuals to bolster both the technical and financial skills of farmers in cooperatives through outgrower programs, and cooperative participants have access to loans and advances on payments (Kelly & Mbizule, 2014). Interviews with stakeholders in the downstream portions of the maize value chain in Rwanda indicated that cooperatives represent the highest growth segment of suppliers and are improving their ability to deliver quality maize and adhere to contracts.

Despite some of the successes of the cooperative model, there are still prominent challenges in the production segment. Downstream actors reported in interviews that cooperatives often lack understanding of the commercial aspects of the industry and need education on market dynamics (USAID, 2013). Furthermore, traders and processors said they have to reject substantial volumes of maize, with an official from one prominent downstream company indicating that 60% of the output it inspects is deficient. According to interviews with stakeholders, the maize formal processors decline to use often ends up on the informal market.

AGGREGATION: Farmers generally sell maize to one of two categories of actors: cooperatives or small traders. The liquidity of the farmer often determines which group of aggregators they interact with and accounts for some of the quality issues encountered in the production segment of the chain. According to interviews with stakeholders, small-scale traders provide farmers with immediate cash but do not inspect or pay a higher premium for quality maize. The network of smaller-scale traders follows a similar model as Uganda, with traveling traders purchasing maize and selling it to urban aggregators.

There are a small handful of large trading companies. ENAS is one, operating primarily in the eastern portion of the country, while Murezi is another, with a focus on the western half (Kelly & Mbizule, 2014). The Rwanda Development Board created the Rwanda Grains and Cereal Corporation (RGCC) in 2012. A public-private partnership between the government, two Algerian companies (Cevital and Benamor), and a small number of local businesses, the RGCC collects an estimated 30% of Rwanda's total maize production from 60-70 cooperatives that work with the organization.[25] After aggregating and storing the grain, the RGCC sells it to a variety of institutional buyers, mills, and processors, both inside the country and in regional markets such as Uganda, Algeria, and Kenya.[26]

The scarcity of adequate storage facilities is a major constraint in this segment of the chain. According to stakeholder interviews conducted for this project, the total storage capacity in Rwanda was roughly 50,000 MT in 2015, with as much as 30,000 MT scheduled to become available in the near future.[27] However, officials estimate that Rwanda needs roughly 200,000 MT in storage capacity to service the maize industry's needs. The RGCC does not own its warehouse space, instead renting from the government. High interest rates limit capital investment plans, although stakeholders said in interviews that loans can be accessed through foreign firms at lower rates.

[25] The Rwandan government owns 57% of the total shares in the venture, while the two Algerian companies control 40% and Rwandan companies such as Minimex and others combine to own 3% (Rwanda Ministry of Communications, 2012).
[26] In interviews, stakeholders reported that 20-25% of the RGCC's maize is exported with the remainder used by domestic clients.
[27] That estimate was made during field research conducted in May and June of 2015.

PROCESSING: Minimex is the dominant maize processor in Rwanda, with a capacity of 43,000 MT per year at its dry mill east of Kigali.[28] It is one of the few integrated maize companies in Rwanda, which provides both backward and forward linkages for its inputs and products. Key facets of the integration include:

- **RAW MATERIALS:** Minimex works closely with 10-15 cooperatives throughout the country to source maize, using its sister company (ProDev) to provide warehouse and drying facilities. It also has a minority share in the RGCC and looks to the import market to source the remainder of its maize.

- **CONSUMERS:** Minimex is a part of the BraMin joint venture with Bralirwa, which is the Heineken-affiliated brewery in the country. The JV provides the company a market for its maize grits, which account for 10-15% of Minimex's output volume and 25-30% of its sales (Gathani & Stoelinga, 2013). Its second product is maize bran—while the input for animal feed represents 25-30% of its output volume, it is not a high-value good. Moreover, a sizeable percentage of Minimex's maize bran is exported to livestock producers in Kenya. Finally, flour accounts for the majority of Minimex's sales (55-60%), with the company producing both fortified and unfortified varieties for Rwanda and regional markets such as the DRC and Burundi. Exports represent roughly three-quarters of flour sales.

There are a number of small hammer mills that generate flour for rural households or regional markets. Rwanda does import some maize flour from Uganda, often destined for urban settings, but much of the flour formally traded by Ugandan processors is the higher-quality No. 1 flour that is generated by roller mills. Roller mills have production costs that are at least 22% higher than hammer mills, which means Rwandan hammer mills have competitive advantages in the rural markets in Rwanda, the DRC, and Burundi, where consumers are cost conscious (USAID, 2013).

MARKETING AND DISTRIBUTION: Estimates of market share of the major maize consumers within Rwanda are hampered by the lack of official data. Kelly & Mbizule (2014) provided the following estimates in their survey of the nationwide industry: consumed on the farm or in households (35%); informal markets (24%); post-harvest loss (20%); Minimex (9%); prisons (6%); World Food Programme (2%); National Strategic Grains Reserve (2%); other institutional buyers (2%)

Despite these approximations, firm conclusions about the market for Rwandan maize are undermined by the absence of verifiable data. Interviews with stakeholders said that there are five primary consumers of maize, each with relatively equal shares: the government (in the form of the National Strategic Grain Reserve), the World Food Programme, the RGCC, Minimex, and NGOs. Other than Minimex, these actors are all institutional buyers, highlighting the significance of that market segment.

[28] The information about Minimex is based on publicly available information published on its company website (http://www.minimex.co.rw/en/about-us.php) as well as company literature. Additional information was accessed through Gathani & Stoelinga (2013) and interviews.

FAO data suggests DRC and Burundi have been the destination for 99% of Rwanda's maize flour exports in the last five years. A USAID analysis as part of the Enabling Agricultural Trade project confirmed the importance of these markets. The DRC received 69% of Rwanda's maize exports from 2009-2012, with an estimated 61% of this occurring on informal markets (USAID, 2013). Rwanda's maize flour exports to the DRC have been growing consistently; whereas they were US$875,000 in 2008, they eclipsed US$6.2 million in 2013 (FAOSTAT).

3.3 Recent Trends in Rwanda and Uganda

From foreign investments in upstream segments to the creation of Warehouse Receipt Systems (WRS) to changing demand patterns to the expansion of value-addition activities to attempts to institutionalize EAC standards, there have been a number of recent developments in both the Rwandan and Ugandan maize industries. This section highlights some of the most prominent from the last five years. Table 11 provides a summary.

Table 11: Recent Trends in Maize Industry in Rwanda and Uganda

Trend	Characteristics	Actors	Value Chain Segments
1. Evolving export markets	— Uganda increasing maize exports to Kenya — Rwanda increasing maize flour exports to DRC, Burundi	— **Uganda:** Joseph Initiative, Afrgi, Aponye, others — **Rwanda:** Minimex, informal sector	Aggregation, Processing
2. Different government approaches to upstream challenges	— Uganda using market-based approach — Rwanda government taking active approach to PPPs and JVs	— **Uganda:** Amatheon-Agri, Afgri, Uganda Investment Authority, NGOs — **Rwanda:** MINAGRI, RGCC, Seed Co. Limited	Inputs, Production, Aggregation
3. Development of warehouse receipt programs	— Governments attempting to drive efficiency in trading system	— **Uganda:** Uganda National Commodity Exchange — **Rwanda:** Rwanda Grains & Cereal Corp.	Production, Aggregation, Processing
4. Fortification providing nutritional, value-addition benefits	— Uganda has passed mandatory maize flour fortification — Rwanda with optional fortification	— **Rwanda:** Ministry of Health, Minimex	Processing, Marketing and Distribution
5. Local ordinances attempting to drive compliance with quality standards	— EAC passing harmonized SPS and import standards — Local governments in in Uganda passing compliance ordinances	— **Uganda:** Nakaseke District, — **EAC:** TradeMark East Africa	Production, Aggregation, Processing, Marketing and Distribution

Source: Authors.

1. Evolving export markets: Given maize's peripheral place in the national diet, the export market is a critical outlet for Ugandan traders and processors. Kenya and Rwanda are the largest growth segments for Uganda's formal exports. Kenya is the more significant destination, accounting for at least 50% of total exports in each of the last four years. Its processors,

including prominent millers such as Unga Limited, Mombasa Maize Millers, Nairobi Flour Mills Ltd., TSS Grain Millers, and Pembe Flour Mills, act as lead firms in the formal regional maize chain, demanding its suppliers adhere to high quality standards. According to Ugandan stakeholder interviews, Rwanda is also increasingly important market, with demand increasing 6-8% on annual basis in recent years. Its processors and millers also prioritize high-quality maize.

Both Uganda and Rwanda have experienced a consistent recent expansion of their exports of maize flour. Rwanda, especially, appears to have some advantages with this product. Many of its processors use hammer mills that generate the lower quality flour that is in high demand in the DRC and Burundi because of cost considerations. Rwanda's maize flour exports to its neighbors had been negligible until recent years, but Minimex's 2006 investments in improved milling machinery as well as the surge in maize production associated with the CIP appears to have facilitated the jump. Uganda's maize flour exports are concentrated to neighboring South Sudan, which Rwandan processors have more difficulty accessing because of logistical considerations.

2. Different government approaches to upstream challenges: Many of the challenges farmers and traders face in both Rwanda and Uganda are analogous. The difficulty in securing quality inputs (seeds and fertilizer) for maize is perhaps more pronounced in Uganda than Rwanda,[29] but farmers in both countries are smallholders who often lack liquidity and interact with traders who fail to clearly communicate market signals for quality differentiation. Warehouse and storage capacity is a prominent constraint in both countries.

Uganda and Rwanda have employed different strategies to reduce some of these challenges. Uganda's government has taken more of a hands-off strategy, relying primarily on outside actors to help improve efficiency in these segments. For instance, Amatheon-Agri, a German company that is spending on US$115 on cultivation investments in Uganda, negotiated leases for land directly with farmers instead of working directly with the government to facilitate land acquisition (Reuters, 2015).[30]

The de-centralized approach can sometimes lead diverse models. One such example centers on treatment of small traders or village agents, which are often described as the "middlemen" in the chain. Afgri, a South African maize trading company that has been operating in Uganda since 2013, has taken steps to avoid working with these "middlemen" by integrating backwards. The firm recently invested $10 million and had roughly 24,000 tons in storage capacity in the northern portion of the country (Reuters, 2015). Afgri works directly with farmers and has set up extension services, forging 5-10 year partnerships where both sides split costs and profits, and the company also provides loans for inputs such as seeds and fertilizers and access to machinery such as combine harvesters (Aglionby, 2016).

[29] The World Bank's Enabling the Business of Agriculture database (http://eba.worldbank.org/) gives Rwanda the lowest score (27.7) of any country for seed development and seed certification indicators. Uganda's score (44.2) places it among the bottom 10% of emerging countries. The data points used by the World Bank measure the environment for developing and registering new seed varieties within a country; as part of CIP, Rwanda has imported maize seed from regional countries in high volume to ensure access to quality inputs.

[30] In communications for this report, the company does report engaging with the National Environmental Management Authority (NEMA) and the Uganda Investment Authority.

Chemonics has taken another tack. As part of its development efforts, the NGO has embraced the "middlemen" of the Ugandan maize industry, working to strengthen ties and information-sharing between farmers and traders to enhance transparency (Chemonics, n.d.). The program involved roughly 84,000 farmers, 115 traders, 600 village agents, and 17 processors, with aggregators promising to convey accurate price information to farmers, who in turn committed to supply higher-quality maize.

Meanwhile, Rwanda's government has orchestrated more of the country's responses to upstream constraints. Under the CIP, the country has increased its seed imports six-fold over the last decade, with the government subsidizing both seed and fertilizer distribution to farmers. The government has sought to reduce these subsidies, entering into a 2014 partnership with Seed Co. Limited, a public company based in Zimbabwe, to form Seed Co. Rwanda (MINAGRI, 2014). Under the arrangement, Seed Co. Limited has agreed to produce seed in Rwanda and sell it to RAB, which in turn markets and distributes it to farmers. MINAGRI has also bolstered the development of the country's expansive cooperative networks by requiring that at least 40% of its grain for initiatives such as the National Strategic Grains Reserve is sourced from smallholder-based cooperatives. Finally, the government is also the leading shareholder in the RGCC.

3. Development of Warehouse Receipt Systems (WRS): Both the Rwanda and Ugandan governments have attempted to facilitate improved trading regimes through support of entities that aim to create or expand WRS. The Ugandan Commodity Exchange was first established in 2009 before being revitalized in 2014 as the Uganda National Commodity Exchange (UNCE). Whereas international donors and the government provided the funding for the first iteration, the more recent version of the exchange has relied on the private sector for 80% of its investment. While some commercial farmers are using the system, stakeholders reported in interviews that 80% of the maize is from smallholders with less than three hectares. The UNCE's mission is two-fold: 1. To guarantee higher supplies of maize that meets EAC standards through improved storage facilities where the crop can be cleaned and dried; 2. To operationalize the creation of a WRS. According to interviews, the WRS in Uganda offers farmers increased liquidity by providing deposit receipts that can be taken to banking institutions, where farmers receive credit for up to 70% of the value.

In Rwanda, the RGCC has expanded its initial focus of serving as a platform for stakeholders to trade and share market information by establishing a WRS for the 60-70 maize cooperatives that work with the organization. In addition to future plans to expand storage capacity, the RGCC has formed partnerships with the Eastern African Grains Council (EAGC) and the KCB Bank in Kenya to receive financing for agribusiness projects that will provide technical assistance to the maize cooperatives that are part of the RGCC (Nirere, 2015).[31]

[31] The EAGC is a regional industry association based in Kenya that advocates for EAC stakeholders in maize and other grain industries. According to its website: "the goal of the EAGC is to support structured grain trade with the Eastern and Southern Africa region. It works closely and in partnership with governments through a fast growing PPP framework in the region. The Council works closely and variously with a number of development partners and research Institutions to deliver its mandate while staying on the cutting edge of technology and innovation." Table A-5 in the Appendix presents a full list of EAGC members in Rwanda and Uganda.

Box 2. Lessons from Ethiopia's Commodity Exchange and Warehouse Receipt System

The Ethiopian Commodity Exchange (ECX) is a public-private enterprise that began operation in 2008 with the intent of boosting the productivity of Ethiopia's agricultural sector. Prior its establishment, Ethiopia's agricultural sector was largely characterized by high transaction costs, high risk, and high volatility, all of which combined to result in low efficiency and limited participation in GVCs. It is structured in such a way that ownership, membership, and management are all kept separate from one another; owners cannot be involved in trading, members cannot be involved in ownership, and neither owners nor members can be involved in management. Its primary functions include implementation of a WRS program, promoting the sharing of market information between actors at different segments of the chain, and active grain trading in Addis Ababa.

After being the most widely traded commodity in the initial five months of the ECX, maize trade decreased to close to zero by 2011. There are a number of reasons for this trend:

- A global increase in maize prices. With domestic prices also increasing, the incentive for Ethiopian farmers and traders to participate was reduced.
- Ethiopia faced a balance-of-payments crisis that caused the government to rationalize foreign exchange. In response, the ECX shifted its focus toward export goods.
- A general lack of awareness of the ECX trading platform and associated quality standards.

Despite the fact that the vast majority of maize produced in Ethiopia is not traded on the ECX— only 5% of farmers are involved with the ECX—maize farmers have benefitted from the immediate dissemination of prices, which provides leverage for producers in negotiations with farmers.

Sources: Woldegiorgis, 2011; Meijerink et al., 2011.

4. Fortification provides possibility of higher-value products: Uganda and Rwanda have both taken steps to mandate the fortification of maize flour with nutrients and minerals. Uganda has been more proactive, passing legislation in 2012 requiring the addition of iron, zinc, folic acid and B vitamins (thiamin, riboflavin, niacin, B6, and B12) (Joughin, 2012). Rwanda has only passed a non-binding memorandum that details the benefits of purchasing fortified foods; while the Ministry of Health encourages government and institutional buyers to purchase fortified maize flour, there is not an official requirement.[32]

The price difference between fortified and unfortified flour is small (roughly 3%), yet rural consumers are often reluctant to pay the premium. According to interviews, reasons for the hesitancy include unfamiliarity about the health benefits (especially for pregnant women and children), concerns about taste and potential adverse side effects, as well as general cost sensitivity.

[32] The Flour Fortification Index (FFI), an industry database that monitors fortification requirements around the world, incorrectly lists Rwanda as having mandatory maize flour legislation.

gInterviews with stakeholders indicated that Kenya is the most advanced market for fortified maize products and has the most expansive network of food processing companies that use maize as an input for snack products. Neither Rwanda nor Uganda export maize flour to Kenya in significant volume—Kenyan millers generally produce the high-quality, fortified flour consumed in the country. Additionally, the officials with Rwandan and Ugandan firms were unaware of many local businesses that had the extruders required to generate advanced maize outputs such as chips or flakes.

5. Local ordinances attempt to increase adherence to quality standards: As part of a broader effort toward harmonized standards, EAC countries Kenya, Rwanda, and Uganda agreed in 2012 to maximum levels of moisture, aflatoxin, foreign matter, broken kernels and other defects for maize. However, the process of creating national-level legal and institutional frameworks to implement these standards is ongoing, and there are still frequent disputes between Uganda and Kenya over concerns about Uganda's adherence to quality standards, which results in non-tariff barriers for Ugandan producers and aggregators that undermine their competitiveness.[33]

Through the National Trade Policy and the National Bureau of Standards, the Ugandan government has attempted to increase compliance to EAC standards. However, a host of challenges remain at all segments of the value chain, with lack of farmer awareness and inadequate certification and testing capacity being among the most prominent. Local governments in Uganda have taken the initiative to bridge the compliance gap. In 2015, Nakaseke District in the center of the country passed an ordinance that penalized farmers that do not adhere to best practices when growing maize—the harvest of green maize, drying maize on the ground, and application of unapproved chemicals can be punished with fine (Mukisa, 2015). Capacity building and education about EAC maize standards are also part of the program, which is being funded in part by TradeMark East Africa (Mukisa, 2016).

3.4 Advantages and Challenges for GVC Participation and Upgrading

Table 12: SWOT Analysis of Maize Industry in Rwanda and Uganda

Strengths	**Weaknesses**
— Widespread maize farming with increases in production and export volume in Rwanda and Uganda — Favorable conditions for maize cultivation in both countries — Government attention to the sector in Rwanda and Uganda	— Substandard quality of maize on formal and informal markets in Uganda and Rwanda — High levels of segregation within the private sector in Uganda and Rwanda — Failure to implement government policies in Uganda — Low compliance capacity for maize standards in Uganda
Opportunities	**Threats**
— Demand for maize products strong in regional neighbors — Potential for value-added products and greater diversity in products	— Political instability in significant markets (South Sudan, Burundi) — Consumers in important markets unwilling to pay price difference for higher-quality maize — Climate change

Source: Authors.

[33] In interviews, stakeholders reported that there are also differences between maize that is classified as Grade 1 or 2 in Kenya and Uganda—Uganda allows for more variance in color in Grade 1 maize, while Kenyan processors prefer only white maize.

While the maize sectors in Uganda and Rwanda have significant weaknesses and challenges, there are advantages that can help enable future upgrading. Table 12 above summarizes many of these in the form of a SWOT analysis. The most prominent strengths and challenges (both weaknesses and threats) are then outlined in the section below. The potential upgrading section that follows expounds on the opportunities.

3.4.1 Advantages

Uganda and Rwanda's most pronounced strengths in the maize GVC relate to natural resources. The most prominent include the following:

1. **Widespread maize farming with recent increases in production and export volumes:** While there are conflicting estimates about maize production and exports in the EAC as well as concerns about its overall reliability, the clear trend line is for increasing production volumes in both Rwanda and Uganda. Table 13 depicts the increase over the decade from 2004-2013. Rwanda's surge can be partially attributed to the emphasis placed on maize as part of the CIP, while Uganda's jump corresponds to efforts to boost commercialization. The gains have helped Uganda solidify its place as one of Africa's three largest exporters of maize and maize flour.

Table 13: Maize Production in Rwanda and Uganda, 2004-2013 (MT, thousands)

Country	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Rwanda	88	97	96	101	166	286	432	525	573	667
Uganda	1,300	1,237	1,258	1,261	2,314	2,354	2,373	2,551	2,734	2,748

Source: FAOSTAT based on FAO item code 5922. Retrieved on August 15, 2016.

2. Favorable conditions for maize cultivation: Maize production is widespread in both countries. Uganda benefits from two growing seasons and large swaths of fertile land. While the eastern portion of the country has historically been the largest source of maize, northern districts have received investments from foreign firms such as Afgri Limited and Amatheon-Agri that are bullish about the country's prospects about becoming the leading supplier of agricultural products in the EAC (Reuters, 2015).

3. Government attention to the sector: Both the Rwandan and Ugandan governments have included maize as part of broader pushes to spark agricultural development. In Rwanda, the CIP provides subsidies to farmers for key inputs such as seed, fertilizer, and insecticide. It has also encouraged land consolidation and helped with extension services. In Uganda, the *Development Strategy and Investment Plan (DSIP)* developed by the Ministry of Agriculture, Animal Industry & Fisheries in 2010 included maize as a priority crop. As part of the program, the government identified five potential areas for interventions: 1. Strategic research on environmental and scientific challenges; 2. Seed distribution; 3. Extension services; 4. Warehouse capacity; 5. Standards and certification (Uganda Ministry of Agriculture, Animal Industry & Fisheries, 2010).

3.4.2 Challenges

There is overlap in the profiles of the Rwandan and Ugandan maize industries. Both suffer from upstream challenges that impair quality and push processors toward the informal market. Both suffer from inefficiencies in the aggregation segment, including lack of storage facilities and poor communication of market signals and standards by traders. Neither industry is particularly integrated in either country. The following section outlines the most prominent constraints for both. In some cases, the trading profiles and government programs associated with each nation make some of the challenges more acute for one particular country—for example, while Uganda's fertile land and natural resources provide it with production advantages, those assets also make the constraints found in the upstream segments more pressing as it seeks to boost exports. Where appropriate, the section highlights the country most affected.

1. Substandard quality of maize on formal and informal markets. The maize industries in both Rwanda and Uganda are characterized by lower quality outputs. Rwanda's profile, however, works to its advantage in some respects, whereas Uganda's serves as a constraint for boosting exports. While domestic consumers in Rwanda prefer higher quality maize, the country also exports significant quantities of maize flour to the DRC and Burundi, both of which prefer cheaper product because of cost considerations. Uganda, on the other hand, relies on Kenya as a significant source of demand—processors in Kenya seek premium maize.

Table 14: Major Constraints in Maize GVC in EAC

Segment	Constraint	Primary Country	Significance
Inputs	— Inferior seeds	Uganda	High
	— Low use of fertilizer and insecticide	Uganda	Medium
Production	— Lack of liquidity and access to credit	Uganda, Rwanda	High
	— Insufficient economies of scale	Uganda	High
	— Human capital	Uganda, Rwanda	Medium
Aggregation	— Misaligned motivations	Uganda, Rwanda	High
	— Lack of coordination	Uganda, Rwanda	High
	— Storage conditions	Uganda, Rwanda	High
	— Warehouse capacity	Uganda, Rwanda	High
Processing	— Limited number of large-scale mills	Uganda, Rwanda	Medium/Low
	— Underdeveloped backward and forward linkages	Uganda, Rwanda	Medium
Distribution & Marketing	— Adherence to standards	Uganda	High
	— Certification capacity	Uganda, Rwanda	High
	— Low demand for higher-value products	Rwanda	Medium

Source: Authors.

Many Ugandan and Rwandan maize traders and processors lamented the low quality of maize in the country in interviews, with many reporting that they reject between 30-60% of potential volume. The constraints, first outlined in the Industry Organization sections, persist even though

they have been studied at length (see Table 14 above).[34] Perhaps the single most significant revolves around the issue of liquidity for upstream actors. Because of the low income levels for farmers and their need for cash, they accept payment from small traders who do not differentiate for quality. Without incentive to grow higher quality maize, producers have little incentive to invest in improved technology or seek to increase scale. Finally, farmers' lack of liquidity and the costs associated with conforming to EAC standards also have the effect of driving producers to the informal market, which may be as large as 70-80% of regional production.

2. High levels of segregation within private sector. There are few examples of integrated companies in Rwanda and Uganda (see Figures 4 and 8). Minimex, Rwanda's largest maize processor, is one of the most visible examples. It has a sister company, ProDev, and an ownership stake in the RGCC to provide important aggregation and warehousing services. It also has links with brewery Bralirwa to purchase its maize grits. In Uganda, there are individual cases of companies performing multiple activities—Agrinet, to cite one example, is both a trader and producer of animal feed, and Joseph Initiative is integrated across the various levels of traders to allow it to deal with farmers more directly. Most companies, however, have a narrow focus. The segregation within the private sector reduces communication of market signals throughout the chain while also perpetuating the misalignment of incentives.

3. Failure to implement government programs. While the Ugandan government included maize as part of development initiatives, it has not implemented DSIP at a broad level. There has been progress toward some of the DSIP goals, with the UNCE starting its WRS and the Ministry of Agriculture creating the Seed Subsector Coordination Group. However, there does not appear to be institutional support to adopt the DSIP, with government officials apparently concerned that full implementation and increased autonomy for the sector may undermine the interests of entrenched, elite stakeholders (Joughin, 2014a).

4. Low compliance capacity for maize standards. While there is harmonization of maize standards at the EAC level, there is uneven adherence to these requirements at the national level in Uganda and Rwanda. The challenges are larger than the maize sector, with food safety and SPS standards a concern for most agricultural products. Even when there is agreement between EAC countries on industry or SPS standards, the failure to comply with these guidelines is the result of one of three factors: 1. Consumers' unawareness of the benefits of food safety; 2. Consumers sensitivity to higher prices; and 3. Inability of national governments to publicize, test or enforce the standards at all stages of value chain. Together, these features provide little incentive for value chain operators to invest in protocols or equipment that will enhance food safety (GIZ, 2012).

4. Potential Upgrading Trajectories

While there are entrenched challenges, there are also opportunities for the Ugandan and Rwandan maize industries to enhance efficiency and boost exports. Stakeholders in Uganda should focus on upstream segment of the chain, where process upgrades can address shortages of critical inputs, poor storage conditions, inadequate warehouse capacity, and misaligned

[34] Joughin (2012) conducted an extensive literature review of the Ugandan maize industry and concluded there was an average of two major studies per year in the period between 2000 and 2012. The volume has not slowed in the time since.

motivations of key actors. Given its fertility and its potential to generate large volumes of maize, Uganda can also increase the size of its farms while improving its ability to deliver EAC-certified maize to Kenya, which is its most important trading partner. Rwanda would benefit from some of these same upgrades, especially in the aggregation segment of the chain. However, it can also focus on downstream elements such as marketing to boost demand for its largest export product, maize flour. This section discusses potential upgrading trajectories for the regional maize sector. The section that follows then outlines strategies for implementation.

1. **Process upgrading in Uganda to increase maize quality.** The low quality of Ugandan maize has been discussed at length throughout this report. Process upgrades can reduce or eliminate prominent bottlenecks in specific segments of the chain. These include the following:

    - **Seed distribution:** Although Rwanda has taken steps to improve access to high-performing maize seed and fertilizer through its CIP, the use of informal, counterfeit or inferior varieties of seeds within Uganda remains high. The government has opened up its sector to the private sector, although it is unclear whether many make money. Joughin (2014a; 2014b) has studied the market inefficiencies at length and concluded that one of the primary restraints is the inability of the government to set up an effective institutional environment. If nurtured properly, Joughin (2014a) notes there is the possibility to attract FDI from seed companies interested in the regional market.

    - **Farm size:** Three-quarters of maize is grown on plots of less than 0.5 hectares. A move toward commercial-sized farms can help boost the country's exports. Stakeholders reported in interviews that 50 hectares is an appropriate target to generate the economies of scale and encourage subsequent investments in capital and quality inputs.

    - **Aggregation (Uganda and Rwanda):** While addressing the input and production size constraints will pay dividends particularly for Uganda, both it and Rwanda would benefit from improvements in the aggregation sector. There are two challenges that undermine both countries in this segment of the chain: 1. The failure of smaller traders to communicate market signals about the value of quality maize; and 2. Substandard storage conditions. There is a variety of initiatives in both countries to address these shortcomings. Government-led efforts include the support of the UNCE and the RGCC in their efforts to boost storage capacity, initiate WRS, and connect buyers and sellers. The private sector—Afgri working directly with farmers in Uganda—and NGOs—Chemonics working with village agents—are also attempting to drive efficiency in this segment.

2. **Process upgrading in Uganda to ensure adherence to EAC standards.** Uganda can employ a multi-faceted approach as it looks to expand its presence in the regional market. Increasing the size of farms as described above is one element—it can help generate economies of scale and boost exports. Another involves ensuring that the large number of

smallholders can access export markets. In order to do this, the government can increase education efforts and certification capacity to ensure adherence to EAC quality standards. Kenya is the largest growth market for Ugandan maize—stakeholders can continue discussions and negotiations designed to reduce mistrust in the trading relationship.

3. **Product and functional upgrading in Uganda and Rwanda to increase quality and diversity of outputs.** The global maize industry has shifted toward an emphasis on ethanol and livestock feed. Given the crop's importance for food security in the region, it is not surprising the EAC industry is oriented toward food products. While ethanol production would likely require substantial FDI from an ABCD firm that evaluates expansion based on prospective market size, animal feed may provide more immediate upgrading opportunities. Currently, feed is a low-value output because of the production process—dry mills separate bran from the kernel instead of more sophisticated wet milling operations. Additionally, there are few if any producers of higher-value maize food outputs such as flakes or chips.

4. **Functional upgrading in Rwanda and Uganda to increase marketing and education regarding benefits of higher-value products.** Mills that produce fortified maize flour report difficulty in having cost-sensitive consumers pay a 3% premium, with officials estimating the more nutritious version comprising only 10-15% of sales. The Rwandan government encourages maize flour fortification; however, as of yet, it is not mandatory. The absence of regulation has deleterious effects—with cheaper product available in informal markets, formal processors who sell fortified flour are uncompetitive since consumers are unaware of the nutritional benefits associated with fortified flour and unwilling to pay the higher price.

4.1 Policy Recommendations

The challenges impeding the development of Rwanda and Uganda's maize sector are comparable to the ones that many small and medium-sized enterprises face in agricultural value chains throughout emerging nations. In previous studies, Duke CGGC has identified four major pillars that every intervention should address in order to raise the competitiveness of smallholders as they integrate into GVCs: access to markets; access to finance; access to training; and coordination and collaboration building. This section outlines steps that align with those pillars and will encourage the upgrading trajectories described above. Consistent with the project's focus on EAC integration, it also incorporates steps that would strengthen the development of a regional value chain.

1. **Process upgrading in Uganda to increase maize quality.** While there are a number of challenges, the previous section prioritized three areas for intervention. This section outlines each below.

    - **Seed Distribution:** Joughin (2014a; 2014b) and others (World Bank, 2013; Keyser, 2012) have advanced policy steps that would address some of the constraints preventing greater distribution of maize seeds inside Uganda. Some of the most pressing include the following:

- *Allow easier access to Kenyan seed market.* Easier access to the Kenyan seed market would allow Ugandan farmers to reduce the reliance on informal or fraudulent seed (Joughin, 2014a). Uganda restricts seed imports from Kenya and other regional peers through an extensive maze of bureaucratic hurdles. Some of the more prominent include not honoring the testing of new seed varieties conducted by EAC peers (instead requiring a separate two-year monitoring period led by Ugandan authorities), overly restrictive importing paperwork, and requiring that regional companies register with the Ugandan Ministry of Agriculture and adhere to its standards (instead of, for instance, accepting Kenyan registration).

- *Enhance and simplify the institutional environment.* In addition to its failure to advance the DSIP, the government has lagged in other ways. These include: 1. The national seed board has not met; 2. The National Agricultural Seed Policy has not been approved; and 3. The Draft Seeds and Plant Act Regulations has not been implemented. Some of these pieces of legislation would introduce further complexity. Joughin (2014a) and Keyser (2012) both observe that Uganda and other Sub-Saharan African countries have a tendency to over-regulate the seed industry through opaque institutional environments as well as the import controls described above.

- *Investigate causes for seed market failures in Uganda.* Bold et al. (2015) showcased the failure of seed markets to provide quality inputs to Ugandan farmers. Their paper called for further study into the causes for inferior supply. In its research, this report found similar challenges and agrees with the call for increased government and donor attention.

- **Increase size and number of commercial farms.** Recent investments by larger companies in Uganda provide lessons for increasing the scale of Ugandan maize farms. Some of the more tangible include:

  - *Help formulate system that will provide clarity of land ownership.* Land ownership disputes recently derailed a planned US$100 million, 40,000-acre sugar investment by Madhvani Group (Reuters, 2015). Madhvani is one of Uganda's largest and connected businesses, underscoring the depth of the challenge of securing land for large-scale production. As part of its investment in Uganda, Amatheon-Agri, a German firm, negotiated leases directly with the approximately 5,000 local farmers to expand its holding to 2,700 hectares in northern Uganda (Reuters, 2015). However, the lack of clear land titles—especially in the northern regions of the country where past conflicts have created ownership vacuums—presents challenges with the strategy.

  - *Attract regional firms for FDI through tax credits or broader infrastructure investments.* The Uganda Investment Authority (UIA) provided Amatheon-Agri with tax breaks to help entice the company to Uganda (Aglionby, 2016).

Moreover, the Nwoya District has also benefitted from national investments the government has made in critical infrastructure such as road and power. The UIA can use these elements to entice FDI from agribusiness companies that are primarily attracted by the fertility of the land.

- **Improve efficiency in aggregation segment in both Rwanda and Uganda.** Upgrades in this segment of the chain are critical for the overall health of the industry. There are two key elements stakeholders can focus on: 1. Enhancing the trading network; and 2. Improving storage. Potential strategies that can be followed include the following:

    - *Education of key trading actors:* One model for ensuring processors receive higher quality maize involves trading companies making direct outreach at the village level in efforts that mimic vertical integration. In some cases, this has happened organically—Afgri and Joseph Initiative both prioritize working as near farmers as possible and have key aggregation centers in close geographic proximity. While the transaction costs associated with buying small quantities is high, these processors benefit from access to cheaper maize since it has not passed through multiple traders. Additionally, these companies profit from controlling storage conditions to a greater degree.

      While that model can spread, the "middlemen" or small traders that populate this segment of the chain are an entrenched feature that cannot entirely eliminated by integration. Instead, efforts to educate and promote information sharing among traders may provide measurable benefit. NGOs, such as Chemonics, have employed this approach, educating village agents and traders about the importance of quality standards and communicating market information to farmers. Under the program, farmers commit to providing higher-quality maize in exchange for accurate price data.

    - *Encourage financial institutions to provide support for projects to expand warehouse capacity.* Parts of the UNCE's and RGCC's mandates are to increase storage capacity in their respective countries. Both have had some success—the UNCE reports that it has expanded its warehouse capacity from 20,000 tons to close to 200,000 tons in roughly five years,[35] while the RGCC had plans to add close to 30,000 tons as part of a project scheduled to come online in 2016. However, stakeholders in both countries said that storage remains a prominent constraint, both in terms of capacity and quality of facilities.

      Short of governments directly constructing new warehouses—Uganda does not have a national strategic grain reserve, and Joughin (2012) discusses why it might be a strategic move—they can encourage financial institutions to provide loans for storage projects. In interviews, stakeholders reported that

[35] This is for all crops, including maize, rice, sorghum and others.

they rely on foreign companies for financing because of the difficulty in securing credit at reasonable terms from national institutions.

- *Collaborate with regional institutions to expand capacity*. Organizations such as TradeMark East Africa—an EAC trade support group based in Kenya—and the EAGC have taken proactive roles in providing financial or advocacy support for efforts to improve maize quality in the region. In Rwanda, the EAGC and KCB Bank partnered with RGCC for financing of agribusiness projects (Nirere, 2015). The East African Commodity Exchange (EAX) has also expressed interest in expanding its operations to Uganda, although discussions have not advanced (Esiara, 2016). National government officials can consider re-engaging these discussions and communicate the importance of investments in this segment of the chain to such stakeholders in order to spark new projects.

2. **Process upgrading in Uganda to ensure adherence to EAC standards.** In his analysis of EAC trade policy regimes, Keyser (2012) outlines the unintended negative consequences of strict harmonization standards that are not suited to African context—namely, driving up costs for smallholders—and advocates for simplified regulations. Building off his recommendations, maize stakeholders can focus on two parallel tracks:

   - *Increase certification capacity*. Kenyan processors act as lead firms in the regional value chain and demand high-quality maize. Given the importance of the Kenyan market for Ugandan producers and traders, there is incentive to ensure compliance with EAC and Kenya protocols. Many of the recommendations proffered in this report address the issue of improving maize quality. In addition, government officials can make a concerted push to ensure farmers are aware of market standards. This can be done at both the national and local levels. Efforts by the Nakaseke District could serve as a model. In 2015, the local government passed an ordinance that penalized farmers that do not adhere to best practices when growing maize (Mukisa, 2015). TradeMark East Africa is helping to provide funding to ensure the implementation of the program, which also includes capacity building and education about EAC maize standards (Mukisa, 2016).

   - *Evaluate appropriate legal frameworks and engage in conversations with stakeholders*. In adopting strict SPS standards that are in line with WTO agreements, Keyser (2012) argues the EAC and other African regions have set too high a bar for certification that smallholders cannot be expected to clear. In line with his recommendation of mutual recognition of verification and equivalence agreements rather than straight harmonization, regional policymakers can engage in discussions with the goal of simplifying trade agreements to make them business friendly and promote greater compliance.

3. **Product and process upgrading in Uganda and Rwanda to increase quality and diversity of outputs.** Estimates suggest that between 10-30% of the total volume of maize in Rwanda and Uganda is used as animal feed (Gates Foundation, 2014; USAID,

2010). Stakeholders reported the quality of feed is low, partially because of outdated processing techniques—dry mills separate bran during hulling instead of more sophisticated wet milling techniques. However, there may be opportunities to expand market size and value-creation through more advanced dry mills even without the construction of more expensive wet mills. In a move that highlights the potential higher-quality feed, Cargill announced in 2015 that it was expanding its animal nutrition operations in Kenya after acquiring LGHL, a bulk grain trading company, in 2014 (see Box 1).

There are other potential ways to diversify maize portfolios through higher-value products. Cargill's recent investment in wet maize mills in India is partially to generate glucose and other thickeners and sweeteners for the African market (Cargill, 2016b). Another possibility might be to address the limited capacity within the region to generate products such as chips and flakes.

Efforts to improve maize quality in Rwanda and Uganda will provide benefits for this particular upgrading trajectory. Additionally, policymakers can consider the following actions:

- *Initiate new studies of livestock industries.* There has not been a comprehensive study of the animal feed industries in Rwanda and Uganda over the last decade (Joughin, 2012). The previous study, conducted in 2002, projected that animal feed volumes in Uganda would increase from 105,000 to 185,000 tons in the period from 2002 to 2010 (IITA, 2002). However, the regional population growth that is factored into such forecasts was higher than expected, and it is possible actual demand was higher. Anecdotal evidence from media reports suggests there is insufficient supply of animal feed in the EAC.

- *Encourage communication between participants in livestock and maize GVCs.* The Ministries of Agriculture in each country can use their convening power to encourage relevant actors in both industries—maize processors, livestock input providers—to host communication forms to discuss quality and supply needs. Together, the stakeholders can identify possible solutions to technical challenges and supply bottlenecks.

4. **Functional upgrading in Rwanda and Uganda to increase demand for higher-value products.** Processors in Rwanda report low demand for maize flour fortified with nutrients and minerals, despite a relatively marginal price difference (3% compared with unfortified flour). With consumers apparently unaware of the health efforts, officials may consider the following approaches:

   - *Introduce mandatory fortification in Rwanda.* While Uganda and as many as seven other African nations have passed legislation requiring maize flour fortification,[36]

[36] The Flour Fortification Index provides a database of countries with mandatory flour fortification and estimates there are 16 countries globally with such requirements (http://www.ffinetwork.org/global_progress/). However, it includes Rwanda as one of its 16, despite the fact it the government only encourages it.

Rwanda has passed only a non-binding memorandum that details the benefits of purchasing fortified foods. The Ministry of Health can consider adopting requirements that are more expansive.

- *Create public relations campaigns in Rwanda and Uganda that highlight health benefits of fortified flour.* Even with mandatory fortified flour, the size of the informal markets in Uganda and Rwanda provides large supplies of unfortified flour at lower prices. In order to ensure the legislation does not drive consumers to informal markets, government agencies need to initiate marketing campaigns that both communicate the nutritional value of fortified flour and reach a large audience. The Fortified Food (FF) logo that processors can affix to packaging is a step in this direction.

- *Conduct market studies for both Uganda and Rwandan maize consumers.* Fortified flour is only one aspect of better marketing and distribution of maize products. Burundi, the DRC, and South Sudan are major consumers of Ugandan and Rwanda maize products, yet some of the value chain dynamics in these nations is ambiguous to outside stakeholders. Joughin (2012) made note of this characteristic and recommended market studies, especially for the South Sudan market for Uganda. This report concurs with that assessment.

- *Collect better export data by working with traders.* This will yield benefits across the chain. Policymakers and industry stakeholders will have a more comprehensive sense of each country's maize exports as well as destinations. Potential strategies include working directly with large-scale traders as well as organizations such as the UNCE and the RGCC that have government ties to get a comprehensive sense of exports and production.

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6. Appendix

Table A-1: Countries with Highest Maize Consumption in the World

Country	Region	Maize consumption (grams/person/day)
Lesotho	Africa	328
Malawi	Africa	293
Mexico	Americas	267
Zambia	Africa	243
Zimbabwe	Africa	241
South Africa	Africa	222
Timor-Leste	Southeast Asia	190
Guatemala	Americas	187
Bosnia-Herzegovina	Europe	181
Kenya	Africa	171
Honduras	Americas	169
Togo	Africa	160
El Salvador	Americas	157
Swaziland	Africa	152
Nicaragua	Americas	148
Venezuela	Americas	135
Tanzania	Africa	128
Namibia	Africa	127
Egypt	Africa	127
Paraguay	Americas	121
Benin	Africa	119
Mozambique	Africa	116
Burkina Faso	Africa	107
Nepal	Southeast Asia	98
Ethiopia	Africa	94
Korea	Southeast Asia	93
Colombia	Americas	92
Bolivia	Americas	86
Romania	Europe	85
Morocco	Africa	84
Angola	Africa	81
Indonesia	Southeast Asia	79
Botswana	Africa	78
Cameroon	Africa	75
Slovenia	Europe	75
Cape Verde	Africa	72
Central African Republic	Africa	71
Mali	Africa	70
Seychelles	Africa	69
Cuba	Americas	66
Israel	Europe	64
Uruguay	Americas	63
Senegal	Africa	62
Belize	Americas	61
Nigeria	Africa	60
Macedonia	Europe	59
Kyrgyzstan	Europe	58
Brazil	Americas	55

Ghana	Africa	53
Panama	Americas	53
Uganda	Africa	52
Haiti	Americas	50

Source: Ranum, 2014. Note: Based on FAOSTAT data from 2007-2009.

Table A-2: Top 5 Global and African Producers of Maize, 2004-2013

Country	Production Quantity (MT, millions)					World or African Share (%)				
	2004	2006	2009	2011	2013	2004	2006	2009	2011	2013
WORLD	**728**	**706**	**820**	**887**	**1,017**					
US	299	267	332	313	353	41.1%	37.8%	40.5%	35.4%	34.8%
China	130	151	163	192	218	17.9%	21.4%	20.0%	21.7%	21.5%
Brazil	41	42	50	55	80	5.7%	6.0%	6.2%	6.3%	7.9%
Argentina	—	—	—	23	32	—	—	—	2.7%	3.2%
Ukraine	—	—	—	22	30	—	—	—	2.6%	3.0%
Mexico	21	21	20	—	—	3.0%	3.1%	2.5%	—	—
Indonesia	—	—	17	—	—	—	—	2.1%	—	—
India	—	15	—	—	—	—	2.1%	—	—	—
France	16	—	—	—	—	2.2%	—	—	—	—
AFRICA	**47**	**49**	**59**	**66**	**70**	**6.5%**	**7.0%**	**7.3%**	**7.5%**	**7.0%**
S. Africa	9.7	6.9	12	10.3	12.4	20.4%	14.0%	20.1%	15.6%	17.6%
Nigeria	5.5	7.1	7.3	8.8	8.4	11.7%	14.3%	12.8%	13.4%	11.9%
Egypt	6.2	6.3	7.6	6.8	7.9	13.1%	12.9%	12.3%	10.4%	11.2%
Ethiopia	2.9	4.0	3.8	6.0	6.4	6.1%	8.1%	6.5%	9.2%	9.2%
Tanzania	4.6	3.4	—	4.3	5.3	9.8%	6.6%	—	6.6%	7.6%
Malawi	—	—	3.5	—	—	—	—	6.0%	—	—

Source: FAOSTAT based on FAO item code 5922. (—) indicates country was not in the top 5 in the given year. Retrieved on August 15, 2016.

Table A-3: Top 15 Ugandan Formal Exports by Percentage Share, 2010-2014

Crop	2010	2011	2012	2013	2014
Coffee	17.5	21.6	15.8	17.7	18.1
Petroleum products	4.5	4.8	5.8	5.5	6.4
Fish and fish products	7.9	6.3	5.4	5.3	6.0
Animal/vegetable fats and oils	3.4	4.7	4.7	4.2	4.5
Iron and steel	3.3	3.5	3.5	3.9	4.1
Cement	4.4	4.4	4.5	4.3	3.9
Tea	4.2	3.3	3.1	3.6	3.7
Hides and skins	1.1	1.5	1.8	2.7	3.3
Sugar & sugar confectionary	3.7	3.8	5.2	3.5	3.0
Tobacco	4.2	2.5	3.0	5.0	2.9
Cocoa beans	2.2	2.1	1.6	2.3	2.6
Sesame seeds	0.8	0.8	0.5	1.2	2.4
Maize	**2.4**	**1.2**	**2.4**	**1.8**	**1.9**
Plastic products	0.6	0.9	1.1	1.5	1.7
Sorghum	0.1	0.0	0.2	1.1	1.6

Source: Uganda Bureau of Statistics, 2015.

Table A-4: Formal and Informal Exports of Rwandan Maize, 2012-2015

	2012-13		2013-14		2014-15	
	Formal	**Informal**	**Formal**	**Informal**	**Formal**	**Informal**
Maize						
Volume (MT)	2,878,264	3,785,692	1,553,897	3,430,950	1,280,158	2,172,127
Volume (%)*	43.1	56.8	31.1	68.8	37.0	62.9
Value (USD)	1,925,940	961,887	1,224,088	686,302	419,894	297,103
Value %	66.6	33.3	64.0	35.9	58.5	41.4
Maize Flour						
Volume (MT)	637,662	13,276,724	3,166,226	11,270,883	11,542,044	13,281,828
Volume (%)*	4.5	95.4	21.9	78.0	46.4	53.5
Value (USD)	897,674	8,924,032	2,442,865	7,701,397	8,441,838	7,109,337
Value %	9.1	90.8	24.0	75.9	54.2	45.7

Source: National Institute of Statistics of Rwanda, 2015. * = Percentage of total volume.

Table A-5: EAGC Members in Rwanda and Uganda

Company	Country	Value Chain Segment
East Africa Exchange	Rwanda	Aggregation
Rwanda Grains and Cereal Corporation	Rwanda	Aggregation
Healthy Foods	Rwanda	Aggregation
Sarura Commodities	Rwanda	Aggregation
Yak Fair Trade Limited	Rwanda	Producer/Aggregator/Processor
Kaidu Cooperative	Rwanda	Producer
Uganda Grains Trader	Uganda	Aggregation
Ugeri Traders	Uganda	Aggregation
AFRO-KAI	Uganda	—
Export Trading Company	Uganda	Aggregation
Produce and Export Ltd.	Uganda	—
Uganda National Commodity Exchange	Uganda	Aggregation
Allied Cereal Growers Association	Uganda	—
Aponye	Uganda	Aggregation/Processing
Namukat General Supplies and logistics	Uganda	—
Chemiphar Ltd	Uganda	—
Kinoni Produce Farm Ltd	Uganda	—
Busia Produce Dealers	Uganda	—
Coronet Group Ltd	Uganda	—
Agroways Ltd	Uganda	Aggregation
Agtrade Ltd	Uganda	—
Audit Control & Expertise Ltd	Uganda	—
Askar Enterprises Ltd	Uganda	—
Farmers Centre Ltd	Uganda	—
Nile Breweries	Uganda	Production
aBi Trust	Uganda	—
Smith & Bolton	Uganda	—
Victoria Seed Ltd	Uganda	Inputs
Kapchorwa Commercial Farmers	Uganda	—
Akiba International Ltd	Uganda	—
Pura Organic Agro Tech Ltd	Uganda	—
Elshaday General Trading	Uganda	—
Agasha Group Ltd	Uganda	—
Upland Rice Millers	Uganda	—
Rewa Grains	Uganda	—

Source: EAGC website (http://eagc.org/membership/list-of-members/). Accessed on September 29, 2016.

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