UNITED NATIONS UNIVERSITY
UNU-WIDER

WIDER Working Paper 2019/70

Assessment of demand in agro-processing machinery in the SADC region

A case study of the maize-milling machinery value chain in South Africa and Zambia

Gillian Chigumira

September 2019

United Nations University World Institute for Development Economics Research
wider.unu.edu

Abstract: This working paper is the fourth in a series that forms part of the project 'Southern Africa – Towards Inclusive Economic Development', a three-year partnership between UNU-WIDER and the South African government aimed at generating a better understanding of regional value chains and supporting industrialization in the Southern African Development Community region. The SADC Industrialization Strategy and Roadmap 2015–2063 aims to arrest deindustrialization and resuscitate manufacturing capabilities within the region. Agro-processing, the largest contributor to manufacturing in most of the member states, has been chosen as one of the growth paths to help the region reindustrialize. Because of its backward linkages with the agricultural industry and forward linkages into the diverse food industry, this subsector has received immense government support and private sector investment. However, the region faces important leakages in imports of machinery. This paper investigates whether the sector is stimulating additional manufacturing capabilities in agro-processing machinery, equipment, and parts, and whether these could drive capabilities, factor accumulation, and technological capability-building to capture the full value envisioned in the Roadmap.

Key words: agro-processing, grain milling, industrialisation, manufacturing, SADC, South Africa, Zambia

JEL classification: F1, K3, L5, O2

Acknowledgements: Sithembiso Mtanga directed the project with support from Natasha du Plessis. Saul Levin and Tracy Ledger provided comments and guidance. The author would also like to acknowledge Bridget Astridah Munsaka, an independent researcher from Zambia, for support with stakeholder engagement. TIPS acknowledges UNU-WIDER and the South African Department of Trade and Industry for their support.

* Trade and Industrial Policy Strategies, Pretoria, South Africa, gillian@tips.org.za

This study has been prepared within the UNU-WIDER project Southern Africa – Towards Inclusive Economic Development (SA-TIED)

Information and requests: publications@wider.unu.edu

ISSN 1798-7237 ISBN 978-92-9256-704-0

https//doi.org/10.35188/UNU-WIDER/2019/704-0

Typescript prepared by Joseph Laredo.

The United Nations University World Institute for Development Economics Research provides economic analysis and policy advice with the aim of promoting sustainable and equitable development. The Institute began operations in 1985 in Helsinki, Finland, as the first research and training centre of the United Nations University. Today it is a unique blend of think tank, research institute, and UN agency—providing a range of services from policy advice to governments as well as freely available original research.

The Institute is funded through income from an endowment fund with additional contributions to its work programme from Finland, Sweden, and the United Kingdom as well as earmarked contributions for specific projects from a variety of donors.

Katajanokanlaituri 6 B, 00160 Helsinki, Finland

1 Introduction

The SADC Industrialization Strategy and Roadmap 2015–2063 aims to arrest deindustrialization and resuscitate regional manufacturing capabilities. Agro-processing as a subsector of manufacturing has been selected as one of the growth paths to help the SADC to transform its 'deep structural fault-lines that remain entrenched, characterised by resource-dependence, low value-addition and low levels of exports of knowledge-intensive products' (SADC 2017a: 3). Agro-processing is the largest contributor to manufacturing in most of the SADC states. Because of its backward linkages with the agricultural industry and forward linkages into the diverse food industry, this subsector has received immense government support and private sector investment. A 10-year review of South Africa's agro-processing sector shows total government and private sector investments of around R7 billion (Department of Trade and Industry (DTI) 2018). In Zambia, the government and multinationals have invested heavily in agribusiness related to grain milling, including grain for animal feed, among other areas. In 2017, the World Bank launched the Zambia Agribusiness and Trade Project, with a US$40 million (479 million kwacha) credit over five years (World Bank 2018). A fundamental question is whether growth and investment in the sector is stimulating regional manufacturing capabilities in agro-processing machinery, equipment, and parts. In addition, are there corresponding opportunities in the manufacture, repair, and maintenance of capital goods used in agro-processing, and could these drive capabilities, factor accumulation, and technological capability-building?

Research on agro-processing machinery and value chains is fragmented or non-existent. Most agricultural value chain research concentrates on agricultural product value chains or agricultural inputs at the farming level. This paper aims to fill gaps in the body of knowledge and to encourage future research for the region around the machinery used in the major agro-processing value chains.

Since agro-processing machinery is not a homogeneous category, assessing a specific value chain enables a better understanding of the relevant dynamics. This paper focuses on case studies in the maize-milling machinery value chain in two countries—South Africa and Zambia—since maize is a staple food in both countries.

The paper is structured as follows: Section 2 outlines the theoretical framework and methodology used, and describes prior research conducted on agro-processing. Section 3 assesses demand trends that drive agro-processing and provides case studies of the maize-milling value chains in Zambia and South Africa. Section 4 provides case studies of the machinery value chain in the aforementioned countries. Section 5 analyses the supply-side trends, and Section 6 assesses the potential for development of a regional value chain in agro-processing machinery, specifically in maize milling, and concludes with recommendations to support such a development.

2 Theoretical framework and methodology

2.1 Theoretical framework

The underlying theory for this paper is manufacturing-led industrialization and import substitution industrialization (ISI). Proponents of structural change and industrialization-led growth (Chang and Lin 2011; Kaldor 1976 in Targetti 2005; Tregenna 2008) argue for industrialization and reindustrialization by growing the manufacturing sector. Manufacturing is seen as an engine for

growth; it has strong backward and forward linkages between itself and other sectors of the domestic economy; it has strong properties of learning-by-doing, innovation, and technological progress. Agro-processing as a subsector of manufacturing fits within that conceptualization, as it has strong linkages. Its forward linkages stimulate the agriculture sector, while its output (processed agricultural products such as flour and maize meal) is input for food industries and the retail sector. In addition, it stimulates demand for the machinery, equipment, and parts used in this industry, as well as the aftermarket for repair and maintenance services. In turn, the manufacturing of machinery stimulates demand for metal products and for services in fabrication or steel-working and engineering. Concurrently, there are spill-over effects such as the development of skills and knowledge, the adaptation of capabilities, innovation and technology advances, and the strengthening of manufacturing capabilities, in line with the vision outlined in the SADC Industrialization Strategy and Roadmap.

ISI is generally a trade and economic policy initiative that advocates replacing foreign imports with domestic production. ISI is based on the premise that a country or region should attempt to reduce its foreign dependence. It consists of establishing domestic production facilities to manufacture goods that are normally imported. ISI induces profound structural changes, which encourage manufacturing and employment creation (International Relations Organisation (IRO) 2015). Import substitution industrialization as a trade policy instrument has been primarily led by the state. State-led initiatives—'picking winners'—is often criticized by proponents of inward-looking growth, who argue that resource allocation should be driven by free markets, which will let them realize their natural comparative advantage, optimize dynamic advantage, and yield the maximum attainable growth. However, the state can look from a national and long-term perspective at the benefits that can result from self-discovery; learning by doing and experimenting have an important role in facilitating structural change. Therefore, for the SADC region, which is a net importer of machinery, targeted and well structured ISI could be a policy initiative to support industrialization and achieve structural change.

2.2 Methodology

A regional value chain approach has been used in this research. For agro-processing machinery, an integrated regional supply chain would be one in which the majority of agricultural machinery, equipment, and parts used are manufactured within the region. Chain analysis allows us to understand the current nature of machinery supply and demand, as well as the enablers or blockages, in order to determine what constraints could be addressed or capabilities strengthened through policy interventions.

Demand factors examined in the paper encompass the agro-processing subsector, local consumption of maize, machinery procurement, imports of agro-processing machinery, equipment and parts, and levels of investment. Supply factors include supplier capabilities, types of machinery manufactured in the region, and government support. The paper draws on interviews and engagement with firms, industry associations, and government departments, and secondary data from government publications, newspapers, international data portals, and firm websites to provide an indication of the nature of the agro-processing machinery value chain within the region.

The research centres on machinery that accords with the following definitions. Agro-processing activities comprise two major categories: primary and secondary operations. Primary processing operations are activities such as shelling, crop drying or threshing, cleaning, grading, and packaging. These activities are mainly carried out at the farm and only slightly modify the commodity prior to storage, marketing, or further processing. Secondary processing entails increasing the nutritional or market value of the commodity, whereby its physical form or appearance is often totally changed. Secondary processing includes milling grain into maize meal or flour, grinding

groundnuts into peanut butter, pressing oil out of vegetable seeds, pressing juice out of fruit, making cheese out of milk, and manufacturing mincemeat (Mhazo et al. 2012). Machinery referred to in this paper is machinery or equipment that is used both in primary and in secondary agro-processing.

2.3 Current research on agro-processing in SADC

Research has been undertaken on multiple agro-processing value chains within several countries in the SADC region. Research topics include:

- Growth and development in the sugar-to-confectionery value chain (Das Nair et al. 2017)
- Initiatives to increase trade and regional industrialization: soya bean value chain (Imakando et al. 2017)
- Agricultural inputs in the SADC region (Ledger 2018)
- Structural transformation in agriculture and agro-processing value chains (Dube et al. 2018)
- Soybean value chain in South Africa, Zimbabwe, and Zambia (Chambati et al. 2016)
- Developing capabilities in Mozambique's food processing sector (Das Nair and Nkhonjera 2018).

The underlying aim of much of this research was to assess the potential of regional value chains by identifying chain enablers and blockers, and develop policy recommendations to support or address these. The research did not look at the nature of the machinery utilized in these value chains in any detail.

The Food and Agriculture Organization (FAO) publishes time series data and reports on the use and trade of agricultural machinery such as tractors, combine harvesters, balers, and threshing machines, but does not provide data on agro-processing machinery. This omission highlights the fact that agro-processing often occupies a virtual 'no man's land' between agriculture and manufacturing in terms of research and analysis. This paper aims to fill those gaps.

3 Demand drivers

3.1 The SADC region and the agro-processing sector

The SADC Industrialization Strategy and Roadmap 2015–2063 sets out 'three potential growth paths – agro-processing; mineral beneficiation and downstream processing and industry- and service-driven value chains. The paths are mutually supporting and inclusive, encompassing the combination of downstream value addition and backward integration of the upstream provision of inputs, intermediate items and capital goods' (SADC 2017a: 3). These paths have been selected in an effort to transform the SADC's 'deep structural fault-lines that remain entrenched and characterised by resource-dependence, low value-addition and low levels of exports of knowledge-intensive products' (SADC 2017a: 3). According to the Roadmap, if the declining share of manufacturing in GDP is not reversed, the 'ladder' required to address the deep structural problems in these economies will be removed. In SADC, the share of manufacturing in GDP dropped from 13 per cent in 2008 to 10 per cent in 2017 (SADC 2017b). The Roadmap aims to facilitate a 'vibrant agricultural sector that will stimulate domestic and regional production of essential inputs, and improved investment in productive agro-industry value chains' (SADC 2017a: 11).

To capture the full possible value, this paper recommends that the Roadmap also focus on the nature of the supply of machinery used for agro-processing.

Table 1 lists the contribution of various subsectors to total manufacturing, in descending order of contribution. Agro-processing subsectors are clearly important components of manufacturing in many countries, particularly South Africa, Zambia, Zimbabwe, and Namibia.

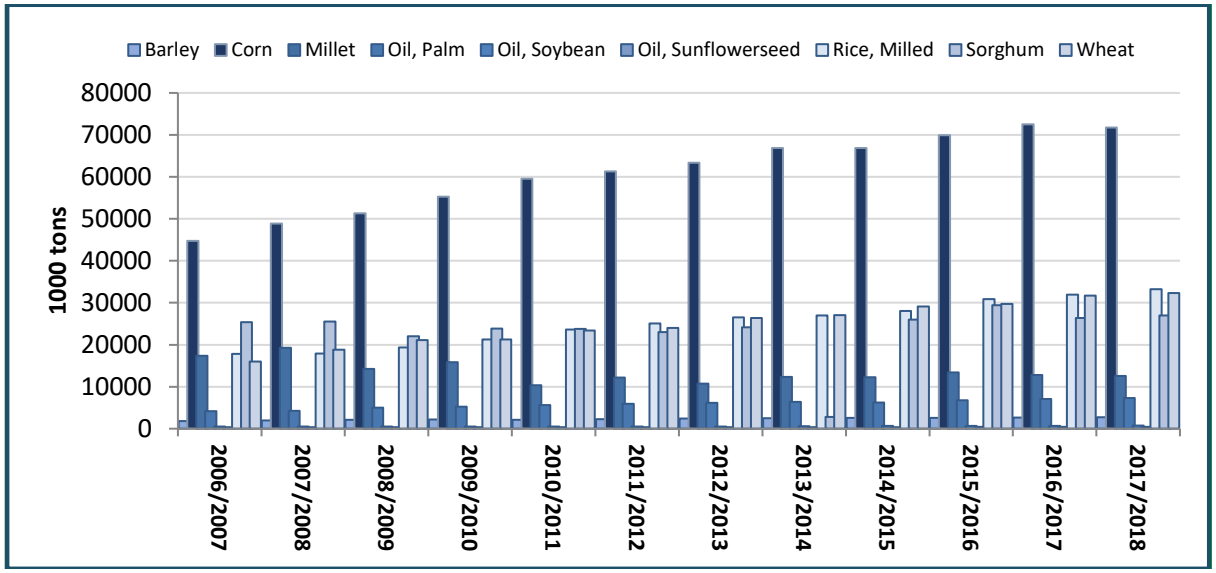
Table 1: Largest contributing subsectors to total manufacturing in SADC countries

Country	2006/07	2010/11	2016/17
Botswana	Other manufacturing; meat and meat products; beverages	Other manufacturing; meat and meat products; beverages	Other manufacturing; meat and meat products; beverages
Lesotho	Textiles, clothing, footwear and leather; other manufacturing; food products and beverages	Textiles, clothing, footwear and leather; other manufacturing; food products and beverages	Textiles, clothing, footwear and leather; other manufacturing; food products and beverages
Namibia	Other manufacturing; meat processing; grain-milling products, other food products; beverages; basic non-ferrous metals	Other manufacturing; meat processing grain-milling products; other food products, beverages; basic non-ferrous metals	Other manufacturing; meat processing; grain-milling products; other food products; beverages; basic non-ferrous metals
South Africa	Food, beverages and tobacco; metals; chemicals, plastic, rubber	Food, beverages and tobacco; metals; chemicals, plastic, rubber	Food, beverages and tobacco; metals; chemicals, plastic, rubber/ transport equipment
Tanzania	Manufacture of rubber and plastics products; manufacture of wood and wood products; manufacture of textiles	Manufacture of furniture; manufacture of basic pharmaceuticals, medicinal, chemical and botanical products; manufacture of rubber and plastics products	Manufacture of furniture; manufacture of rubber and plastics products; manufacture of beverages
Zambia	Non-metallic mineral products; food products and beverages; wood and wood products	Food products and beverages; non-metallic mineral products; wood and wood products	Food products and beverages; wood and wood products; paper and paper products
Zimbabwe	-	Food-stuffs (including stock feeds), drink and tobacco; textiles including ginning; non-metallic mineral products	Foodstuffs (including stock feeds), drink and tobacco; non-metallic mineral products; wood and wood products

Source: Author's compilation from SADC member states' Open Data for Africa portals and Trade & Industrial Policy Strategies (TIPS) (2018).

Detailed sub-subsector-level data for the agro-processing sector are not consistently reported by SADC countries. Figure 1 illustrates the dominance of maize (corn) in the consumption of grains and oils in sub-Saharan Africa. Global demand for maize continues to grow as it is a staple food item consumed by an increasing population (as well as an input into animal feed). According to the United States' Foreign Agricultural Service, consumption of maize has grown in sub-Saharan Africa from less than 45 million tons in 2006 to 72 million tons in 2018. The strength of the maize consumption markets suggests a positive outlook for related agro-processing of grains and therefore growing demand for agro-processing machinery.

Figure 1: Consumption of grains and oils in sub-Saharan Africa

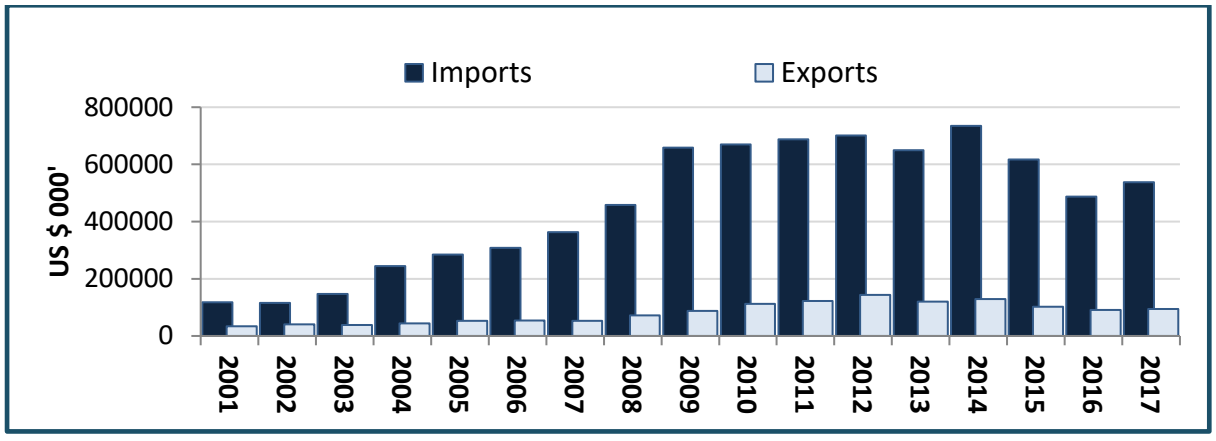


Source: Author's compilation from USDA FAS (n.d.).

The FAO provides data on the use of agricultural machinery in farming such as tractors and in agro-processing (e.g. milking machines), but does not report on any other machinery utilized in the agro-processing sector. As no reporting exists at SADC member state level for the use of agro-processing machinery, trade in such machinery has been used as a proxy for the nature of demand in the region.

The SADC region is a net importer of agro-processing machinery (see Figure 2).

Figure 2: SADC region imports and exports of agro-processing machinery



Source: Author's compilation from International Trade Centre website, Import and Exports of Machinery HS code 84: https://www.trademap.org/Index.aspx (downloaded in 2018).

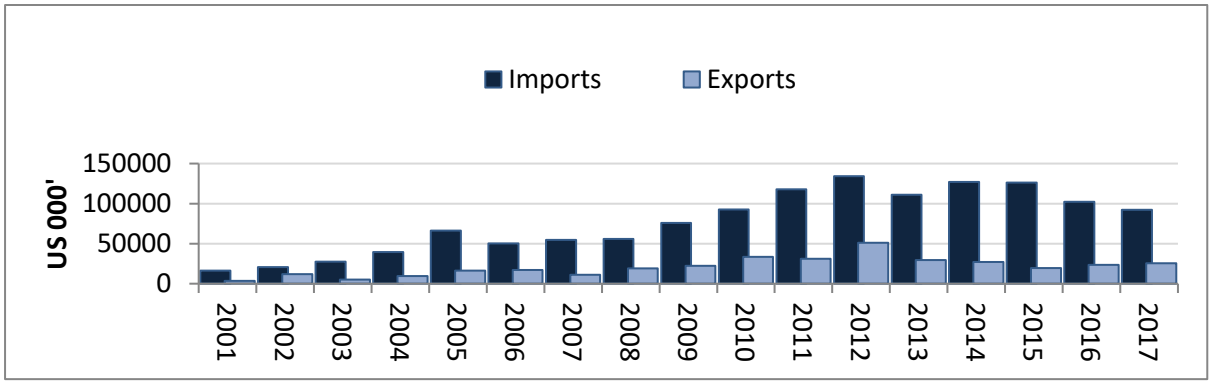
As can be seen, since 2001, there has been significant growth in the import of various types of agro-processing machinery, equipment, and parts: spending on machinery and equipment was worth US$121 million in 2001, rising to US$780 million in 2014 and US$537 million in 2017 (Trade Map n.d.). By total value, the following types of machinery have dominated imports in the past 10 years.

1. Industrial preparation or manufacture of food or drink
2. Extraction or preparation of animal or fixed vegetable fats or oils
3. Industrial preparation of meat or poultry

4. Parts for machinery used in the preparation or manufacture of food or drink
5. Bakery, industrial preparation, or manufacture of macaroni and spaghetti
6. Sugar manufacture
7. Brewery machinery
8. Cleaning, sorting, or grading eggs, fruit, or other agricultural produce
9. Parts for milling machinery
10. Industrial preparation of fruits, nuts, or vegetables
11. Presses, crushers, and similar machinery used in the manufacture of wine, cider, and fruit
12. Industrial preparation or manufacture of confectionery, cocoa, or chocolate
13. Mixing, kneading, crushing, grinding, screening, sifting, homogenizing, emulsifying, or stirring
14. Milling industry or for the working of cereals or dried leguminous vegetables
15. Milling machinery for cleaning, sorting, or grading
16. Milking machinery and bakery ovens.

The region is a net importer of machinery for the processing of grains (see Figure 3). Growth in the imports of such machinery is due to increasing demand for grain products as a staple food, and for livestock feed for the poultry and beef industries. In addition, government and private investments and initiatives have contributed to a growth in new processing firms, and this has supported machinery imports. The top importers of grain-milling machinery and parts are South Africa, Zambia, Malawi, Angola, Namibia, Mozambique, and Tanzania.

Figure 3: Imports and exports of machinery and parts for grain and legume processing



Source: Author's compilation from International Trade Centre website, Import and Exports of Machinery HS 84: https://www.trademap.org/Index.aspx (downloaded in 2018).

4 Case studies

4.1 Zambia

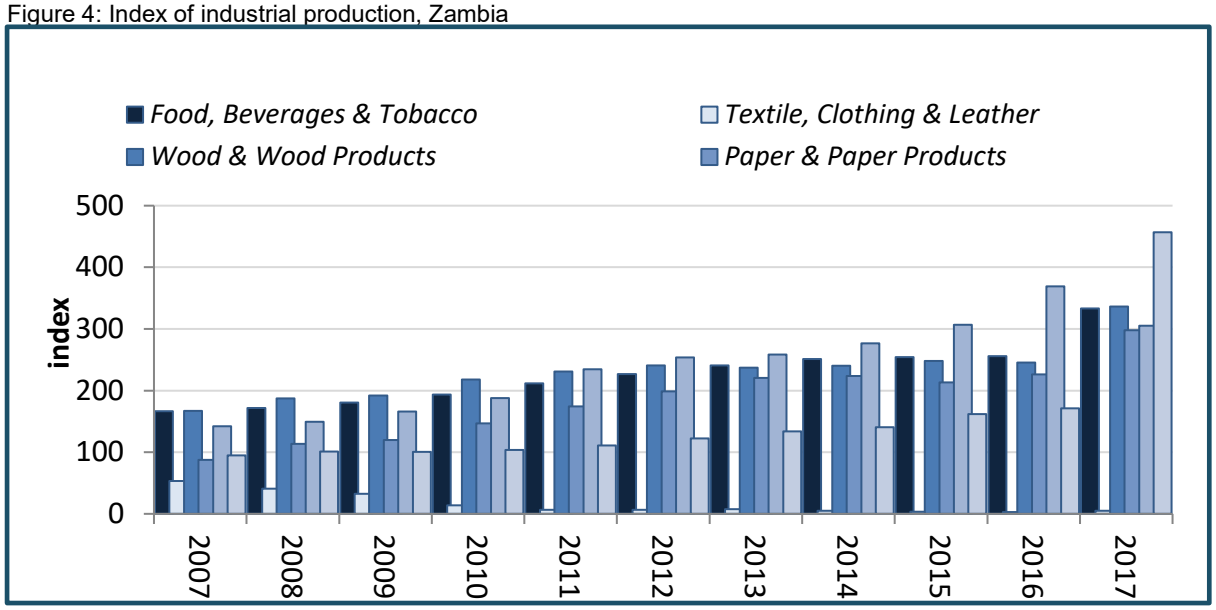
Background

The National Industrial Policy of Zambia (Republic of Zambia 2018) has as its objectives to 'foster new industrial capacity, promote the diversification of production, facilitate the creation of inter-sectoral and inter-industry linkages, promote the establishment of cooperatives across value chains, promote the development of industry-specific skills and facilitate the shifting of economic activity towards higher value-added activities to spur sustainable economic growth'. It sets out eight priority focus areas within the manufacturing sector: agro-processing; textiles and garments; engineering products; wood and wood products; leather and leather products; mineral (metallic and non-metallic) processing and products (beneficiation); pharmaceuticals; and the blue economy

(which refers to the transformation of marine and coastal sectors as well as freshwater inland rivers and lakes through the development of fisheries and aquaculture, transport and logistics, and tourism) (Republic of Zambia 2018).

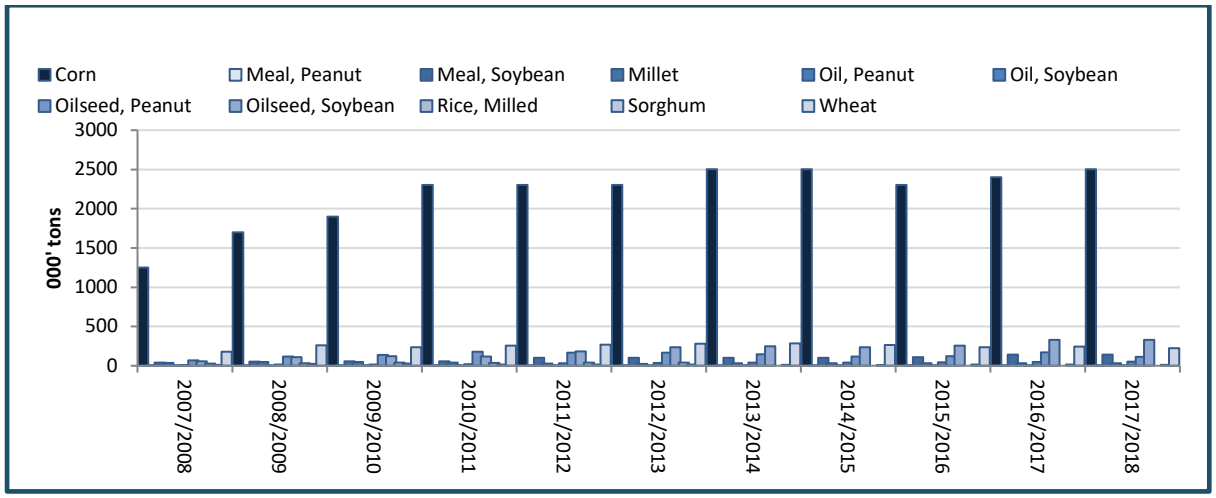
The contribution of agro-processing (food, beverages, and tobacco) to total industrial production is significant (see Figure 4). The agro-processing subsector contributes about 11 per cent of Zambia's GDP. Growth is mainly attributable to growing investments in Zambia by the government and private sector. The substantial size of the subsector is positive for the agricultural sector, as it uses the sector's output as inputs.

Figure 4: Index of industrial production, Zambia



Source: Author's compilation from Central Statistical Office of Zambia: http://zambia.opendataforafrica.org/oqqlgnf/index-of-industrial-production-january-2017 (downloaded in 2018).

Figure 5: Domestic consumption of grains and oils, Zambia



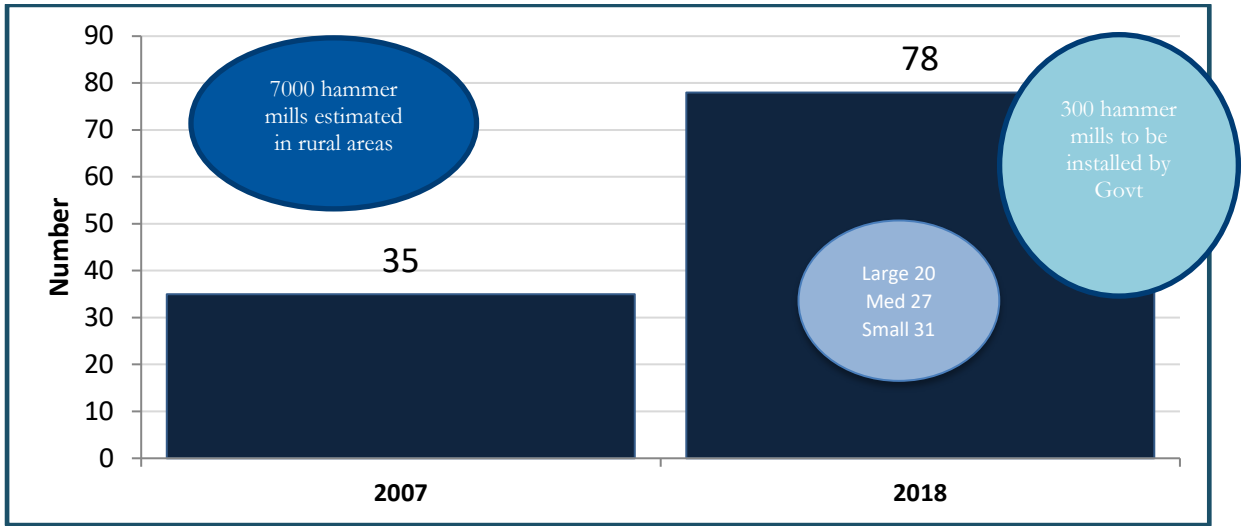
Source: Author's compilation from USDA FAS website; Domestic Consumption of Agricultural Products: https://apps.fas.usda.gov/psdonline/app/index.html#/app/advQuery (downloaded in 2018).

An assessment of grains and oils consumed by the domestic market in Zambia (Figure 5) illustrates consumer preference for maize: the consumption of maize far outweighs that of any other grain by significant margins. Maize is used to make maize meal as well as to produce non-alcoholic beverages (*maheu* or *munkoyo*) and beer.

Grain milling in Zambia

Figure 6 illustrates that the number of firms processing grain (maize, wheat, sorghum, millet) that are members of the Millers Association of Zambia has more than doubled since 2007 to 78 (Millers Association of Zambia 2018). Of these, 20 are large-scale, 27 medium-scale, and 31 small-scale millers located in Lusaka, and the Copperbelt, Northern, and Central provinces. In 2007, it was estimated that about 7,000 smaller hammer mills were operating in mostly remote, rural areas. Most of these are not members or affiliates of an association and mill only for the local community. This number is expected to have grown since that date. The Presidential Empowerment Initiative Fund (PEIF) programme aims to set up at least 300 solar hammer mills across the nation in its effort to boost agro-processing in under-developed areas (Chibuye 2017). The rise in the number of milling firms and agro-processing infrastructure rolled out by government indicates growing demand for related machinery. From a linkage perspective, the growth of milling firms and government initiatives is also an opportunity for transforming manufacturing capabilities in agro-processing machinery, parts, and/or repairs.

Figure 6: Maize-milling firms in Zambia



Source: Author's compilation from Tambulukani (n.d.) and Zambia Milling Association (2019).

From a demand perspective, agro-processing firms have noted growth over the last decade in sales of processed products, which has led to the purchasing of bigger and more advanced milling plants or expansion to meet demand. One firm interviewed for this study indicated that, since 2014, it had installed five extra processing machines due to demand, while another noted that it had expanded operations to other provinces of the country (study interviews).

Milling firms in Zambia use a combination of mechanical and semi-automated machinery, but large firms are generally automated. Those that make use of more advanced machinery usually import their requirements. Imports originate from Turkey, Russia, Germany, Switzerland, the United Kingdom (UK), Italy, the United States (US), and South Africa. There are two major local manufacturers of machinery (SARO Agro Industrial and CAMCO Equipment Zambia), which also supply imported machinery and carry out repairs and maintenance. The choice of supplier is driven by affordability, durability, quality, and speed. The maintenance of machines is done locally by trained personnel who are usually in association with the foreign machinery suppliers. Spare parts generally cannot be interchanged between brands, but can be purchased from foreign-affiliated authorized depots or suppliers of the machinery. It is estimated that 10 per cent of spare parts are sourced either locally or within the SADC region, while the remainder must be imported.

In terms of government support, although the government has shares in certain agro-processing firms, it provides no direct support for the acquisition of machinery. However, companies do benefit from a zero tariff rate on machinery imports.

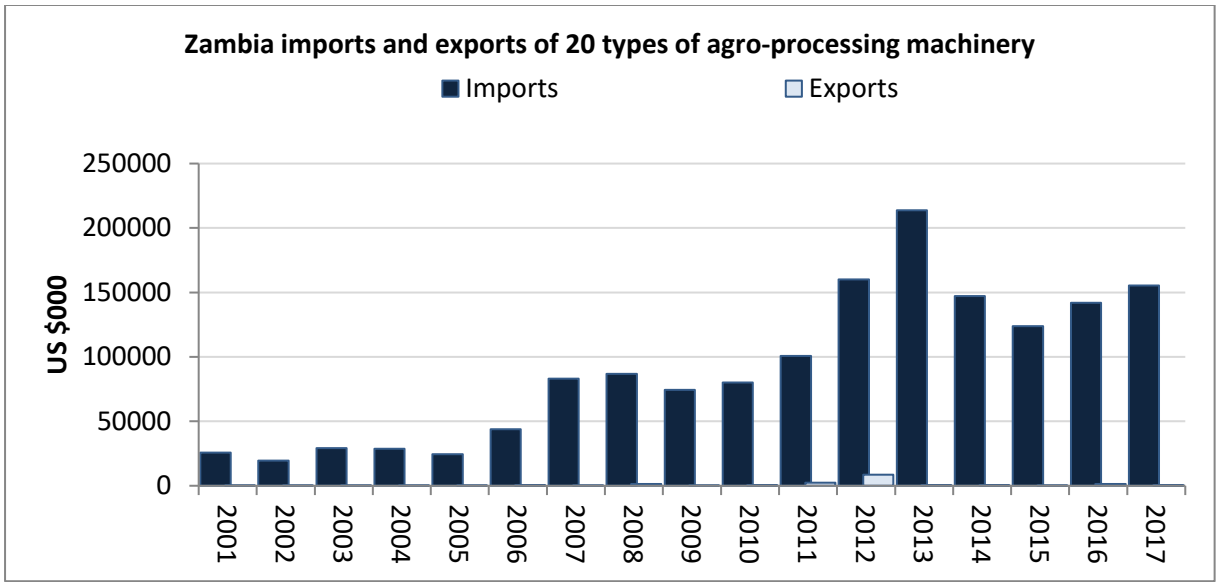
A major constraint faced by milling firms is the unavailability of locally produced advanced milling machinery and parts, which forces firms to import. There is generally a long waiting period between ordering and receiving machinery. Waiting periods for machinery imported from Europe can be as long as five months—a delay that disrupts production. In addition, a fluctuating currency increases the unpredictability of investment decisions.

Imports and exports of agro-processing machinery

Zambia is a net importer of agro-processing machinery (Figure 7). The top five types of agro-processing machinery imported by Zambia in value terms are:

1. Machinery for milling grain and cereals
2. Brewery machinery
3. Machinery for the industrial preparation or manufacture of food or drink (not elsewhere specified)
4. Bakery and industrial machinery for macaroni and spaghetti
5. Parts for machinery used to mill grain, cereals, and dry vegetables.

Figure 7: Imports and exports of agro-processing machinery, Zambia



Source: Author's compilation from 20 HS codes from the International Trade Centre website; Import and Exports of Machinery HS 84: https://www.trademap.org/Index.aspx (downloaded in 2018).

Imports of machinery, equipment, and parts have grown exponentially since 2001, with peaks in 2013 (US$213 million) and 2017 (US$155 million). Imports of agro-processing machinery represent a leakage that has a negative effect on the balance of payments, exacerbated by fluctuating currencies.

Exports of machinery are negligible and expected to remain so in the near future. However, the value of growth in imports has potential implications for supporting import substitution industrialization on the supply side.

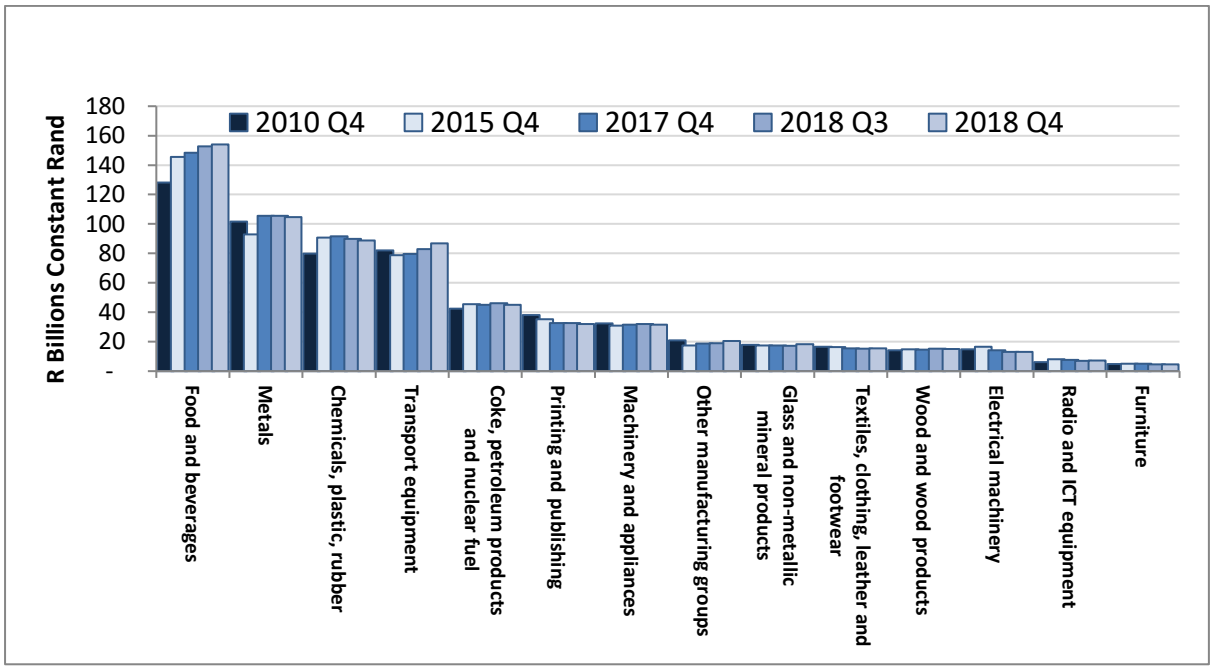
4.2 South Africa

Background

South Africa's Industrial Policy Action Plan (IPAP) emphasizes industrialization through manufacturing-led growth. The South African government has identified agro-processing as a critical driver of inclusive growth, with significant job creation potential. Since 2009, the sector has benefited from total government and private-sector investments of around R7 billion, both by multinationals and by local companies. In addition, in 2017, the Department of Trade and Industry (DTI) launched a R1 billion Agro-Processing Support Scheme (DTI 2017, 2018). South Africa has over 21 government-related agencies funding agro-processing initiatives, including principally the Industrial Development Corporation (IDC) Agri-Business Unit, DTI Incentives Unit, and the Incentive Development Administration Department (IDAD), which encompass the Black Industrialist Programme, Critical Infrastructure Incentive, and Agro-processing Support Scheme. The IDC has invested over R4.6 billion over the last decade (IDC annual reports 2012, 2015, 2016, 2018). Investments have gone into maize, wheat, sugar, livestock, fishing and aquaculture, beverages, forestry and horticulture, fruit, vegetables, nuts, and tea and coffee. In turn, the DTI's IDAD spent R1.7 billion on the agro-processing sector in the 2017/2018 financial year (IDAD 2018).

Agro-processing is the largest subsector of manufacturing, and has shown fairly rapid growth in both sales and employment. This subsector has continued to grow each year, remaining resilient when other subsectors were affected by the global financial crisis of 2008 (Figure 8).

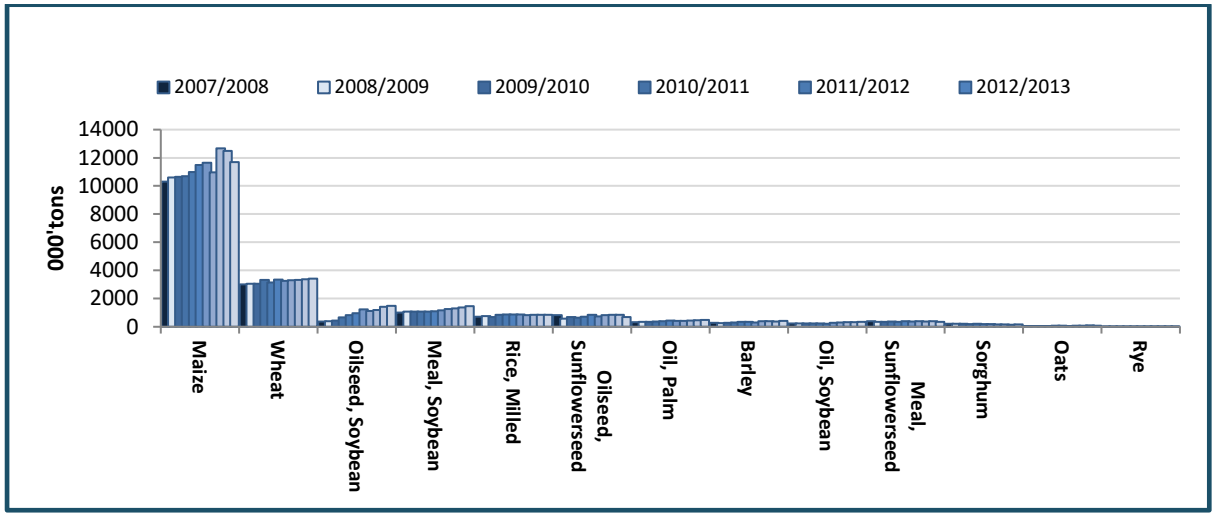
Figure 8: Contribution of manufacturing subsectors in South Africa (R billion)



Source: Author's compilation from The Real Economy Bulletin Data Excel Sheet (TIPS 2018), available at: www.tips.org.za/manufacturing-data/the-real-economy-bulletin/quarterly-bulletin (accessed 5 December 2018).

An assessment of the domestic human consumption of grains and oils in South Africa shows that, as in Zambia and other parts of the region, maize is the most consumed grain. South Africa consumes an average of 12.4 million tons of maize a year (Figure 9). Maize is a staple food, and demand has been supported by the extension of social grants, which has enabled low-income households to increase their consumption of food (TIPS 2017).

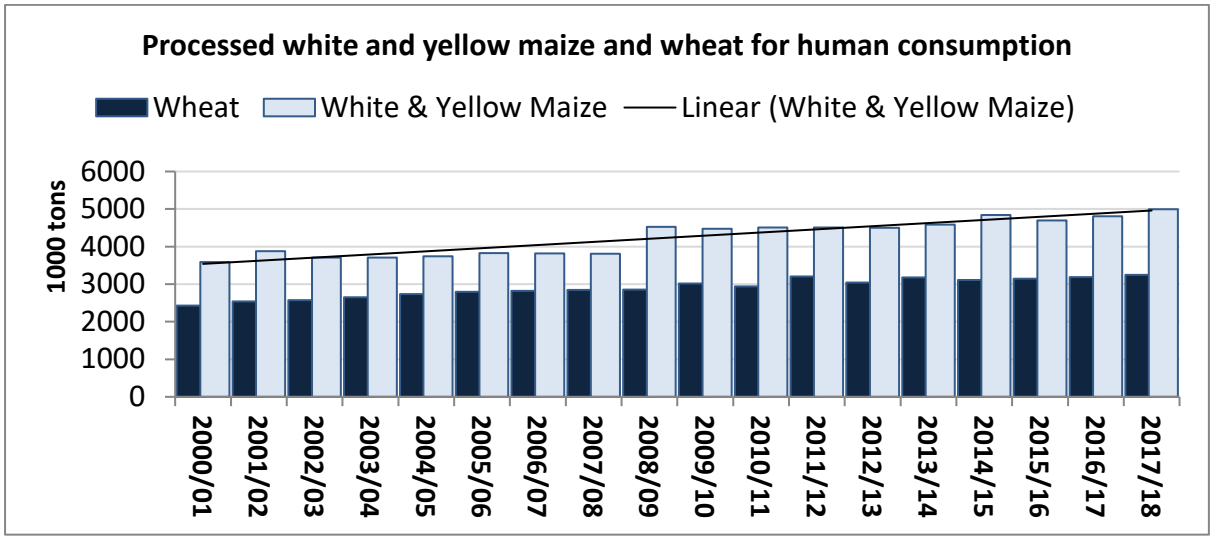
Figure 9: South Africa's consumption of domestic grains and oils



Source: USDA FAS website; Domestic Consumption of Agricultural Products: https://apps.fas.usda.gov/psdonline/app/index.html#/app/advQuery (downloaded in 2018).

Maize in South Africa is processed into maize rice, grits, samp, sifted/special/super maize meal, and other meals and flours. Figure 10 provides the total of processed maize products. Production of processed products has grown from 3.5 million tonnes in 2000/2001 to nearly 5 million tonnes in 2017/2018. Growth in volumes of grains milled—in this case maize—is important as an enabler of demand for machinery through installation of new systems, expansion of existing capacity, repair, maintenance, and replacement of parts.

Figure 10: Processed white and yellow maize and wheat in South Africa



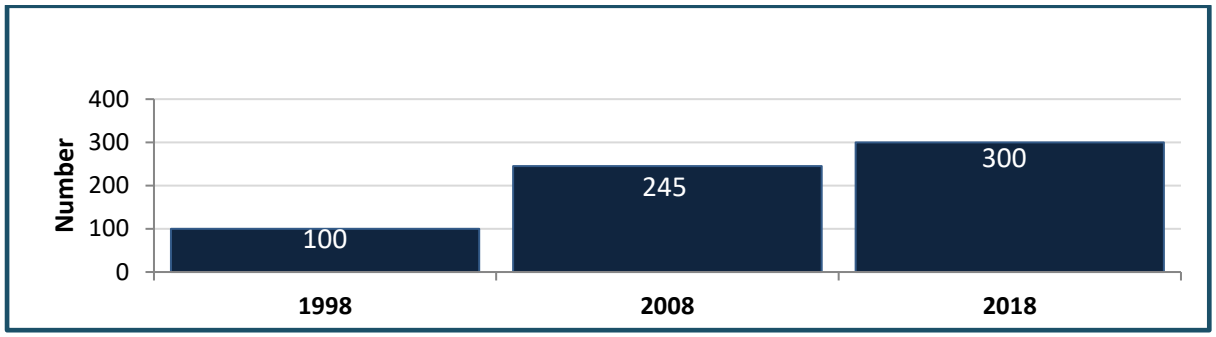
Source: South African Grain Information Services (SAGIS).

Nature of grain milling in South Africa

The maize-milling industry in South Africa is dominated by 25 firms, the 4 largest of which—Pioneer Foods, Premier Foods, Pride Milling, and Tiger Brands—together mill about 75 per cent of the total maize meal production (Who Owns Whom (WOW) 2017). However, since deregulation of the milling industry 25 years ago, there has been a growth in small, independent mills. These mills range in capacity from as little as 40 tonnes/24 hrs to 240 tonnes/24 hrs (National Chamber of Milling 2019). The Department of Agriculture, Forestry and Fisheries

(DAFF) estimates that, since 1998, the number of firms involved in the milling of grain has tripled from 100 to around 300 (Figure 11). The growth in milling firms has been attributed to growing demand for grain products locally and for export markets. The South African government has invested in a number of green and brown field projects in the milling industry. This growth in the number of firms is capable of stimulating growth in the manufacture of machinery or parts and aftermarket services in repairs and maintenance.

Figure 11: Growth of milling firms in South Africa



Source: Author's compilation from WOW (2017); TIPS (2017); DAFF (2017).

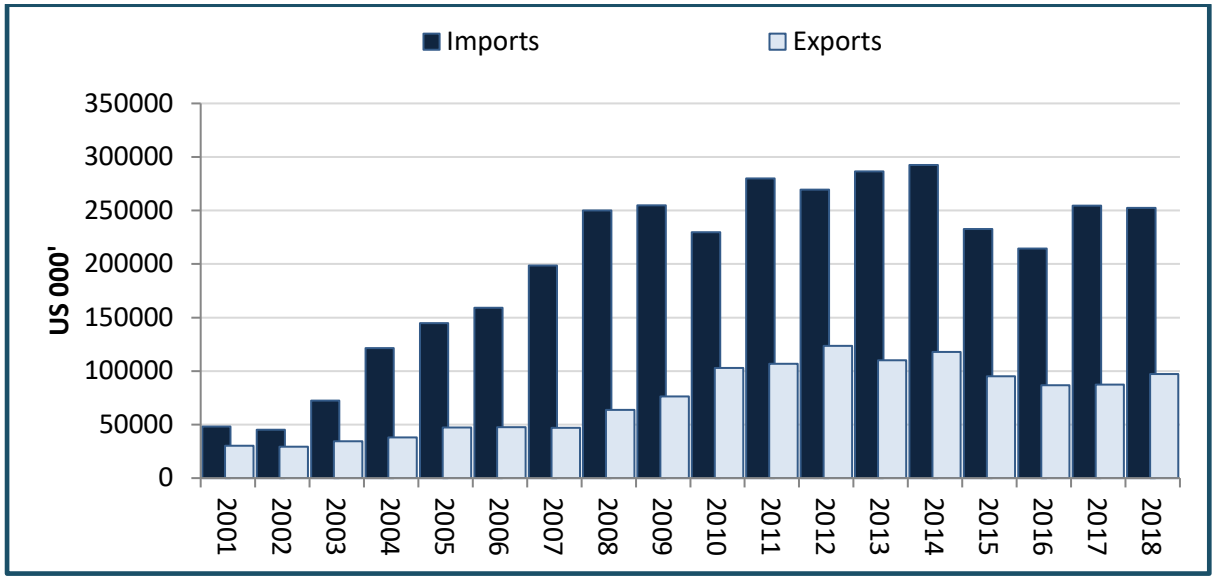
There is very little knowledge on the nature of the equipment used in South Africa for grain milling. Firms are often reluctant to make these details public, for fear of losing a competitive advantage. However, based on primary information gathered from willing firms and South Africa's Grain Milling Association, some conclusions can be drawn.

South African firms are generally larger and better equipped than other firms in the region, and most of the larger firms are automated. However, many small and emerging firms—mainly in rural or peri-urban areas—also use machinery. Machinery and equipment are sourced from both local and international manufacturers. Internationally, firms procure mainly from manufacturers in Europe (Denmark, France, Germany, Italy, Switzerland, Turkey, and the UK), Australia, China, Japan, and the US. The main factors determining machinery purchases for firms are price, quality, service delivery, support, and new technologies that increase efficiency. Spare parts are sourced both locally and internationally. Services to maintain equipment and machinery are available locally from manufacturers and/or internationally affiliated suppliers. Overseas suppliers of milling machines normally offer a service for more advanced maintenance work.

Although maintenance is conducted locally, there is a general shortage of the requisite skills, especially electricians, fitters, and turners. For imported machinery, a major constraint is whether or not the supplier is able to offer the necessary back-up during breakdowns and provide timely spares and maintenance. Therefore, after-sales service is a key factor in supplier selection. The lag time in the arrival of imports creates inefficiencies and, in addition, the cost of freight and insurance adds to overall running costs. Smaller firms in rural areas find it difficult to obtain parts since they are far from urban centres, where most manufacturers and suppliers are located. Although a number of government incentives to support capital investment are available, most firms (of all sizes) indicate that the process of receiving these is cumbersome and difficult, and firms are often unaware of the incentives.

Imports of machinery into South Africa attract a zero tariff rate. South Africa is a net importer of agro-processing machinery (Figure 12). Growth in imports correlates well with growth in the agro-processing sectors and investments from government and the private sector. In value terms, imports have risen from US$48 million in 2001 to US$252 million in 2018, slightly down from the peak reached in 2014. Imports are expected to grow over the next five years.

Figure 12: Imports of agro-processing machinery, South Africa



Source: Author's compilation from 20 HS codes from the International Trade Centre website; Import and Exports of Machinery HS 84: https://www.trademap.org/Index.aspx (downloaded in 2018).

Major imports include machinery and parts for:

- cleaning, sorting, or grading eggs, fruit, and other produce
- industrial preparation or manufacture of food or drink
- industrial preparation of meat or poultry
- bakery and spaghetti and pasta making
- mixing, kneading, crushing, grinding, screening, sifting, and homogenising
- extraction/preparation of animal or fixed vegetable fats or oils
- brewing
- milling of cereals, grain, and legumes
- cleaning, sorting or grading of seed and grain.

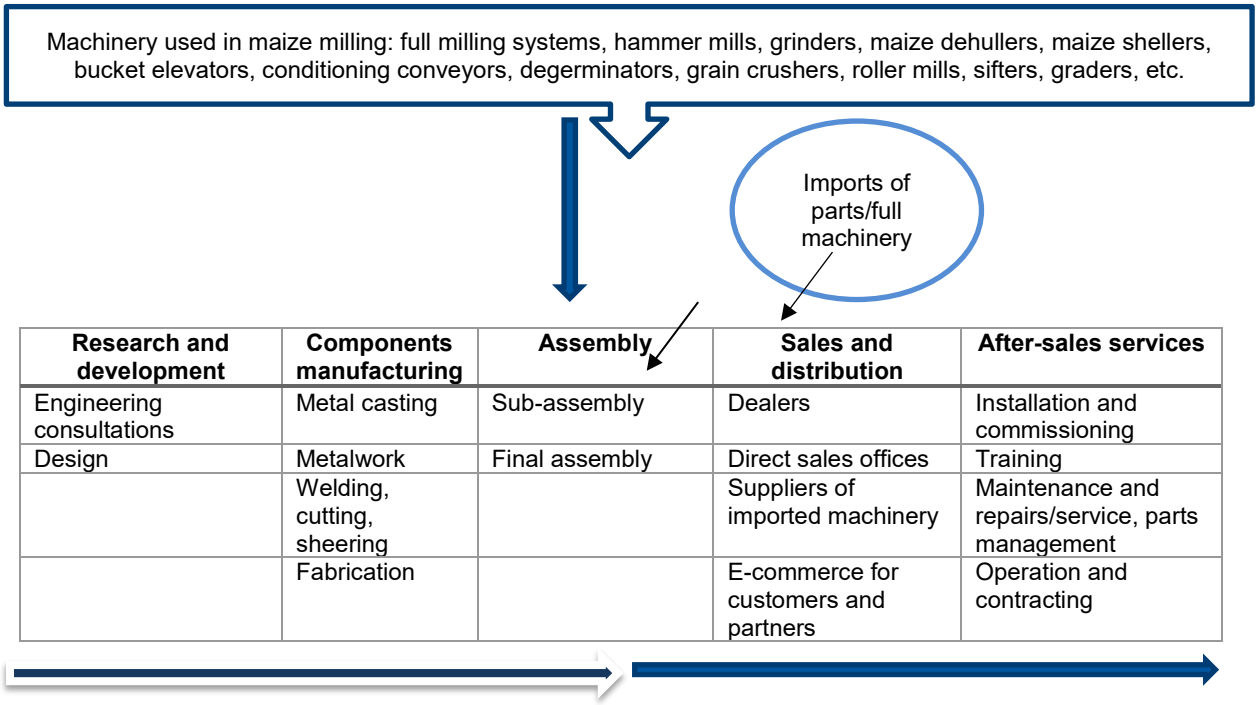
From 2001 to 2007 South Africa exported machinery to an average annual value of US$40 million. Since then, exports have steadily risen to US$100 million. South Africa's top exports in machinery include: milking machines; dairy machinery; bakery ovens; machinery for the industrial preparation or manufacture of confectionery, cocoa, or chocolate; machinery for sugar manufacture; and machinery and apparatus for filtering or purifying beverages (excluding water). South Africa's machinery imports in 2018 amounted to R3.5 billion. It is possible that leakages of this nature could build capabilities in the manufacture of machinery.

5 Supply-side trends

5.1 The machinery value chain

A typical machinery value chain is shown in Figure 13.

Figure 12: A machinery value chain



Research and development	Components manufacturing	Assembly	Sales and distribution	After-sales services
Engineering consultations	Metal casting	Sub-assembly	Dealers	Installation and commissioning
Design	Metalwork	Final assembly	Direct sales offices	Training
	Welding, cutting, sheering		Suppliers of imported machinery	Maintenance and repairs/service, parts management
	Fabrication		E-commerce for customers and partners	Operation and contracting

Source: Author's compilation.

The first link in the chain is the design or research and development (R&D) phase, which usually applies to more sophisticated machinery or a customer-specific request and is essential so that parts installed at a facility fit and function efficiently. New entrants may not be aware of the best or optimal design or technology, and so manufacturing firms often provide pre-consultation engineering services or pre-purchase consultation services.

Second is components manufacturing, in which firms use different techniques in metal fabrication, welding, cutting, or sheering to form the parts of the machine.

Third, components are assembled into complete machines. At this point in the value chain some firms import parts, which they assemble.

Fourth, machinery is sold by dealers or directly by the manufacturing firms. Some agro-dealers or agro-sales agents sell full sets of machinery or parts that are completely imported without any local input into their manufacturing process.

Last are after-sales services offered by manufacturers or suppliers of machinery. Services range from maintenance and repairs, routine checks, installation, and training to the operation of machines.

5.2 The milling machinery value chain in Zambia

Very little data are available on the manufacturing of agro-processing machinery in Zambia, including grain-milling machinery. The conclusions drawn are based on input from manufacturing firms, government departments, and the public profiles of firms. At the design level, smaller milling machines such as hammer mills require no complex techniques. However, larger and more complex milling systems that require installation are designed by established firms such as CAMCO, which has been operating since 1998. Since CAMCO is a Chinese firm, it receives assistance in R&D from entities such as such the China National Machine Heavy Industry Group.

CAMCO also manufactures small-scale mills, as do established firms such as the SARO Group, which specializes in hammer mills. Other firms import parts from India and China, which they assemble for the market. Toyo Agro & Motorcycles Assembly parts are directly imported from Chinese companies that hold international certificates of quality and standards. The more established firms manufacture not only machinery used in farming and agro-processing but also machinery for the mining, construction, forestry, and utilities (electricity and water) sectors. Other large firms—like AFGRI—supply various agricultural processing equipment such as hammer mills and oil expellers.

Table 2 summarizes the types of machinery used for grain milling and the principal manufacturers and distributors.

Table 2: Grain-milling machinery suppliers in Zambia

Firm, year of establishment, and nationality	Type of machinery manufactured	Area of distribution
SARO Group (1968) Zambian	Small-scale hammer mills, feed mixers, hand grinders, oil mills, rice mills, dehullers (with or without blower fans, electric motors, diesel engines)	Zambia (and Angola for hammer mills)
CAMCO (1998) Chinese	Maize dehullers, combined rice mills, roasting cylinders, oil filters, oil expellers, stone separators, rice mills, hammer mills, cornflour processing machines, peanut butter machines, sugar cane squeezers, maize shellers	Zambia, Malawi, Kenya, Cameron
AFGRI Corporation (1923) South African	Hammer mills	Zambia, South Africa, Botswana, Congo, Uganda, Zimbabwe, Tanzania, Mozambique
Grow More Technologies (2009) Zambian	Dehullers with diesel engine or electric motor, hammer mills with diesel engine, maize-grinding mills with power generation, maize shellers	Zambia
Distributors		
Toyo Agro & Motorcycles Zambian	Power tillers and accessories, maize-milling machines, diesel engines, oil pressure machines, rice mills, peanut shellers	Zambia
Zamcapitol Enterprises Zambian	Hammer mills, windmills, walking tractors, harrows and generator sets to feed mixers, maize shellers, milk buckets, feeding buckets, milking cages	Zambia
Afe Zambian	Maize dehullers, hammer mills	Zambia

Source: Author's compilation from firm interviews and publicly available firm profiles.

Agro-processing equipment in Zambia is purchased either direct from the manufacturers or through agro-dealers, which are a more common distribution channel for hammer mills across the country. Some firms have partnerships with manufacturers in Asia and Europe and distribute or assemble machinery on their behalf, and the zero import tariff on machinery supports this business.

Large firms offer various types of aftermarket services. For example, SARO offers regular maintenance and repair services, and CAMCO provides installation, maintenance, and repair services, as well as offering technology support and training. CAMCO uses after-sales experts from both China and Zambia, and also stocks spare parts for maintenance and repairs.

Technology, research and development, innovation

Firms in Zambia have been innovative in manufacturing small solar-powered hammer mills. This not only serves to reduce electricity costs, but also enables milling businesses to be established where there is no access to utilities. CAMCO interacts with several universities, including Kunming University of Science and Technology, Yunnan Minzu University, Northeast Agricultural University, and Jilin Agricultural University, which support the firm's R&D and facilitate access to skills (CAMCO, n.d.). Large manufacturers offer more sophisticated products like maize meal plants that can produce different finenesses of cornflour, thereby providing consumers with more choice.

Government support

The Zambian government provides a tax exemption for machinery imported for manufacturing. The incentive applies to all equipment not manufactured in Zambia. However, Zambia's long-term strategy is to encourage manufacturing by the local iron and steel industry.

Constraints and blockages

From the perspective of government and development institutions, the agro-processing sector provides an opportunity for entrepreneurs to engage in small-scale manufacture and build capabilities. However, there are major constraints to the development and growth of agro-industrial enterprises, principally limited capacity to use existing technologies and inadequate access to new technology.

From the perspective of manufacturing firms, the following were reported as major constraints:

- In certain areas millers are accustomed to buying from agro-dealers and rely on them to supply machinery. However, agro-dealers who act as a medium between manufacturers/ importers and buyers for milling machinery often face liquidity constraints themselves that prevent them from purchasing equipment in bulk for resale.
- The cost of labour and inputs is high, which makes the cost of production high.
- The region is seen as a potential supplier, but there exists information asymmetry between machinery and equipment manufactures and buyers.
- The kwacha has low buying power, which makes the cost of imported materials high.

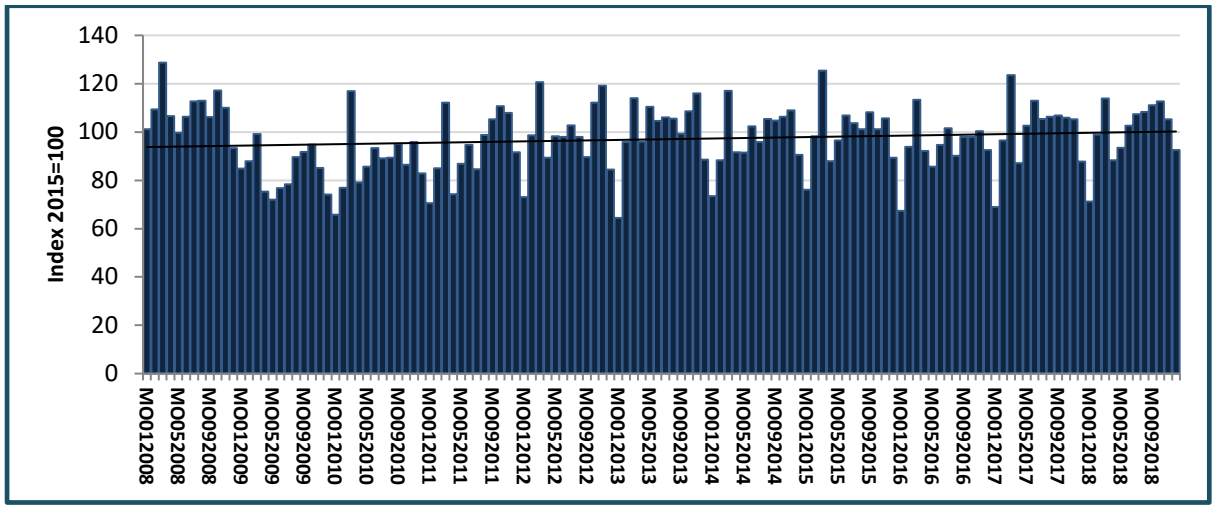
The high level of imports of machinery and parts, coupled with the ongoing growth of the maize sector, presents an opportunity for developing and improving manufacturing capabilities. However, the current framework of zero tariffs on machinery would require a government measure to support a machinery sector, without compromising the viability of the maize-milling firms.

5.3 The milling machinery value chain in South Africa

In South Africa, there is no association that specifically collects information in respect of agro-processing machinery. In contrast, the South African Agricultural Machinery Association reports on farming equipment. General utilization of manufacturing capacity for all machinery and metal products fell from 78.2 per cent in 2017 to 76.9 per cent in 2018 (WOW 2018). According to Alph Ngapothe, interim president of the Steel and Engineering Industries Federation of Southern Africa (SEIFSA) in 2018, 'productivity is generally poor, capacity utilisation is still below the required 85% and investment profit levels are low' (WOW 2018: 6). Most of this decline has been attributed to lower demand, reflecting the broader economic slowdown. However, SEIFSA has noted a

recovery in agriculture and a growing demand for agro-processed foods, which has the potential to stimulate the manufacture of associated specialized machinery. Figure 14 illustrates that the manufacturing of special-purpose machinery (which includes agro-processing machinery) has remained pretty consistent in the past 10 years.

Figure 13: Manufacturing index of special-purpose machinery



Source: : Author's compilation from Statistics South Africa (2018).

South Africa has a few large, well established agro-processing machinery manufacturing firms that have both a regional and a global footprint. One firm, Eiger Engineering, has been manufacturing maize and flour milling machinery since 1978 (Eiger Engineering n.d.).

At the design level, firms have the capability to produce high-quality 3D designs and customized milling systems. Consultancy services in design or choosing the appropriate system are also offered. Some firms are vertically integrated and undertake design, components manufacturing (metalworking), assembly, sales, and distribution, as well as offering aftermarket services such as installation, and repairs and maintenance. At the manufacturing level, firms offer a wide range of products from complete assembled machinery (such as hammer mills) to various types of equipment, more complex systems, and parts. South African firms offer machinery that processes at different capacity levels. This ensures product availability for milling firms of different sizes, including emerging businesses. Table 3 illustrates the types of machinery manufactured by South African firms.

At the distribution level, firms distribute machinery both locally and across the region. Larger, well established firms are also distributors of foreign products, particularly from Europe. For example, Roff Industries, one of South Africa's largest milling machinery manufacturers, is the exclusive distributor for key European machinery, including modular pipework systems from Jacob (Germany) and rotary air valves by Young Massa (Italy) (Roff n.d.).

Most firms offer installation and training on how to use the machinery. Large firms, such as Roff and ABC Hansen Africa, offer certified technical teams to maintain plants. These services can extend the life of plant equipment, in addition to giving firms a competitive advantage by decreasing downtime and keeping extraction rates as high as possible. Large firms also offer servicing of imported machinery.

Most firms offer 'turnkey plants', which means that they are contracted to fully design, construct, and equip a manufacturing/business/service facility and turn the project over to the purchaser when it is ready for operation.

Table 3: Manufactured products

Firm, year of establishment, and area of activity	Products manufactured	Area of distribution
Eiger Engineering (1976) Maize-milling and other machinery	Pre- and post-processing equipment, volumetric measurers with inverter drive, dampening units, flow meters and flow boxes, airlocks and sight glasses, cyclones, pneumatic slides, elevators, elevator buckets, aspirators, turbo sifters, fan impellers, conveyors, filters	South Africa
Mill Technical Services (1990) Maize and wheat	Pre- and post-processing equipment, grain cleaning and conveying equipment, pneumatic conveying systems and equipment, turnkey maize and wheat manufacturing plant and equipment, turnkey silo plant and equipment, computer-aided design draughting facilities	Angola, DRC, Lesotho, Malawi, Mozambique, Nigeria, Zambia
Maize Master Milling Equipment (1988) Maize, wheat, and any hard grain like sorghum, millet, soya beans, salt and spices	Pre- and post-processing equipment, complete electric or diesel-driven small grain mills (for maize, wheat, or sorghum), degerminators, pre-cleaners and sieves, aspirators/polishers, vitamin dosers, turbosifters, spiral mixers, augers	
Roff Industries (1991) Maize	Pre- and post-processing equipment, bucket elevators, conditioning conveyors, degerminators, dehullers, grain crushers, pre-cleaners, hammer mills, milling machines, mixers, mono sifters, screw conveyors, storage and conveyor bins, components, service packages	Namibia, Lesotho, Swaziland, Mozambique, Zimbabwe, Botswana, Zambia, Angola, Tanzania, Kenya, DRC, Eastern Europe, Syria, Belgium
ABC Hansen Africa (part of the ABC Hansen/Cormall group of companies from Denmark) (1990) Maize and wheat, oilseeds, feed mills, silos, grain storage	Pre- and post-processing equipment, weighbridges, degerminators, grain polishers, de-hullers, maize shellers, vitamin dosers, universal mills, vertical stone mills, sifter spares, conveyors, grain spreaders, grain pumps, grain polishers	
CFAM Technologies (1998) Grain milling and extrusion	Pre- and post-processing equipment, batch weighing systems, bucket elevators, bulk bag feeders, colour sorters, hammer mills, sifters, raptor bagging systems, rotary airlocks, mixing systems, counterflow coolers, counterflow dryers, extrusion plants	

Source: Author's compilation from firm websites.

Regional presence

Established firms such as Mill Technical Services (MTS) operate at different stages in the value chain. For maize milling, MTS offers design, manufacture, supply, installation, and commissioning in a number of countries (see Table 4).

Table 4: Mill Technical Services' regional footprint

Lusaka	100 tonnes / 24 hours Maize Mill (1993) Scope: Design | Manufacture | Supply | Installation | Commissioning 60 tonnes / 24 hours Roller Meal / Breakfast Meal Plant (1995) Scope: Design | Supply | Installation | Commissioning 48 tonnes / 24 hours Maize Mill (1994) Scope: Design | Supply | Installation | Commissioning 72 tonnes / 24 hours Maize Mill (1996) Scope: Turnkey Project 200 tonnes / 24 hours Maize Mill (2003) Scope: Turnkey Project 72 tonnes / 24 hours Breakfast Meal Plant Remodel (2007) Scope: Design | Manufacture | Installation | Commissioning 264 tonnes / 24 hours Maize Mill Remodel (2013) Scope: GA Drawings | Manufacture | Supply | Installation
Chisamba	48 tonnes / 24 hours Maize Mill (1994) Scope: Design | Manufacture | Supply | Installation | Commissioning

Kapiri Mposhi	100 tonnes / 24 hours Maize Mill (2001) Scope: Turnkey Project
Kitwe	100 tonnes / 24 hours to 150 tonnes / 24 hours Maize Mill Remodel (2009) Scope: Design | Manufacture | Supply | Installation | Commissioning 150 tonnes / 24 hours to 200 tonnes / 24 hours Maize Mill Remodel (2011) Scope: Design | Manufacture | Supply | Installation | Commissioning
Livingstone	108 tonnes / 24 hours Maize Mill (2015) Scope: Design | Manufacture | Supply | Installation | Commissioning
Muffler	200 tonnes / 24 hours Maize Mill (2015) Scope: Turnkey Project
Lesotho (Maseru)	200 tonnes to 250 tonnes / 24 hours Maize Mill Remodel (2004) Scope: Design | Manufacture | Supply | Installation | Commissioning
DRC (Lubumbashi)	200 tonnes / 24 hours Maize Mill (2016) Scope: Design | Manufacture | Supply | Installation | Commissioning

Source: Mill Technical Services (n.d.).

Technology, innovation, research and development

According to Hippo Hammer Mills, part of the ABC Hansen Africa group, there are generally three categories of maize meal (Hippo Mills n.d.):

i) **Super maize meal** is degerminated before milling to provide the purest starch with the longest shelf-life, and is the highest grade in terms of low fat and fibre content.
ii) **Special sifted meal** is non-degerminated meal, consisting of some fine powder and some coarser particles, and has a high fat content and short shelf-life.
iii) **Sifted meal** contains the most bran and germ meal; while it is doubtless the healthiest maize meal, it also has the shortest shelf life, is very coarse, and is not generally preferred.

South African firms have innovated in recent years and now manufacture machinery that can produce multiple types of maize meal. Recently, Roff introduced the Roff C-80 Maize Mill, which has a capacity of 5–15 tons per hour. The C-80 can produce two grades of maize meal, or it can be designed as a grit plant (which grinds and processes maize into particles of endosperm differing in granulation and largely utilized by the breakfast cereal, corn snacks, and brewing industries). The C-80 ensures an extraction rate of maize meal between 70 per cent and 74 per cent, compared with the industry average of 68–70 per cent (Roff n.d.). However, it is important to note that established firms have agreements or partnerships with international firms to import, assemble, distribute and sell certain equipment. Most such agreements are between South African and firms in Europe (Italy, Germany, Denmark, Turkey, Poland), Russia, India, and the US (Roff n.d.).

Other firms, such as ABC Hansen, have sought to improve the quality of maize meal using less expansive machinery by modifying the regular hammer mill through the introduction of a de-hulling attachment and introducing innovations in maize dampening (ABC Hansen Africa n.d.).

Thanks to their innovative approach, South African manufacturers have been able to cater to the needs of various milling firms. Maize Master has the capability to produce a container mill that can be installed anywhere without the need to construct special buildings. Its quick and easy installation (less than a week) also enables the mill to be relocated to different premises should the need arise. It also complements government and non-government food schemes and programmes because it can be operated in remote locations by a generator. The system requires minimal electricity, making it cost-efficient (Figure 15). Other firms also offer diesel-driven maize mills for areas where electricity infrastructure is not available.

Figure 15: Maize-milling innovations

Source: Adapted from Maize Master (2019) with permission.

Since firms in South Africa are well established, they conduct their own R&D and draw from technologies utilized by partners in Europe. There is also collaboration with academia; for example, CFAM has a centre at the School for Mechanical Engineering at the North-West University (NWU), Potchefstroom, South Africa. CFAM and NWU are engaged in continuous R&D in twin-screw extrusion technology, high-precision manufacturing, product development, and localization. The twin-screw extruders that were developed by CFAM are a good example of localization.

Government support

Manufacturing firms in South Africa have access to the following incentives, which they can use to enhance capabilities:

- **The Capital Projects Feasibility Programme**—a cost-sharing grant that contributes to the cost of feasibility studies likely to lead to projects that will increase local exports and stimulate the market for South African capital goods and services. The grant is capped at R8 million to a maximum of 50 per cent of the total costs of the feasibility study for projects outside Africa and 55 per cent of the total costs of the feasibility study for projects in Africa (DTI 2018).
- **The Critical Infrastructure Programme (CIP)**, which aims to encourage investment by supporting infrastructure that is deemed to be critical, thus lowering the cost of doing business. Agro-processing firms and state-owned Aerospace and Defence National Strategic Testing Facilities qualify. The CIP offers a grant of 10–50 per cent of the total infrastructural development costs, up to a maximum of R50 million (DTI 2018).
- **The Manufacturing Competitiveness Enhancement Programme**, which aims to facilitate feasibility studies that are likely to lead to bankable business/project plans, resulting in investment in new components or products or processes not currently manufactured or performed by the applicant, or in the creation of markets that will lead to a substantial increase in the manufactured products of the applicant (DTI 2018).

Constraints and blockages

Overall, as in Zambia, industry in South Africa faces the same broader constraints faced by the manufacturing sector in general. Major constraints faced by manufacturers include the limited funds available to potential clients, both locally and regionally, to purchase machines, cross-border blockages to exporting, and rising wages in the South African economy.

Import leakages in grain-milling machinery amounted to R588 million in 2015 and R266 million in 2017; local purchases to that value have the potential to support growth in machinery manufacturing and foster local capabilities in addition to aiding one of South Africa's developmental objectives of reducing its overall negative trade balance and reverse negative growth.

6 Conclusion

Agro-processing will in the foreseeable future remain one the largest contributors to the manufacturing sector in SADC, especially in South Africa and Zambia. The governments of South Africa and Zambia in their respective national industrial policies have earmarked agro-processing as a fundamental subsector that can drive economic growth and opportunities for overall economic development. Therefore, opportunities for local expansion and building of manufacturing capabilities and aftermarket services should be considered.

Drawing from demand and supply trends in the region and the case studies, it can be seen that there are opportunities for building and enhancing manufacturing capabilities in agro-processing machinery, equipment, and parts within the SADC region.

These opportunities stem from the fact that from a demand perspective, growing populations mean growth in demand for processed agricultural products such as maize and wheat, which are both staples, and other goods in the bread basket such as fats and oils. For example, it has been shown that in South Africa the production of processed maize products has grown from 3.5 million tonnes in 2000/2001 to nearly 5 million tonnes in 2017/2018 (South African Grain Information Services (SAGIS) 2018). Growth in the volume of grains milled—in this case maize—is important as an enabler of demand for machinery through the installation of new systems, the expansion of existing capacity, and the provision of services such as repairs, maintenance, and replacement of parts. It has been shown that the number of firms operating in grain milling has grown in both countries. As these firms continue to expand and upgrade or maintain their infrastructure, opportunities for the supply of parts and equipment are created. Import data support this, as shown earlier. At SADC level and within South Africa and Zambia, continued imports of machinery, equipment, and parts, mainly from Europe and Asia, demonstrate rising demand. More than US$537 million was spent on imports of agro-processing machinery by the region in 2017.

Furthermore, current and future private and public investments in the agro-processing sector and support through industrial policy instruments such as incentives translates into firms increasing capacity, new firms emerging, and old firms revamping to form viable entities. For example, South Africa has over 21 government agencies funding agro-processing initiatives, including the IDC Agri-Business Unit and the DTI's IDAD incentives, which encompass the Critical Infrastructure Incentive and the Agro-processing Support Scheme. In turn, these stimulate demand for machinery, equipment, parts, and aftermarket services, as well as expanding or building local manufacturing capabilities.

Industrialization requires both government and industry to invest in developmental objectives. It is clear that there is a willingness from both industry and government to procure locally and within the region, which is a positive demand enabler.

So where is the starting point for SADC to develop capabilities in agro-processing machinery?

From a supply-side perspective, SADC member states have different areas of specialization in industry. South Africa and Zambia have some level of specialization in agro-processing machinery. Developing a progressive regional value chain begins with a deeper understanding of the capabilities in countries where initial production exists and of the blockages, constraints, or enablers that affect the unlocking of this potential. There is therefore a need for intensive research into the inputs utilized in agro-processing and their impact on the manufacturing sector as a whole.

R&D in any industry is essential for achieving productivity, efficiency, and inclusivity. Therefore, support from government in drawing and coordinating linkages between firms and research institutions is essential. In South Africa, for example, stronger coordination between firms and engineering faculties in universities or institutions such as the Council for Scientific and Industrial Research (CSIR), which supports R&D and innovation in manufacturing technologies, would be beneficial. This could be extended to include other research institutions and firms in Zambia and across the region. An initiative called ExtruAfrica, jointly organized by the NWU, the Process Engineering R&D Center of Texas A&M University, CFAM Technologies, and the Extrusion and Advanced Manufacturing Cluster of the South African Department of Trade and Industry, promotes R&D in value streams that cover agro-processing and machinery engineering. Its efforts could be scaled up regionally (ExtruAfrica n.d.). The main aim of R&D should be to make machinery of a sufficient quality and durability, that is efficient and affordable.

One of the fundamentals for industrial economic development is skills. Pooled efforts within the region to develop, train, and keep skills are essential. South Africa has a Manufacturing, Engineering and Related Services Sector Education and Training Authority (MerSETA), a body set up to facilitate skills development, education, and training in metalworking and engineering, automobile manufacturing, motor retail and component manufacturing, tyre manufacturing, and the plastics industries. A similar body that caters for skills in the manufacture of agro-processing machinery could be set up between states with existing capability in manufacturing for their mutual benefit.

Even within current manufacturing capabilities, concerted efforts by government to address information asymmetries are fundamental. Assistance to associations and businesses in linking milling firms with local and regional manufacturers is essential. Associations, agro-dealers, and government departments in Zambia and South Africa acknowledge not having full information on stockists and manufacturers of machinery to relay to industry members. Agro-dealers, particularly in Zambia, have better relationships with firms and their reach can span both urban and rural areas. Thus, accessibility of information has the potential to draw milling firms to regional manufacturers and suppliers and, as relationships are established, a mutual benefit is created in terms of demand and supply.

Overall, since the SADC Roadmap identified agro-processing as one of its growth paths, there has been a need for concerted efforts among member states to stimulate regional manufacturing capabilities in agro-processing machinery, equipment, and parts and to leverage the full benefits of linkages between the agriculture, manufacturing, and services sectors.

References

ABC Hansen Africa (n.d.). Available at: www.abchansenafrica.co.za/ (accessed January 2019).

CAMCO (n.d.). Available at: www.camco.cn/ (accessed February 2019).

CFAM Technologies (n.d.). Available at: https://cfam.co.za / (accessed 10 December 2018).

Chambati, W., G. Chigumira, M. Mwanza, and L. Takala-Greenish (2016). 'The soybean value chain in South Africa, Zimbabwe and Zambia'. Trade & Industrial Policy Strategies. Unpublished.

Chang, H., and J. Lin (2011). 'Should industrial policy in developing countries conform to comparative advantage or defy it? A debate between Justin Lin and Ha-Joon Chang'. *Development Policy Review*, 27(5). Available at: http://siteresources.worldbank.org/INTRANETTRADE/Resources/Internal-Training/287823-1256848879189/LinChangeDPRDebateIndustrialPolicy.pdf (accessed 5 May 2014).

Chibuye, J. (2019). 'Installation of solar mills back on track'. *Daily Mail*. Available at: www.daily-mail.co.zm/installation-of-solar-mills-back-on-track/ (accessed 20 January 2019).

Das Nair, R., and M. Nkhonjera (2018). 'Developing capabilities in Mozambique's food processing sector'. Center for Competition Regulation and Economic Development Working Paper. Available at: https://www.competition.org.za/working-papers (accessed 1 December 2018).

Das Nair, R., M. Nkhonjera, and F. Ziba (2017). 'The growth and development in the sugar to confectionery value chain'. Center for Competition Regulation and Economic Development Working Paper. Available at: https://www.competition.org.za/working-papers (accessed 2 December 2017).

Department of Forestry and Fisheries (DAFF) (2017). 'A profile of the South African maize market value chain'. Available at: www.daff.gov.za (accessed 4 November 2018).

Department of Trade and Industry (DTI) (2017). 'Industrial Policy Action Plan – IPAP 2017/18–2019/20'. Available at: https://www.thedti.gov.za/parliament/2017/IPAP_13June2017.pdf (accessed 3 August 2017).

Department of Trade and Industry (DTI) (2018). 'Industrial Policy Action Plan – IPAP 2018/19–2020/21'. Available at: www.thedti.gov.za/DownloadFileAction?id=1245 (accessed 3 August 2018).

Dube, S.C., R. das Nair, M. Nkhonjera, and N. Tempia (2018). 'Structural transformation in agriculture and agro-processing value chains'. Centre for Competition Regulation and Economic Development. Available at: https://www.competition.org.za/working-papers (accessed 9 October 2018).

Eiger Engineering (n.d.). Available at: www.eiger.co.za (accessed 11 December 2018).

ExtruAfrica (n.d.) 'Value streams unpacked'. Available at: www.extruafrica.org.za/ (accessed 27 February 2019).

Grow More Technologies (n.d.). Available at: www.growmoreweb.com (accessed 20 January 2019).

Industrial Development Corporation (IDC) (2012, 2015, 2016, 2018). *IDC Annual Reports*. Available at: https://www.idc.co.za/financial-results/ (accessed 28 July 2019).

Incentives Development Administration Department (IDAD) (2018). 'DTI Annual Incentive Report'. Available at https://www.thedti.gov.za/DownloadFileAction?id=1266 (accessed 5 April 2019).

Imakando, M., T. Paremoer, and N. Mbangweta (2017). 'Initiatives to increase trade and regional industrialisation: soya bean value chain'. African Industrial Development and Integration Research Project. Department of Trade and Industry. Unpublished.

International Relations Organisation (IRO) (2015). 'Import substitution industrialization'. Available at: http://internationalrelations.org/import-substitution-industrialization/ (accessed 8 June 2017).

Ledger, T. (2018). 'Agriculture inputs in the SADC region'. Trade & Industrial Policy Strategies and Department of Trade and Industry. African Industrial Development and Integration Research Project. Available at https://www.tips.org.za/research-archive/trade-and-industry/item/3453-case-study-on-the-agricultural-inputs-regional-value-chain-in-southern-africa-south-africa-mozambique-tanzania-and-zambia (accessed 5 May 2018).

Maize Master (2019). Available at: https://www.maizemaster.co.za/2019/01/07/unpacking-maize-masters-revolutionary-containerised-mill-the-mm3500/ (accessed 10 December 2018).

Mhazo, M., M. Mvumi, M., Nazare, and E. Nyakudy (2012). 'The status of the agro-processing industry in Zimbabwe with particular reference to small and medium enterprises'. University of Zimbabwe. *African Journal of Agricultural Research*, 7(11): 1607–22. DOI 10.5897/AJAR10.079

Mill Technical Services (n.d.). Available at: www.milltechnicalservices.co.za/ (accessed 10 December 2018).

Millers Association of Zambia (2018). 'Presentation on the milling structure in Zambia'. Available at: http://ffinetwork.org/about/calendar/2016/documents/Day%202-3-5-Zambia-PRESENTATION-ON-THE%20MILLING-STRUCTURE.pdf (accessed 19 January 2019).

National Chamber of Milling (2019). Interview by email, 14 February 2019.

Open Data for Africa (n.d.). Botswana. Available at: http://botswana.opendataforafrica.org/ (accessed 25 September 2018).

Open Data for Africa (n.d.). Lesotho. Available at: http://lesotho.opendataforafrica.org/ (accessed 25 September 2018).

Open Data for Africa (n.d.). Namibia. Available at: http://namibia.opendataforafrica.org/ (accessed 25 September 2018).

Open Data for Africa (n.d.). Tanzania. Available at: http://tanzania.opendataforafrica.org/ (accessed 25 September 2018).

Open Data for Africa (n.d.). Zambia. Available at: http://zambia.opendataforafrica.org/ (accessed 25 September 2018).

Open Data for Africa (2018). Zimbabwe. Available at: http://zimbabwe.opendataforafrica.org/ (accessed 25 September 2018).

Republic of Zambia (2018). *National Industrial Policy of Zambia.* Available at: www.zda.org.zm/sites/default/files/National%20Industrial%20Policy%202018.pdf (accessed 7 January 2019).

Roff (n.d.). Available at: https://www.roff.co.za (accessed 10 December 2018).

SADC (2017a). *Action Plan for Industrialization Strategy and Roadmap*. Southern African Development Community. Available at: https://www.sadc.int/files/4514/9580/8179/Action_Plan_for_SADC_Industrialization_Strategy_and_Roadmap.pdf (accessed 10 October 2018).

SADC (2017b). *SADC Selected Economic and Social Indicators, 2017*. Southern African Development Community. Available at: https://www.sadc.int/files/7115/4021/7218/Selected_Indicators_2017.pdf (accessed 10 October 2018).

SARO Group (n.d.). Available at: https://www.sarozambia.com/ (accessed 20 January 2019).

South African Grain Information Services (SAGIS) (n.d.). Historical product information. Available at: www.sagis.org.za (accessed 12 March 2019).

Statistics South Africa (2018). Indices of Physical Volume Production. Available at: www.statssa.gov.za (accessed 10 February 2019).

Tambulukani, A. (n.d.). *Zambian Maize Value Chain*. Available at: https://www.academia.edu/6258870/Zambian_Maize_value_chain_powerpoint (accessed 20 January 2019).

Targetti, F. (2005). *Nicholas Kaldor: Key Contributions to Development Economics*. Available at: www.ferdinandotargetti.it/articoli/art/1_4.htm (accessed 3 April 2014).

Trade & Industrial Policy Strategies (TIPS) (2017). 'Strategic framework for agro-processing'. Unpublished.

Trade & Industrial Policy Strategies (TIPS) (2018). *The Real Economic Bulletin*. Available at: www.tips.org.za/manufacturing-data/the-real-economy-bulletin/quarterly-bulletin (accessed 5 December 2018).

Trade Map (n.d.). 'International Trade Centre Imports and Exports of Machinery HS 84'. Available at: www.trademap.org/ (accessed 1 August 2018 to 1 March 2019).

Tregenna, F. (2008). 'The contributions of manufacturing and employment creation and growth in South Africa'. *South African Journal of Economics*, 76(2): https://doi.org/10.1111/j.1813-6982.2008.00187

USDA FAS (n.d.). 'Domestic consumption of agricultural products'. United States Department of Agriculture - Foreign Agricultural Service. Available at: https://apps.fas.usda.gov/psdonline/app/index.html#/app/advQuery (accessed 3 January 2019).

Who Owns Whom (WOW) (2017). 'Manufacture of flour and grain mill products'. Available at: https://www.woweb.co.za/ (accessed 11 January 2018).

Who Owns Whom (WOW) (2018). 'Manufacture of general purpose machinery'. Available at: https://www.woweb.co.za/ (accessed 27 December 2018).

World Bank (2018). 'Zambia: harvesting agricultural potential'. Available at: https://www.worldbank.org/en/about/partners/brief/zambia-harvesting-agricultural-potential (accessed 18 March 2019).

Zambia Association of Chamber of Commerce and Trade (ZACCT) (2019). Interview conducted February 2019 in Lusaka, Zambia.

Zambia Milling Association (2019). Interview. Interview conducted February 2019 in Lusaka, Zambia.