



COTTON AND ITS BY-PRODUCTS

in Zambia

ANALYSIS OF COTTON BY-PRODUCTS SURVEY



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List of acronyms

CAZ	Cotton Association of Zambia
CBZ	Cotton Board of Zambia
CDT	Cotton Development Trust
CEDORA	Crushers and Edible Oils Refinery Association
CFS	Crop Forecast Survey
COMESA	Common Market for Eastern and Southern Africa
CSO	Central Statistics Office
ESA	Eastern and Southern Africa
FAO	Food and Agriculture Organization
FGDs	Focus Group Discussions
GRZ	Government Republic of Zambia
IAPRI	Indaba Agricultural Policy Research Institute
LINTCO	Lint Company
SSA	Sub-Saharan Africa
UNCTAD	United Nations Conference on Trade and Development
UNECA	United Nations for Economic Commission for Africa
UNDP	United Nations Development Programme
VAT	Value Added Tax
ZAM	Zambia Association of Manufacturers

Executive summary

The importance of the cotton sector cannot be overemphasized. It is a source of income for the over 250,000 smallholder farmers participating in cotton production and therefore, the sector has potential to reduce poverty among rural households. The sector is also a source of foreign exchange for the country and a source of employment opportunities for many people along the value chain. However, the main product of cotton - lint - has face stiff competition from artificial fibres and this affect the profitability and performance of the activities along the cotton value chain. Therefore, the development of the cotton by-product offers an opportunity to raise the profitability of cotton throughout the value chain. This study therefore analyses the development, challenges and opportunities of the cotton by-products value chain in Zambia.

The study has revealed that there are many opportunities to develop the cotton by-product value chain in Zambia. These include: a large ginning and crushing capacity, a vibrant livestock sector, especially for large ruminant animals; the government prioritizing cotton and textiles as key sectors for job creation and economic diversification. The potential for developing the cotton by-products value chain is therefore high.

However, the cotton by-product value chain has not realized its full potential and further investment and policy support is needed to tackle the various challenges identified in this report.

The local cotton by-product sector need policy instruments that are aimed at protecting the sector from cheap imported products, such as palm oil, and also exempt cottonseed from VAT. Market incentives, especially on the price of seed cotton, should be provided through a price stabilization fund that could provide a guaranteed minimum price and protect farmers from incurring losses during periods of low prices.

The Government can also promote the “Let’s consume Zambian” advocacy to try and stimulate demand for the local cotton by-products which can support job creation locally. For example, a campaign to consume locally produced cottonseed edible oil because of its good qualities in deep-frying and baking. An awareness campaign to farmers about the value of cotton stalks and that they can make an extra income, alongside seed cotton, increasing the profitability of cotton production. Furthermore, the Government could support co-ventures between farmers and processors or ginneries to strengthen linkages between them in cotton by-products value addition.

Above all, improving production and productivity of seed cotton should be the first priority according to all the key stakeholders along the cotton value chain. Therefore, farmer training in good agricultural practices is key in improving productivity and production of cotton. In particular, all stakeholders should encourage and support farmers in the use of fertilizer.

The Government should also research and develop cotton varieties with high oil content in the seeds, as the oil content of current varieties is low.

1. Introduction

1.1 Background

Cotton remains an important crop in Africa, especially for producing countries. Cotton production is undertaken by more than two million rural households in sub-Saharan Africa (SSA) as a primary source of income. The crop is mainly grown by smallholder farmers. The heavy involvement of smallholder farmers means that the effect on rural poverty is greater and felt more widely (Tschirley, 2009). Furthermore, the sector generates export revenues for governments, as well as employment and incomes for families, particularly in rural areas. Although cotton is primarily used for lint, several by-products can be derived to increase value added in the sector, to the benefit of a variety of actors, including farmers, traders and processors. Cotton by-products include: cottonseed oil used for human consumption and soap manufacturing; cake used for animal feed; and waste used for industrial applications, such as polishing cloths and wipers. In addition, cotton stalks can be used in the production of particle board, pellets and briquettes for heating, mushrooms, compost and manure, pulp, paper and corrugated boxes.

1.2 Knowledge Gap

Despite the value-added potential they represent, cotton by-products are underdeveloped in Africa, especially in Eastern and Southern Africa (ESA), owing to several impediments. These include, for example: a lack of adequate downstream infrastructure; a shortage of enabling policies and institutions to support the development of cotton by-products industries; poor market information on cotton by-products; and a lack of data to assess the economic viability of investment opportunities in cotton by-products industries. In this regard, the United Nations Conference on Trade and Development (UNCTAD) in collaboration with the United Nations Economic Commission for Africa (UNECA) and the Common Market for Eastern and Southern Africa (COMESA), have designed a project to assess the development of the cotton value chain and to identify and analyse the challenges that hinder or may hinder the growth of the cotton by-products industries in the region and in particular Zambia.

1.3 Study objectives

UNCTAD is implementing the project in four countries in ESA: Tanzania, Uganda, Zambia and Zimbabwe. It aims to increase the value added to cotton by-products, with two broader objectives:

- 1) Improve the capacity of cotton value chain stakeholders - including government officials, the private sector and farmers' associations - in Zambia to assess the market opportunities for cotton by-products; and
- 2) Improve the capacity of policymakers in Zambia to (a) formulate evidence-based policies that help to develop cotton by-products industries; and (b) devise investment profiles to attract investors to these industries.

The specific objectives of the study to inform a value chain analysis include the following:

- To identify the main impediments to the development of the cotton by-products;
- To understand the infrastructure, including technologies, available at each activity step of the value chain
- To understand producers' demographic and income profiles, margins and cost drivers from cotton and cotton by-product activities;
- To understand the perceptions, mind-sets and views of each value chain actor about the development of the cotton by-product;

- To understand the main motivation of the value chain actors' decision to invest or not in cotton by-products;
- To identify the incentives that would motivate farmers, ginners, and other actors to develop cotton by-product

1.4 Methodology

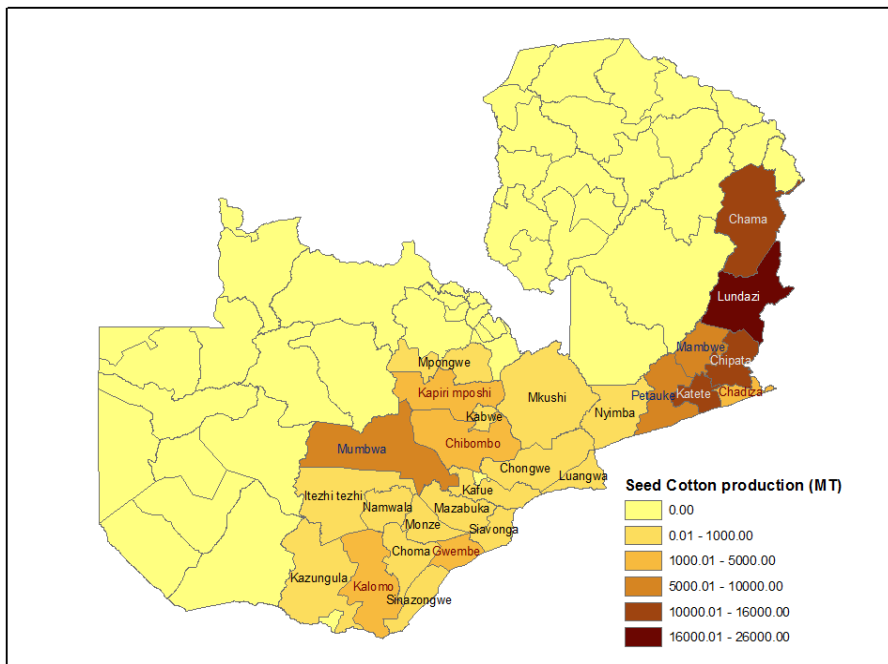
The overall goal of this study was to assess the market opportunities and challenges of the cotton by-products development along the cotton value chain in Zambia. To achieve the stated overall objective, the study adopted a multi-faceted approach in data collection. The approach helped to triangulate results from different methods and data sources in order to enhance the confidence in the research findings. The study started with the desk review of literature on the subject and project materials as well as the COMESA Regional Strategy for Cotton-to-Clothing Value Chain in order to get an in-depth understanding of the cotton by-products.

Primary data was obtained through conducting key informant interviews and focus group discussions. Thirty-two (32) key informant interviews were conducted among cotton stakeholders to get their perspectives of the development of the cotton by-products value chains in Zambia. The key informants included; government (Ministry of Agriculture, Ministry of Commerce, Trade and Industry and Ministry of Finance), quasi-government (Cotton Board of Zambia (CBZ), Cotton Development Trust (CDT), Central Statistics Office (CSO)), Zambia Cotton Ginners Association (ZCGA), Associations (Cotton Association of Zambia (CAZ), Zambia Manufacturers Association (ZAM), Crushers and Edible Oil Refiners Association (CEDORA)), UN agencies (United Nation Development Programme (UNDP) and Food and Agriculture Organization (FAO)), and regional bodies, particularly the Common Market for Eastern and Southern Africa (COMESA). Key informants were also drawn from the private companies such as ginners, spinners, edible oil expressers and stockfeed producers. The study also conducted eleven (11) focus group discussions (FGDs) with an average of 13 cotton producers in each group, were conducted in key cotton growing areas.

1.4.1 Selection of study areas and scope of the study

Six districts were purposively selected for the FGDs across seed cotton growing areas, namely: Mumbwa, Chipata, Katete, Lundazi, Sinda and Mazabuka. The selection of these districts was based on the intensity of cotton production in terms of production volumes of seed cotton (see Figure 1 below) and also perceived intention of cotton producers engagement in cotton value addition activities, e.g. in Mumbwa and Mazabuka. Eastern province being the major producer of seed cotton accounted for 66% of the cotton producers interviewed through FGDs and then Central and Southern Provinces accounted for 17% each respectively. Meanwhile, the key informants interviewed were from Lusaka, Livingstone, Ndola, Chipata, and Kabwe.

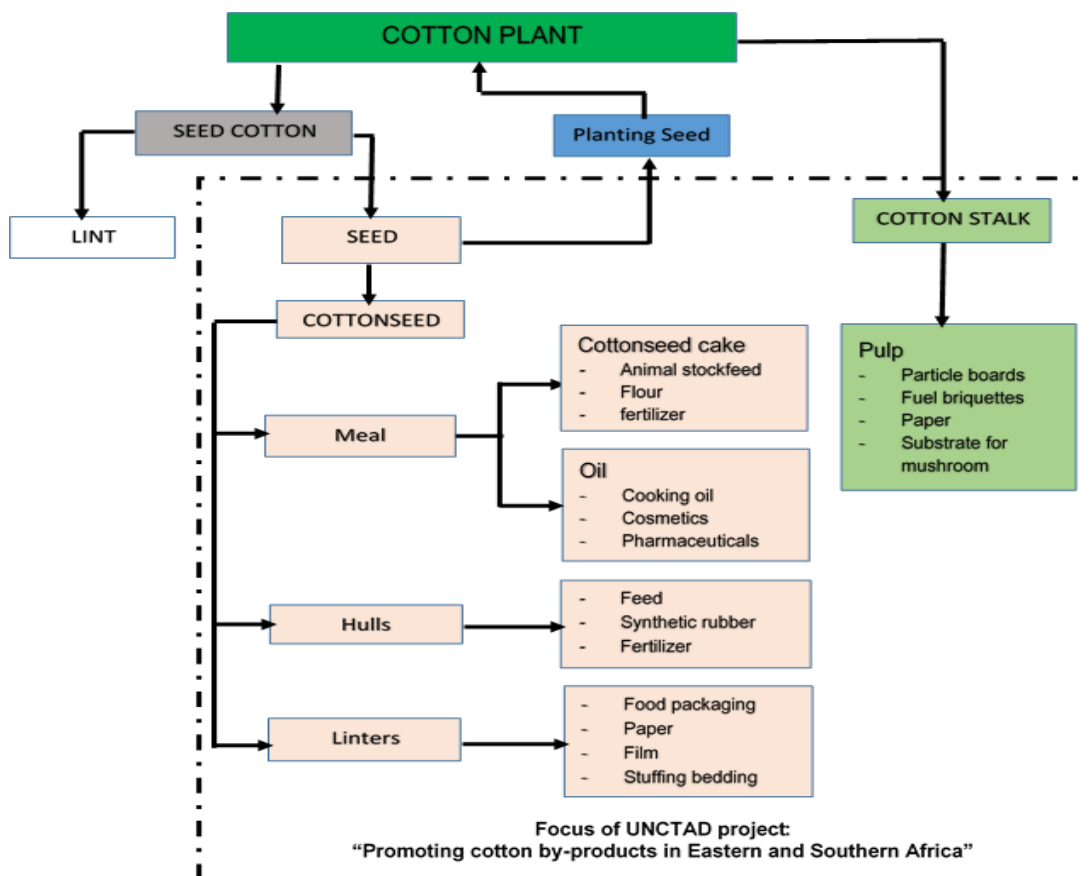
Figure 1. Cotton production by district in Key cotton growing provinces (mt) 2014/15



Source: IAPRI 2015

The scope of the study focused on the cotton by-products and not the main product (lint) of cotton. The cotton by-products of interest are depicted as shown in figure 2 below.

Figure 2. Cotton by-product value chain diagram



Source: Adapted from the Cotton Development Organization, Uganda

2. Development and performance of the Zambian cotton sector

2.1 Evolution of the Zambian Cotton Sector

Before 1994, the government parastatal Lint Company of Zambia (LINTCO) oversaw all facets of the cotton sector in Zambia, from production, ginning of seed cotton up to marketing of lint. However, because of the inefficiencies experienced in the cotton sector and as a way of restructuring the Zambian economy, the Government sold LINTCO to Lonrho Cotton/Dunavant¹ and Clark Cotton² in 1994. The goal of this was to create production efficiency in both input procurement and in the output markets. LINTCO's ginneries were divided, with Clark Cotton taking those in the Eastern Province and Lonrho assuming control of those in the southern and central provinces of Zambia so as to restrict competition between the two companies in the same region. However, that restriction did not last long as of 1998, Lonrho extended its presence into the Eastern Province.

The period between 1994 and 2005 witnessed a rise in innovations in the cotton sector as a direct result of the privatization of LINTCO. The private companies improved the provision of inputs and extension services to farmers, resulting in increased seed cotton production. During the first few years (1994 – 1996) after privatization of the sector, price of seed cotton paid to the farmers increased and was above 40 cents per kg. This was due to the relatively high price of lint at the international market. However, the price per kg of seed cotton declined by 50% in 1998 (to about 24 cents per kg) and again this followed the decline in the trends of price of lint at the international market. After 2002, the price of lint at the international market rebound and the local price of seed cotton rebound as well and in 2011, ginning companies paid the highest price ever paid, at 66 cents per kg. This high price did not last long the following year, it declined to 30 cents per kg range.

These price dynamics at the international and local markets, attracted a number of ginning companies (Continental/Olam/Parogate Ginneries, Mulungushi Ginneries, Chipata Cotton Company/China Africa Cotton, Great Lakes Ginneries, Amaka Ginneries, Mukuba Ginneries) in the sector. The number of ginning companies increased from two to 11 by the 2015/16 season, before falling to 9 in the 2016/17 season. This growth resulted in an increase of the ginning capacity from 90,000 to over 366,000 metric tonnes (MT). Similarly, production of seed cotton also grew to an average of about 100,000 MT between 1995 and 2017 from less than 50,000 MT at the time of the privatization in 1994. In recent years, Zambia has dominated in seed cotton and cottonseed production in the Southern Africa region. However, the growth in seed cotton production has not kept pace with the growth of ginning capacity. Gin utilization at the time of privatization was around 50%, but declined to approximately 30% in 2016/17, which made it difficult for operational gins to cover overhead costs and turn a profit. Furthermore, competing crops such as soybeans are also attracting farmers away from cotton producing. The 2015/16 and 2016/17 agricultural seasons are good examples where the price of soybeans was relatively higher (USD 0.45 per kg compared to USD 0.30 per kg of seed cotton) and resulted in farmers reducing the area under seed cotton production to other competing crops like soybeans.

Furthermore, in the early 2000s, Zambia sold the highest quality lint in Africa (Tschirley et al. 2007). This was due to its good natural fibre characteristics, as well as the leading buyers, Dunavant and Cargill, implementing grading systems of A, B and C on their seed cotton purchases. Grading used to happen at the farm level, as well as at the ginnery. Farmers were paid a price based on the grade of their seed cotton. The other measure that was put in place by these two companies was to remove foreign

¹ Currently trading as NWK Agri Services

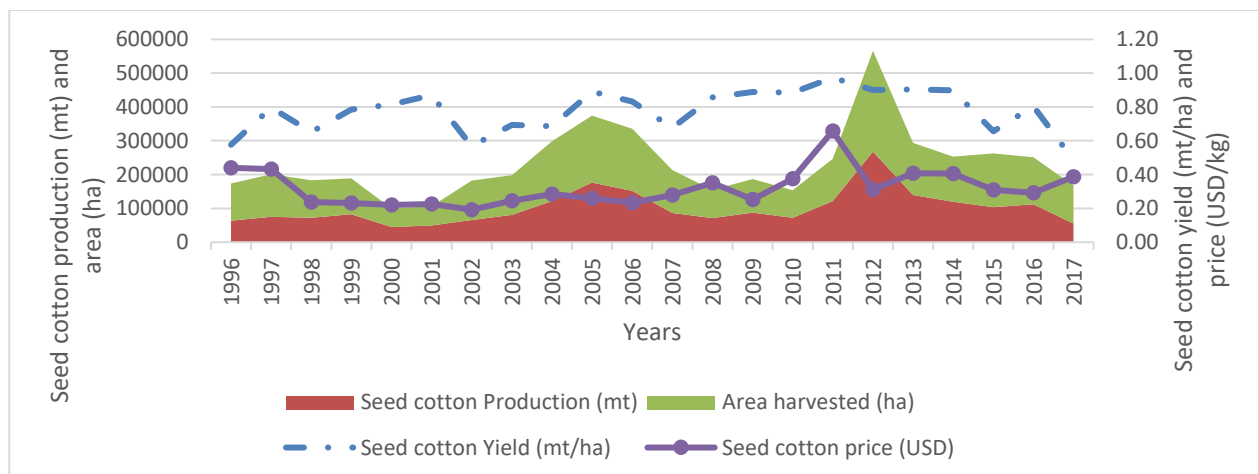
² Which traded as Cargill before September 2017 and currently Highland Cotton Company

materials, such as polypropylene, chicken feathers, stones from seed cotton before it was ginned. These measures resulted in Zambia exporting high quality cotton lint, which attracted a premium.

During this period of growth, the cotton sector experienced some crashes in seed cotton production due to various challenges such as side marketing of seed cotton. The first seed cotton production crash was experienced in 2000 after the major companies Lonrho and Clark Cotton reduced support to cotton production because of poor loan recovery rates in the previous year due to side marketing of seed cotton by other companies that did not adequately finance seed cotton production. The other ginning companies that entered the sector did not invest as much in providing farmers with inputs and extension services, and were able to buy more seed cotton more than they had supported. This crash almost destabilized the sector and Lonrho sold its operations to Dunavant, citing losses due to unrecovered loans amounting to USD 2 million (Tschirley et al. 2007). Lonrho’s losses resulted mainly from side marketing of seed cotton – the company invested in providing its contracted farmers with inputs, but other buyers that invested less were able to offer higher prices to Lonrho’s contracted farmers, buying the seed cotton from under them, after which Lonrho was unable to recover the loans to these farmers. In 1999, ginning companies created an informal grouping, in which they shared some information to enhance coordination among themselves.

After privatization, the Government’s involvement in the sector was only in granting export permits, researching, breeding and certifying new seed varieties. However, after the first crash in 1999 to 2000, the Government decided to get involved in regulating the sector. The process of developing the Cotton Act began in 2001, involving key stakeholders that included the Ministry of Agriculture, the Cotton Development Trust and the ginning companies. The resulting Cotton Bill was enacted as a Cotton Act in 2005, followed by the establishment of the Cotton Board of Zambia in 2009. In parallel, the Cotton Association of Zambia was created in 2005 to represent about 300,000 cotton farmers – nearly all of the smallholders – under aegis of the Zambia National Farmers’ Union, the apex farmers’ union. But the association had only approximately 40,000 paid up cotton farmers in 2017.

Figure 3. Trends in seed cotton production and seed cotton prices in Zambia



Sources: Central Statistics Office (CSO) – production indicators, Cotton Board of Zambia – prices

After the enactment of the Cotton Act in 2005, the cotton sector has experienced three crashes of seed cotton production, in 2007, 2010, 2013, and the recent one in 2017. There have been varied reasons for these crashes, including price, side marketing of seed cotton and weather effects, as was the case with the 2017 crash.

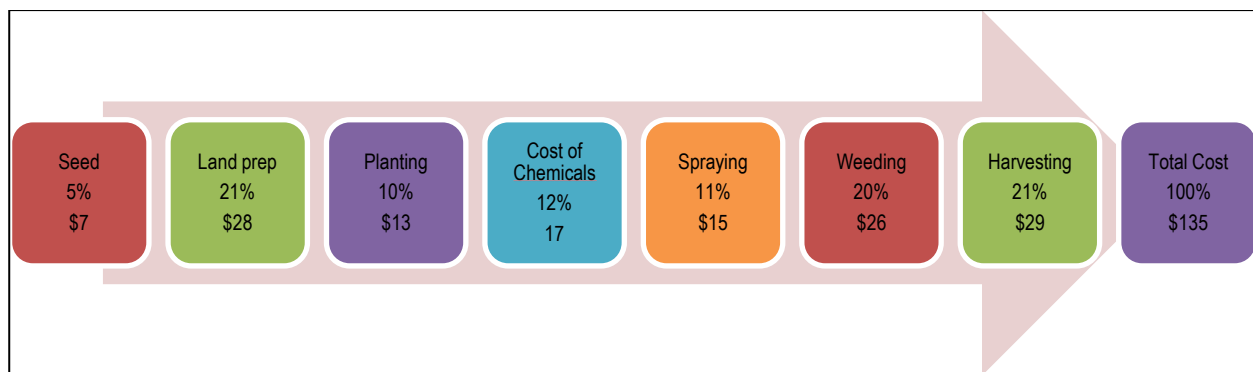
2.2 Producer margins and cost drivers

Zambian seed cotton production has been characterized by low yields. The average yield of seed cotton between 1994 and 2017 ranged from 490kg per ha in 2017 to as high as 970kg per hectare in 2011

with a national average of 850 kg per hectare (Crop Forecast Surveys conducted by Central Statistics Office). These yields are against the yield potential of above 2000 kg per ha for most of the seed varieties in Zambia. The low yields are due to poor agronomic practices and non-use of macro fertilizers in the seed cotton production system by the majority of farmers. If we consider the average yield of 769 kg of seed cotton per hectare as estimated from the focus group discussions for 2016 season and the 490 kg per hectare for 2017, in both seasons, farmers made marginal profit of USD105 and USD45 per hectare respectively. The profit margin farmers gained in 2017 declined because the yield was severely affected by weather effects.

The cost drivers for the majority of farmers in seed cotton production are highlighted in figure 4. To produce seed cotton costed about USD135 per hectare. The major cost drivers in seed cotton production is labour and it accounts for about 83% of the total cost of per hectare. Input costs only account for 17% of the total costs. The activities that contribute the most to labour costs are picking/harvesting (21%), land preparation (21%) and weeding (26%).

Figure 4. Cotton value chain cost drivers per hectare (2015/16)



Source: Cotton by-product survey 2017

However, introducing fertilizer in the cotton production systems may increase the cost of production for seed cotton. However, fertilizer may also affect the yield of cotton. A good example is the group of model cotton farmers around Cotton Development Trust (CDT), Mazabuka who in addition to being exposed to good agricultural practices, also apply fertilizer in cotton. From the focus group discussion, these farmers were able to achieve yield levels of approximately 1,700 kg per hectare of seed cotton in 2016. This yield was almost double the average yield (769 kg/ha) obtained estimated from focus group discussions.

2.3 Economic Importance of the Cotton Sector in Zambia

The Government of the Republic of Zambia aims to create approximately 1,000,000 new formal jobs between 2013 and 2018 (GRZ 2013). To achieve this, it has identified the following priority sectors: agriculture, tourism, construction and manufacturing. The agriculture sector is considered as the key sector because it has the potential to create about 54% of the targeted number of 1,000,000 formal jobs (GRZ 2013). In addition, the Government aims to diversify the agriculture sector away from its reliance on maize, through the development of the coffee, tea, soybeans, sunflower and cotton sub-sectors. The Government further indicated that it would promote value addition in the cotton subsector by increasing the ginning capacity and output.

In addition to this, cotton is the top cash crop among smallholder farmers, grown by over 200,000 farmers under out-grower schemes (GRZ 2013). The dependency ratio in rural households is 1:6 household members (Chapoto et al. 2016), meaning that over 1.2 million family members are directly dependent on cotton. Therefore, advancements in this sector provide a means of tackling rural poverty.

Table 1. Importance of the cotton value chain to the Zambian economy (%)

Indicators	2010	2011	2012	2013	2014	2015	2016
Total Zambia's GDP (USD million)	19,149	21,232	21,408	21,816	20,271	21,151	19,550
Contribution of cotton value chain to Zambia's GDP per year (USD million)	47	118	309	80	67	54	65
Contribution of the cotton sector to GDP (%)	0.25	0.56	1.45	0.37	0.33	0.25	0.33
Number of people employed in the cotton value chain (ginning companies)	About 1,000 permanent employees and over 9,500 seasonal employees						

Source: CSO 2017

The value chain is also a source of revenue. From year in year out, the cotton sector contributed an average of about USD 60 million per annum to Zambia's GDP, or 0.32% of the total. The sector has the potential to contribute as much as 1.5% or more to GDP, as shown in 2012, when the sector contributed 1.45% (see Table 1). Furthermore, cotton production and marketing are labour intensive. Therefore, these two activities can employ over 10,000 permanent and seasonal employees. If the value chain is further developed beyond lint, to include value added cotton by-products and textiles, total employment in the cotton value chain could be much greater than 10,000 jobs. Therefore, the cotton value chain is key for both job creation and economic development.

3. Cotton by-products production and use in Zambia

Zambia has seen the transformation of its cotton sector, from being relatively unimportant, to a sector with significant potential to contribute to the national economy. Cotton is grown mainly for its fibre, which constitutes an estimated 35-41 % of the seed cotton. Nevertheless, cottonseed constitutes 55-65 % of seed cotton, making it the largest by-product (Chitah, 2016) but in Zambia, the gin outturn (GOT) for lint and cottonseed is 41% and 55%, respectively. Cottonseed and waste are the by-products of ginned seed cotton. Value added products from cottonseed may include cottonseed oil, cottonseed cake, cottonseed hulls, and linters. Cotton stalks are another by-product of the cotton plant that can be processed into fuel, paper or particle board products.

3.1 Cotton Stalks

Cotton stalks are part of the cotton plant that remains after seed cotton has been harvested (Figure 5). They are rich in cellulose and its fibre composition is comparable to hardwood species, making cotton stalks a potential input to many wood-based industries (Bajaj 2017). On the other hand, cotton stalks are the only by-products that are utilized, and value added at farm-level (Chigumira 2017). According to the literature, four key by-products can be derived from the cotton stalks: briquettes or pellets, particle boards, pulp and paper (Bajaj 2017).

Figure 5. Cotton stalks after harvesting of seed cotton



Source: Bajaj 2017

However, little value is added to cotton stalks in many African countries, Zambia included. Results from the study show that the majority of farmers are unaware of the cotton by-products that can be produced from cotton stalks. Farmers from three out of the eleven focus groups were aware of some of these by-products, but farmers from nine other focus groups were unaware. However, results show that no farmer or farmer group produces any cotton by-product from cotton stalks. For those who knew that some by-products can be produced from cotton stalks, they indicated that they lacked the knowledge, capacity and the appropriate technology to do so.

All interviewed farmers burn their cotton stalks in the field. This is because, in extension meetings, farmers are taught to destroy the cotton stalks. The destruction of cotton stalks is as per Zambian law (Cap 233 Plant Pests and Disease Act), which requires that the cotton stalks be destroyed in order to prevent breeding of the pests and diseases that may have a negative impact on the cotton sector. The easiest method of destruction of cotton stalks is usually burning them. If farmers do not comply with this regulation, they are liable and can be fined or imprisoned.

The results further revealed that not all company representatives are aware of by-products that can be obtained from cotton stalks. Of the eight representatives of the ginning companies that were interviewed, five were aware that some cotton by-products (e.g. particle boards, pellets, briquettes) can be derived from cotton stalks. However, no ginning company was engaged in producing any form of by-product from cotton stalks, because their focus is in buying the seed cotton for their lint and cottonseed businesses.

Analysis shows that there is potential for utilizing cotton stalks in Zambia. According to the literature, about 3 MT of cotton stalks can be produced per hectare (Chita 2010). At a four-year average of 105,000 ha under seed cotton (Crop Forecast Surveys 2013 - 2016), this represents approximately 305,000 MT of cotton stalks that can be utilized. If this value chain is developed and farmers are engaged in supplying the cotton stalk, and if we assume that a tonne of cotton stalk would cost about USD 10 (Chita 2010), it may mean that about USD 3 million would be expected as additional revenue for smallholder farmers.

3.2 Cottonseed

Cottonseed is one of the by-products from seed cotton. According to the ginning companies, cottonseed is separated from lint in the ginning process and constitutes about 55% of the weight of seed cotton. All the ginning companies produce cottonseed through the ginning process, where seed cotton is separated into lint and cottonseed.

Table 2. Table of Seed Cotton and Cottonseed from 2012/13 to 2016/17

	2012/13	2013/14	2014/15	2015/16	2016/17
Seed cotton (MT)	104,219	96,196	118,160	116,557	55,000
Cottonseed (MT)	57,320	52,908	64,988	64,106	30,250
Total local demand for cottonseed (MT)	47,432	46,791	56,344	52,969	30,250
Exported volume of cottonseed (MT)	9,888	6,117	8,644	11,137	-

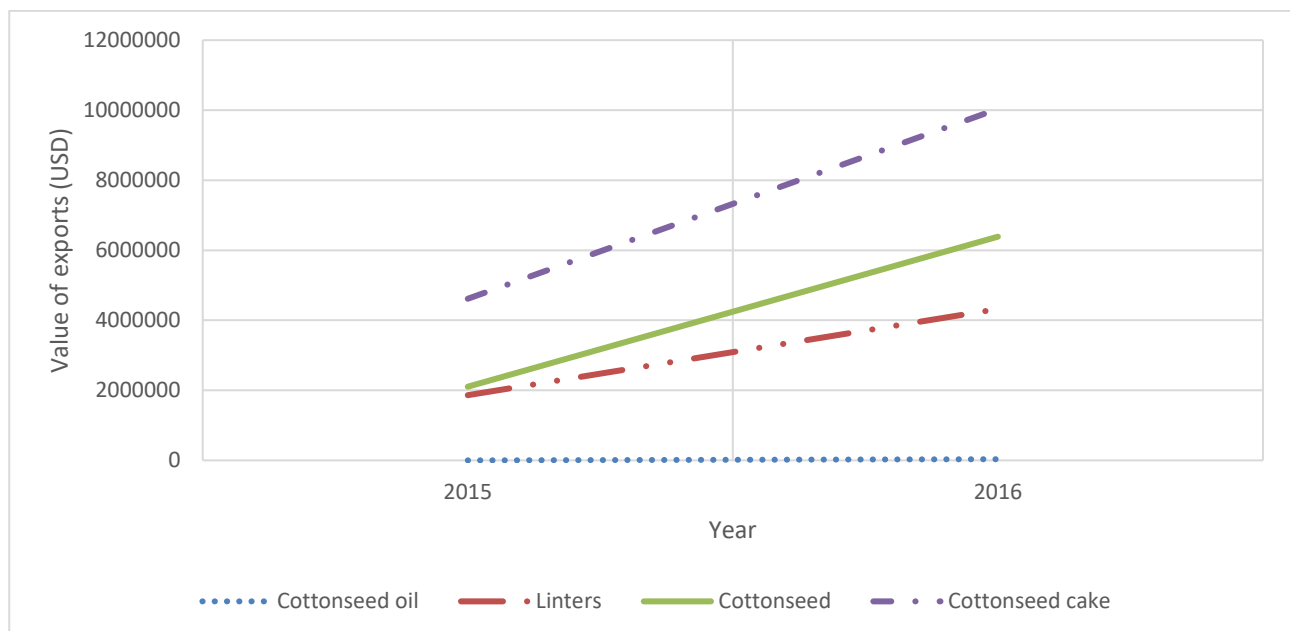
Source: CBZ/ZCGA 2017

Due to the way the marketing of seed cotton is arranged in Zambia, almost all the cottonseed is owned by the ginning companies because, after buying and ginning seed cotton, the ginning company owns both lint and cottonseed. If we consider a five-year period from 2012/13 to 2016/17 agricultural seasons, production of seed cotton ranged from 55,000 MT to 118,160 MT. With an extraction rate of 55% for cottonseed, the country produced 30,250 MT of cottonseed in 2016/17 season and 64,988 MT of cottonseed in 2014/15 (see Table 2). Production of cottonseed was lowest in 2016/17 agricultural season because of excessive rainfall as a result of La Niña weather effect experienced in the country that year.

Most of the cottonseed produced in Zambia is consumed locally. About 85% of cottonseed is retained for local use while about 15% is exported to neighbouring countries, such as Namibia, Botswana and South Africa. For cottonseed that is retained for local use, 90% of cottonseed is channelled towards commercial oil and cake production and about 10% if retained for replanting as cotton seed.

Figure 6, also shows that the value of export of cotton by-products increased between 2015 and 2016. For example, the value of export for cottonseed increased by 67%, from USD 2.1 million in 2015 to about USD 6.3 million in 2016, an indication of a growing business opportunity.

Figure 6. Value of Exports of cotton by-products in 2015 and 2016



Source: CSO 2017

Only two ginning companies (Parogate Ginneries and China Africa Cotton) with a total crushing capacity of 17,000 MT per annum process cottonseed into oil and cake. Dunavant/NWK Agri-Services used to have an oil crushing plant but sold the plant because it was deemed unprofitable. Like Dunavant/NWK, the other ginning companies do not have oil/cake crushing plants. The main reason why other ginning

companies have not engaged in cottonseed crushing is the excessive competition experienced in the oil sector.

In addition to the ginning companies that crush cottonseed, there are three oil crushers in Zambia that buy cottonseed for crushing into oil and cake: one large-scale corporate, one medium-scale corporate and one SME. The large-scale ones are Mount Meru and Sakkar oils. Mount Meru is the largest oil crusher with a crushing capacity of about 235,200 MT and was established in 2007. However, it can crush up to 67,500 MT of cottonseed while the remainder capacity is built to crush other oilseeds (e.g. soybeans). In 2016/17, it bought about 70% of the cottonseed produced in Zambia. Sakkar oils is another medium-scale corporate oil crusher with an annual crushing capacity of 11,000 MT. It is specialized in crushing only cottonseed. Before Mount Meru was established, most of the cottonseed produced in Zambia was exported to neighbouring countries. However, that trend has changed, and about 85% of cottonseed is now locally utilized. The selling price of cottonseed by the ginning companies to the oil crushers ranges between USD 150 and USD 240 per tonne, while the selling price of cottonseed cake by the oil crushers ranges from USD 250 to USD 260 per tonne.

Several by-products can be produced from cottonseed. According to the cottonseed oil crushers and ginning companies, cottonseed can be processed into various by-products with commercial and nutritional value. And these may include; cake, edible oil, margarine, soap, linters, hulls, and waste, which is further refined into cosmetics and soaps. But the by-products that are being produced from cottonseed in Zambia are only cottonseed oil and cake.

3.3 Cottonseed cake

Cottonseed cake is the main product and constitutes 45% weight of the cottonseed. This is another by-product that is well-developed in Zambia. Cottonseed cake is produced by all the cottonseed crushing companies: Mount Meru, Parogate Gineries, China Africa Cotton and Sakkar Oils. In addition to these, one SME also crushes cottonseed into cake and oil. The cottonseed cake produced is rich in protein and is used as an ingredient in the production of animal feed for ruminant animals, especially lactating cows. If we consider 48,583 MT of cottonseed (less planting seed) determined at 55% cottonseed extraction rate from a five-year average figure of 53,915 MT of cottonseed (commercial seed for cotton by-products plus planting seed), the expected cottonseed cake that could have been produced at the rate of 45%, is around 21,835 MT.

When oil is extracted from the cottonseed using oil expeller machines, a solid cake is produced. The cake is about 82% weight of the cottonseed. However, when the cottonseed is crushed and then oil extracted using solvent extraction process, the cottonseed cake that is produced is fragmented (see Figure 7).

Figure 7. Cottonseed cake meal



Source: Cotton by-product Survey 2017

Results show that three of the five oil crushing companies use the solvent extraction methods to get oil and produce the fragmented cottonseed cake. While the medium-scale and SME oil crushing company use the mechanical oil expeller machines to produce oil and produce the solid cottonseed cake.

The cottonseed cake is sold to the stockfeed industry and commercial farmers in the local and export markets for use in making feed for ruminants animals. Statistics from stockfeed companies interviewed that use cottonseed cake as source of protein for making feed, bought about 260 MT in 2015 and about 320 MT in 2016 representing 19% increase. While one commercial farm that uses cottonseed cake in its feed formulation, has been buying about 1,000 MT of cottonseed per annum. Stockfeed companies do not buy as much cottonseed cake, because commercial farmers usually opt to buy the cottonseed cake directly from the oil crushers and then formulate their own feed. However, results from figure 6 above shows that cottonseed cake has a higher potential in the export market where the quantity and value of export have increased by over 50% from 14,270 MT to 26,750 MT and USD 4.6 million to about USD 10 million respectively. The main reason for this could be the investment which oil crushers have put in place for crushing cottonseed to cake and oil in recent years. Despite this potential shown by cottonseed cake as a source of proteins for livestock, the cake is only suitable for feeding adult ruminants and is unsuitable for non-ruminants. The main limiting factor in the utilization of cottonseed cake for non-ruminant animals is the presence of gossypol in the cake. Gossypol is a phenolic compound produced by pigment glands in cotton stems, leaves, seeds and flower buds. It binds to haemoglobin iron displacing oxygen uptake by non-ruminants animals (Holt and Wedegaertner 2017). Because of this limiting factor, cottonseed is not used in the production of feed for poultry and other non-ruminant animals such as pigs and goats. The source of protein for stockfeed of non-ruminant animals is soybeans or sunflower cake. For example, one of the commercial farmers keeping animals indicated that the farm does not use cottonseed cake because of possible poisoning of gossypol.

Information from the stockfeed companies indicated that cottonseed cannot overtake the other sources of protein like soybeans and sunflower. This is because cottonseed cake is only used in making stockfeed for ruminants while soybeans and sunflower can be used for a variety of livestock types (ruminants and non-ruminants) and poultry. Poultry and non-ruminants constitute a major market for stockfeed compared to ruminants markets. In terms of prices, soybeans cake is the most expensive feedstock ranging from USD 300 to USD 650 per tonne, followed by cottonseed cake ranging from USD 250 to USD 300 per ton and the least is sunflower cake at around USD 100.

3.4 Cottonseed hulls

Hulls are the seed husks or hard shell of cotton with some lint attached (see Figure 8), produced from cottonseed. They are rich in fibers and have linters and therefore, act as roughage for animals. The cottonseed hulls are used in making stockfeed for ruminant animals where they are blended with the cottonseed cake to make roughage (Buka 2016). According to the oil crushers, the cottonseed hull constitutes 23% of the cottonseed weight and is therefore second from cake in terms of quantity of by-products extracted from cottonseed.

Figure 8. Cottonseed hulls



Source: Cotton by-product Survey 2017

Table 3. Market of fuzzy cottonseed and cake/hulls - 2016

		Quantity (Mt)	Actual qty of ³ exports (MT)	Actual value of Exports (USD) in millions	Destination
Fuzzy cottonseed	Local market	42,085			Local large and medium scale oil crushers
	Export Market	7,415	23,497	6,387,922	Botswana, Namibia and South Africa
Cottonseed cake/hulls	Local market	8,600			Local commercial and medium scale dairy farms and stockfeed companies
	Export Market	27,900	26,750	10,037,922	Botswana, Namibia, South Africa and Tanzania

Source: Ministry of Agriculture and Central Statistics Officer

The results from the study show that cottonseed hulls are produced in Zambia. Mount Meru is the only company producing cottonseed hulls. If we consider the 48,523 MT of cottonseed feedstock, the potential quantity of cottonseed hulls the country can produce at an extraction rate of 23% is around 11,160 MT. However, since Mount Meru captures about 70% of the actual cottonseed produced, 7,812 MT of cottonseed hulls is the likely quantity the country can produce under the current situation. Cottonseed hulls are utilized locally and also exported to the regional market.

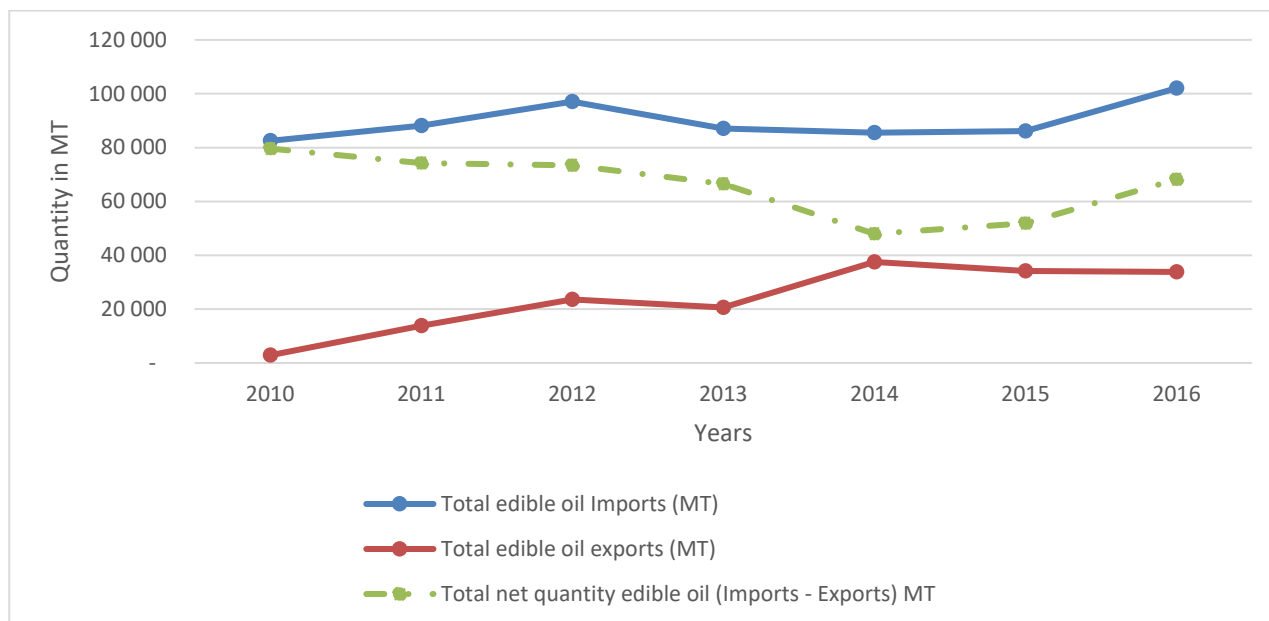
Using information from the Ministry of Agriculture and Central Statistics Offices, shows that after processing of cottonseed, the local market for cottonseed hulls/cake consumes about 24% of the resulting cake and hulls. The major buyers of cottonseed cake and hulls are commercial and medium-scale farms, as well as stockfeed companies. While the majority (76%) of the cottonseed hulls/cake are exported to South Africa, Namibia, Botswana, and, to a lesser extent, Tanzania (see Table 3). The huge quantity of cotton cake/hulls exported to South Africa, Namibia and Botswana are due to vibrant livestock sectors in those countries, particularly cattle. The value of cottonseed hulls/cake exported was over USD 10 million in 2016. This increased by 46% from the value that was realized after exporting cottonseed hulls/cake in 2015.

3.5 Cottonseed oil

Cottonseed oil is another by-product produced from cottonseed. This accounts for 13-16% of cottonseed's weight. If we use 48,523 MT of as quantity of cottonseed and an oil extraction rate of 15%, Zambia can potentially produce 7,300 MT of cottonseed crude oil. According to processors, two methods of extracting oil are used: solvent extraction and mechanical oil expelling. The big companies use the solvent extraction method, which yield about 16% of crude oil from cottonseed. The medium scale and SMEs companies use mechanical oil expelling machines, which yields about 13% of crude oil. The solvent oil extraction method is therefore more efficient than the mechanical oil expelling method. Crude oil is further refined into edible oil, and the waste from this process could be used to make soap, margarine, and biodiesel. However, margarines, soaps and biodiesel are not produced from cottonseed oils, but other oils such as palm oils and soybeans. The reasons given for not using cottonseed oils to make soaps and other by-products is that the quantities of seed cotton are inadequate to guarantee a sustained supply.

³ Information on actual quantities and values of cottonseed and cake were obtained from CSO

Figure 9. Trends in the net quantity of edible oils (Exports - Imports) (MT)



Source: CSO, 2017

The total oilseed crushing capacity in Zambia is over 500,000 MT, while the refining capacity stands at 250,000 MT, more than twice the national annual demand (CEDARO 2017 and Chisanga and Sitko 2013). Therefore, the excess crushing capacity represents an opportunity for the sector to grow, while excess refining capacity represents an opportunity to export refined edible oils. From the eight edible oil companies interviewed, five have the equipment that is capable of crushing cottonseed. Mount Meru has the largest cottonseed crushing capacity of about 67,200 MT per annum. The company has also other lines that can crush other oilseeds. The other companies (Parogate gineries, China Africa Cotton gineries, Sakkar Oil Crushers, and a medium scale private company) have machinery built specifically to crush cottonseed. On the refinery aspect, Global Industries has the largest refinery capacity for crude oils.

The market for refined edible oil, including cottonseed oil, is mainly the local market. All ginning companies and other oil crushers and refinery companies that produce cottonseed oil indicated that they sell most of the oil on the local market. Nevertheless, they face stiff competition from cheap imports of palm and other oils. Figure 9 shows the trends in the net quantity of edible oils (imports – exports) in MT. The net quantity of edible oils has been declining since 2010 until 2014. This means that Zambia has been increasing exports of edible oil. On the other hand, the trend changed after 2014 and the net quantity edible oil has been increasing by 2%. This therefore, shows that the sector has potential to promote the production of local oilseeds (cottonseed) included to bridge the gap which is widening between imports and exports.

3.6 Cotton linters

Cotton linters are usually obtained by delinting ginned seeds. The fuzzy or linters are short fibres of 2-5mm that remain on the ginned seeds. Linters are removed from cottonseed before it is processed into cake and oil. All ginning companies are aware of this by-product. However, only three out of eight ginning companies delint the fuzzy cotton seed to get delinted cottonseed and linters. In addition to ginners, oil crushers can also delint the fuzzy cottonseed to get delinted cottonseed to get linters. Mount Meru, Parogate, China Africa Cotton and Cargill have invested in delinting equipment and delint the fuzzy cottonseed. The linters represent 6% of the total weight of fuzzy cottonseed.

Figure 10. Cotton Linters



Source: Cotton by-product Survey 2017

All the companies that delint fuzzy cottonseed, sell over 90% of the linters to the export market and the remainder is sold locally. The export market for linters in 2016 was mainly South Africa, Switzerland and to a lesser extent China. According to statistics from Central Statistics Office, the value of exports to these countries was USD 2.1 million, USD 2 million and USD 0.21 million respectively. The export of linters increased by 40% from USD 1.9 million to USD 4.3 million between 2015 and 2016. The local market for linters are the furniture manufacturers, who use them in filling the sofa cushions and other carpentry products. The other high-value uses of linters include: paper currency, gun powders, x-ray tape packaging materials, food casing for sausages, medical grade cotton, paints and mattresses comforters upholstery (Bajaj 2017, Buka 2016, Chita 2016). The low use of linters in Zambia may be attributed to lack of knowledge and technology and low quantity of linters that can be produced from cottonseed. With 6% extraction rate and current four years average of 55,000 MT of cottonseed, Zambia can only produce about 3,300 MT of linters per annum.

4. Challenges and opportunities to the development of the cotton by-products

Developing the cotton by-product value chain in Zambia faces a number of challenges, which the study sought to elicit from interviews with key stakeholders, especially those in cotton production, processing, marketing, and government, as well as UN agencies. This section analyses the challenges and opportunities as highlighted by different stakeholders along the cotton value chain.

4.1 Challenges for the development of cotton by-products

4.1.1 Cotton Stalk

Analysis has shown that there is potential to produce over 305,000 MT of cotton stalk in Zambia. With this quantity of cotton stalk gives an opportunity to would be investors and farmers to add value to cotton stalk.

Analysis of the factors that may impede the development of the cotton by-products from cotton stalks, shows that a lack of upstream demand for the cotton stalks is the major factor affecting the development of by-products from cotton stalks. Secondly, there is little or no awareness among farmers of the different cotton by-products that can be produced from cotton stalks. The study revealed that only farmers from three out of eleven focus groups were aware of some cotton by-products that can be produced from cotton stalks. In addition to these factors, during extension meetings, officers tell farmers to destroy the cotton stalks as per the law (Cap 233 Plant Pest and Diseases Act). All these factors make farmers see cotton stalks as having little or no economic value. Therefore, to follow the extension officers' information about destroying the cotton stalks, farmers cut and burn the cotton stalks in the field.

A review of the law shows that the Plant Pests and Disease Act does not impede the development of by-products from cotton stalks because the Act requires that cotton stalks be destroyed. Therefore, if the methods used for producing different by-products from cotton stalks are able to destroy any pests and diseases, then they conform to the law. Furthermore, the Act does not prohibit farmers from collecting the stalks and selling them to processors in order to add value.

4.1.2 Cottonseed

Low production of seed cotton was cited by almost all the stakeholders (e.g. stockfeed manufacturers, oil crushers) as a major impediment to the development of cotton by-products from cottonseed. The current five-year average of 98,026 MT of seed cotton production is inadequate and this may undermine annual consistent supply of feedstock for the development of by-products from cottonseed.

Various factors have contributed to low production of seed cotton in Zambia. Among them include low productivity among cotton farmers, who only manage to produce around 850 kg/ha of seed cotton, against a yield potential of over 2,000 kg/ha for most cotton varieties in Zambia. Price volatility is common in cash crop marketing such as cotton whose prices are affected by the international market prices. This makes farmers move in and out of cotton production depending on the previous year's price. With these movements, some farmers lack the technical knowhow in seed cotton production and this affects their productivity compared to the farmers who consistently grow cotton.

Furthermore, farmers do not use fertilizer in cotton production, typically reserving fertilizer for maize, the staple crop in Zambia. On the other hand, government policies have been favouring the maize crop, for example maize is the major beneficiary of the government subsidies through the Farmer Input Support Programme (FISP) and the Food Reserve Agency (FRA). In 2016/17, this changed somewhat, with cotton included for the first time on FISP. And the introduction of E-FISP could be an answer to the issue of government focusing on maize with regard to provision of input subsidy. This is because E-FISP would allow farmers to access any inputs for the crops of their choice, or for livestock production, thereby allowing farmers to diversify from maize to other crops.

Side marketing of seed cotton impedes the adequate investment in seed cotton production. When incidences of side marketing are high, companies do not invest inputs and extension adequately for fear of losing their investment (Kabwe et al. 2017). Consequently, this may affect the productivity and production of seed cotton.

With low seed cotton production, supply of cottonseed to the crushers is seasonal and oil crushing companies are only able to run economically for up to 4 - 5 months. For example, during the previous season (2015/16), the total fuzzy seed which was bought by all oil crushing companies was about 33,500 MT, far below companies annual requirement of about 77,200 MT, representing an annual deficit of 43,700 MT for oil and cotton cake production.

Table 4. Fuzzy seed annual consumption and deficit, 2015/16

Name of Stockfeed/Oil Expeller	Annual fuzzy seed consumption (MT)	Quantity bought in 2015/16 season
Mt. Meru (Z) Ltd	67,200	27,000
Sakkar Ginnery & Expeller (Z) Ltd	10,000	6,500
Total	77,200	33,500
Total deficit		43,700

Source: Cotton by-product Study 2017

4.1.3 Cottonseed oil

Though the country has signed trade protocols that allow the country to import and export edible oils, it was highlighted by almost all stakeholders that the importation of cheap edible oils, especially palm oil and the illegal edible oil importation mainly through false declarations, are undermining the competitiveness of locally produced edible oils, including cottonseed oil. The Government's recent imposition of a 5% surcharge tax on all imported oils, to promote the development of the local oil sector, seems to be insufficient, as illegal imports persist. Stakeholders have therefore requested government to consider increasing the surcharge tax to 10%. However, it was observed that even if government was to discourage the importation of cheap and competing illegal edible oils to cottonseed oil, the current low production level of cottonseed is not sufficient to meet the demand for cottonseed for oil production and is the major impediment.

4.1.4 VAT on cottonseed

Processors highlighted that the Government imposes Value Added Tax (VAT) on cottonseed, while other oilseeds are exempted of VAT. This makes cottonseed unattractive for use in edible oil processing. Furthermore, all the edible oils produced in Zambia attract a 16% VAT, while most of the imported edible oils from neighbouring countries such as South Africa, Malawi and Zimbabwe are VAT exempt. This makes locally produced edible oil more expensive than the edible oils from neighbouring countries, by 16% or more.

4.1.5 Lack of appropriate technologies, especially among SMEs

SMEs representatives who were interviewed indicated that there was lack of appropriate technologies to spur development of the cotton by-product value chain. Furthermore, they indicated that it is quite difficult for the companies to receive a steady supply of cottonseed throughout the year due to low cottonseed production levels rendering it impossible for them to participate in value added activities. The cotton by-product sector has been lagging behind in terms of low-cost investment into oil crushing technologies. This finding has been partly a result of low profitability of the cotton by-products sector due mainly to low cotton production coupled with imported competing cheap oils.

4.1.6 Presence of Enzyme Gossypol in Cottonseed

Cottonseed cake is mainly suited for feeding adult ruminants and unsuitable for feeding non-ruminants, because of the presence of enzyme gossypol in cottonseed. Gossypol is a phenolic compound produced by pigment glands in cotton stems, leaves, seeds and flower buds. Gossypol inhibits the digestion of some important nutritional enzymes in non-ruminants. Therefore, this is another major factor limiting the use of cottonseed cake in the formulation of stockfeed for non-ruminants (e.g. poultry and pigs), which constitute the largest market for stockfeed.

For example, one of the commercial farmers indicated that he does not give cottonseed cake to his cattle for fear of possible poisoning due to gossypol in cottonseed meal. These fears clearly undermine the potential for utilizing cottonseed for feeding livestock.

Nevertheless, resolving the problem of gossypol shows the potential for using cottonseed meal for various livestock types, other than just ruminants. Therefore, technologies are being developed that can be used to produce glandless cotton which lacks the enzyme gossypol (Holt 2017). For example, technologies such as RNAi Gene Silencing Technology and a Highly Seed-Specific (AGP) Promoter are used to inhibit the Delta Cadinene Synthase, a process of forming glands cotton plants by producing glandless cotton. India is also conducting trials to produce gossypol free cottonseed meal using the de-gossypolization technology for fish, pigs and poultry feeds (Sundaramoorthy 2017)

4.2 Opportunities for the development of the cotton by-product in Zambia

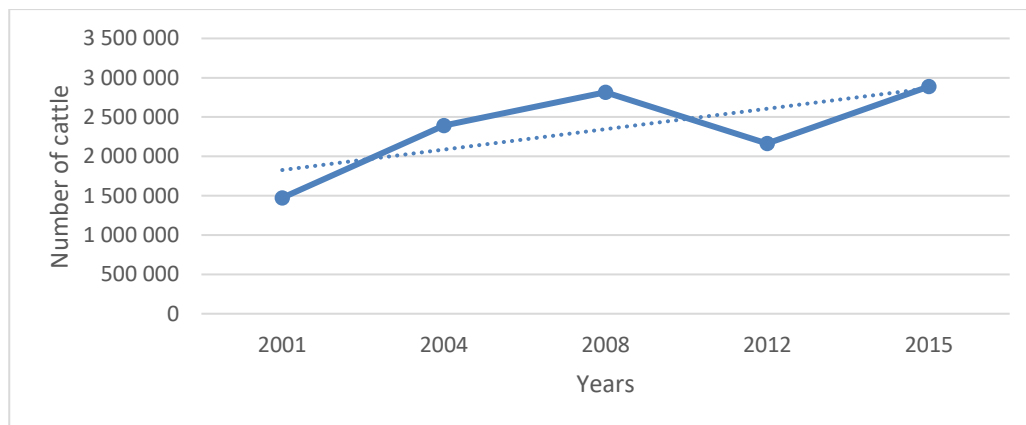
All stakeholders interviewed indicated that, there are high prospects of developing the cotton by-product value chain in Zambia because of the opportunities available in the country. The section highlights and analyses the key opportunities as presented by stakeholders.

4.2.1 Zambia with a vibrant livestock sector

The agricultural sector in Zambia is predominantly crop-livestock based with the two sectors complementing each other. Under intensive livestock production, especially the dairy industry, crops such as maize, legumes and cotton (cottonseed cake) are a major ingredient of the dairy animal feed with the current a vibrant livestock sector, especially for cattle in Zambia.

For example, the number of cattle has been raising in Zambia (Figure 11). Since 2001, the population of cattle has increased by 49% from 1.4 million to about 2.8 million. Therefore, this offers an opportunity for cottonseed crushers to supply cake as a source of protein to farmer, especially those who have lactating cows. The cottonseed cake is considered a cheap source of protein ruminants, especially lactating cows. For example, one SME who is a dairy farmer decided to start cottonseed crushing business in order to provide cottonseed cake a cheap source of protein to lactating cows. He reiterated that the combination of “Dairy farming and cottonseed oil crushing activities” have been the game changer for his business model”. His animals are healthy and providing enough milk for sale and the oil from cottonseed is sold for income. Therefore, a growing cattle population is a growth opportunity for using cottonseed meal in stockfeed for ruminants.

Figure 11. Trends in number of cattle herd in Zambia (2001 to 2015)



Source: Lubungu 2016.

4.2.2 Incentives for farmers to grow cotton

Cotton input support and the ready market offered by ginning companies provide incentives for farmers to grow cotton. Producers have indicated that the access to cotton inputs is easy compared to other crops. Cotton is well supported by the private sector in terms of input credit, especially for seed and agrochemicals. Furthermore, compared to other crops, seed cotton gives farmers an early income and has a ready market, with companies buying off the crop on cash basis. Despite the crop being bulky, the presence of ginning companies at the community level has made cotton marketing less costly to transport, as ginning companies engage buyers/distributors locally within the communities.

4.2.3 Diversity of cotton by-products

Cotton has diverse uses, including the potential to utilize almost all parts of the plant, leaving minimal waste. The fuzzy seed by-product value chain is lengthy and profitable if well capitalized. The diversity of cotton by-product value chain shows the underlying opportunities for different players within the value chain at all levels and scale.

Fuzzy seed demand is very high for the production of cottonseed cake for the dairy industry in the neighbouring countries in the region. Stockfeed producers have found cottonseed cake to be a cheaper source of protein for livestock feed production compared to soybeans.

4.2.4 Ginning capacity

Investment in gins is one of the success story of the cotton sector. At privatization in 1994, the ginning capacity was around 90,000 MT per annum. As of 2017, the country has over 366,000 MT of ginning capacity. This creates an opportunity for increasing production in the sector. However, the five-year average seed cotton production of about 98,026 MT, means average capacity utilization rates are at 27% or below.

We use a sensitivity analysis to ascertain the effect of yield improvement to cottonseed production in relationship to cottonseed crushing capacity (see Table 5). Results show that even if we increase yield by 50%, the cottonseed produced (81,248 MT) would be insufficient to fill the cottonseed crushing capacity (95,200 MT). However, doubling yields of seed cotton from the 0.72 MT/ha obtained in 2015/16, to 1.44 MT/ha would be sufficient to produce adequate cottonseed to reach full crushing capacity. This scenario, therefore, presents a need to improve productivity in cottonseed. Factors that may boost nation cotton productivity and production include: intensifying extension services; investing more in cotton research; and stabilizing cotton prices, to dissuade farmers from dropping out of cotton production for alternative crops with more attractive prices.

Table 5. Sensitivity analysis of increase in yield and its impact on seed cotton production using 2015/16 CFS data

	Actual from CFS	Productivity Increase holding other factors constant			
		25%	50%	75%	100%
Average area under cotton (ha) from CSO Crop forecast survey	150,894				
Farmer productivity (Mt/ha)	0.721	0.90	1.08	1.26	1.44
Average production of seed cotton (mt)	108,783	135,979	163,175	190,370	217,566
Lint (MT) using 41% GOT	44,601	55,751	66,902	78,052	89,202
Fuzzy cottonseed (MT) using 55% GOT	60,184	75,230	90,276	105,322	120,368
Cottonseed (MT) less 10% planting seed	54,166	67,707	81,248	94,790	108,331

Source: Author computation

4.2.5 Cottonseed crushing capacity

As of 2016/17, the oil crushing capacity for the sector is over 500,000 MT. About 95,200 MT (19%) of this capacity is the capacity for crushing cottonseed. This capacity far exceeds the country's cottonseed production quantity which has been in the range of 30,250 MT to 64,988 MT in the last five years. Most of the oil crushers have invested in new technologies of oil extraction (i.e. solvent oil extraction), which improves the efficiency of oil extraction. Therefore, there is potential for sector players to increase production of cottonseed in order to meet the unsatisfied capacity for crushing cottonseed.

5. Perception of value chain actors

5.1 Farmers

5.1.1 Value addition at farm level

In all the focus group discussions, the farmers indicated that cotton stalks are cut and destroyed through burning. According to the farmers, extension officers inform them during meetings to cut and destroy the cotton stalks in order to destroy the pests and diseases that may have been in cotton plants. The producers were asked to find out if they were aware about any by-product that may be produced at farm level. Out of the 11 focus groups, 3 representing 27% were aware about some of the by-products that can be produced at farm level from cotton stalk. These include particle boards and fire pellets. The main reason for them having some awareness about the by-product was being close to Cotton Development Trust and participating in model farmer group and CAZ study circle groups. However, no farmer from the 11 focus groups has ever produced any by-product from cotton stalk. The main reason indicated was lack of demand for the cotton stalks for value addition and lack of knowledge and technology for developing the by-product.

5.1.2 Value addition at ginnery level

Some farmers in some focus groups were aware about the cotton by-product that are produced at the ginnery level. Farmers from the five out of the 11 focus groups indicated that they were aware about some of the cotton by products produced at ginnery level. These include cottonseed oil and cake. However, no farmer was involved in producing these products because they indicated that farmers were contracted by ginning companies to grow seed cotton which the company buy and that exclude them to own the cottonseed which is the feedstock for making those by-products. They also lack knowledge to extract the said by-products. And thirdly, they indicated that they lack the appropriate technologies for extracting the by-product.

The farmers were asked to find out if they would be happy to get involved in extracting the by-products and why. The farmers highlighted five key reasons where it would be beneficial to them to get involved. Firstly, the cake that they would produce from the cottonseed could be used as feed supplement for cattle, secondly, involvement in extraction of the by-products would increase profitability of cotton production. Thirdly, farmers indicated that they would have easy access to seed. Fourthly consumption of cottonseed oil would improve household nutrition and the fifth reason was that involvement in extraction of cottonseed cake and oil has the potential to create business and employment opportunities.

5.1.3 Incentives to grow more cotton

Farmers were asked to determine the reasons that can motivate them to consistently grow more cotton. Several factors were highlighted. Firstly, farmers indicated that having a less volatile price would make them to grow cotton consistently. On this they further indicated that ginning companies can have a stabilization fund to allow them to cushion the depressed price in some years. Secondly, companies were supposed to improve and announce pre-planting prices. This would accord farmers a chance to decide whether to venture in cotton production or grow other crops. And thirdly, farmers indicated that companies should introduce appreciation schemes for farmers that pay a full loan to the company.

5.1.4 Relationship with ginners

The perception of farmers on the relationship between ginners and themselves is mixed. Farmers indicated that during farmer recruitment, officers from ginning companies are always good to the farmers but during marketing period, officers usually become antisocial. Company officials mainly focus

see on loan recoveries and do all sort of things such as property grabbing in order to get back the loan. The main reason cited for this was that there is poor communication between farmers and ginners. Other reasons contributing to straining the relationship between farmers and ginners is the perceived high cost of chemicals and in some cases when there is a crop failure, companies are perceived not to care but focus only in loan recoveries. In addition to crop failure due to weather related effect, farmers indicated that there is no insurance for them.

5.1.5 Cotton vs competing crops

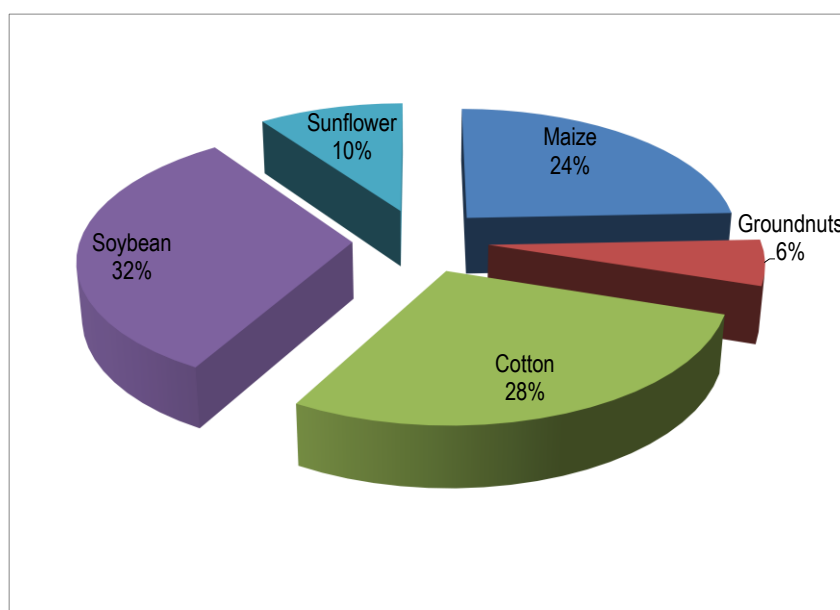
Farmers were asked to find out why they grow cotton in relation to other crops. Key factors were identified. Firstly, the crop is well supported by ginning companies both at input and output levels. Farmers indicated that they get inputs on credit and when marketing comes, the ginner registered with buyers the crop, therefore, the market is ready, and farmers are paid promptly. Secondly, cotton marketing is considered as an early income provider. When other crops are still in the field, seed cotton is ripe and harvest early in the marketing season when income is very scarce. Thirdly, farmers perceive cotton as a low input crop, therefore, indicated that the crop does not require any fertilizer hence a good crop to grow. The other reason indicated was that farmers grow cotton because they know how to grow the crop.

5.1.6 Allocating land between maize and cotton

Farmers were asked to indicate the reasons why they make decision to allocate land to maize or cotton. They indicated that labour availability, household income, fertilizer availability in case of maize and availability of inputs on credit in case of cotton determine how farmers make decisions to allocate land either to cotton or maize. In the context of land allocation, soybean was a priority cash crop, planted on 32% of the total land area, with cotton second, at an average of 1.6 ha, or 28% of the total, and maize third at 24% (see Figure 12).

In 2015/16, soybean prices reached a peak of about US\$0.50 per kilogram (kg) in some locations, compared to a peak price of US\$0.30/kg for cotton. This attracted farmers to plant more land with soybean in 2016/17. However, the price scenario reversed in 2016/17, with cotton selling at a maximum of US\$0.40/kg which represents a 90.5% increase from the previous season's high, while soybean prices dropped to an average of US\$0.20/kg, a 45% drop from the previous year.

Figure 12. Share of total land allocation, by major crop, 2016/17



Source: Cotton by-product Survey 2017

5.2 Oil Crushers

5.2.1 Business case

For those oil crushers that use cottonseed, they were asked to indicate the reason why they crush cottonseed. All indicated that they saw a business opportunity to start crushing cottonseed so that the country could become self-sufficient in edible oil and cake. The main business in this line of oil crushing is the production of cottonseed cake. Cottonseed offered a business opportunity for them to venture into that had the equipment that was suited to crush the cottonseed and saw it.

The major challenge that the oil crushers highlighted is the seasonal supply of cottonseed by the ginning companies which is not adequate. Secondly, they indicated that cottonseed is the only seed that attracts VAT while the other oilseeds do not. This affects oil production as the oil crushers only operate for 4-5 months and after that production lines are closed.

While those oil crushers that do not use cottonseed, indicated that the equipment they have are not designed to crush cottonseed but other oilseeds such as soybeans and sunflower. The other companies indicated that they do not have crushers but refinery equipment's. One of the refinery company indicated that cottonseed oil was difficult to clean from the storage facility.

5.2.2 Cottonseed vs other oilseeds

Oil crushers were asked to find out whether cottonseed can replace other oilseeds. All the crushers indicated that cottonseed cannot replace the other oilseed because, the oil content is lower (17%) than for other oilseeds, which yield over 30% oil. Secondly, the supply of cottonseed is inadequate and seasonal. So, in those lines, the cottonseed is unlikely to replace the other oilseeds.

5.3 Stockfeed producers

5.3.1 Using cottonseed cake in feed

For those stockfeed producers that use cottonseed were asked to find out why they use the cottonseed in making feed. They indicated that cottonseed cake is a source of protein for making feed for ruminant animals such as cattle. Even though, there is that ruminant market, it is small compared to the market of non-ruminant animals like pigs. On the other hand, commercial farmers go straight to buy the cottonseed cake from the oil crushers in order to formulate their own feed for ruminants. That reduces the demand for stockfeed made by stockfeed companies.

We asked the stockfeed producers on the challenges they face when they are using the cottonseed cake. Two challenges were cited. Firstly, they indicated that price of cottonseed cake varies considerably. Usually when the price is on a higher side, demand for the commodity declines. The second challenge is the limited and seasonal supply of cottonseed cake. These make the cottonseed cake unattractive compared to other oilseed cakes. The issue of gossypol also affects its utilization because the cottonseed is only suitable to ruminant animals.

5.4 Ginners

The ginning industry in Zambia is dominated by multinational ginning companies that vary in size, operational scale and geographical coverage. In 2016/17 season there were nine principal cotton ginning companies in Zambia, namely: NWK Agric Services, LUDI Investments, Grafax Ginneries, Parrogate Ginneries, Cargill, Grafax Ginneries, Yustina, China Africa Cotton (Z) Ltd and Mumbwa Farmers Ginning and Pressing Company. Out of the nine ginning companies, MFGPC is the only Zambian-owned company, owned and managed by the local farmers under the CAZ.

Ginners vary in size, in terms of number of employees and ginning capacity. For example, workforces range from 10 permanent employees, to 289 in the case of NWK Agri-Services. Similarly, the number of seasonal employees varies from 45 to around 2,000, again at NWK. Seasonal workers are employed during the marketing season, when ginners need additional manpower.

Zambia has 22 ginneries with a total ginning capacity of 366,000 MT. These are spread across the cotton growing areas of Central, Eastern, Muchinga and Southern Provinces, with 55% of them located in Eastern Province. Of the ginning companies found in Zambia, two companies are completely defunct. While some companies have closed down some of the gins in order to reduce the operational costs. A four years average seed cotton production in Zambia is about 100,000 MT. Therefore, currently, the ginning capacity the country has does not commensurate to the seed cotton production which results in gin utilization of about 30%.

Table 6. Number of permanent and seasonal employees, by ginnery

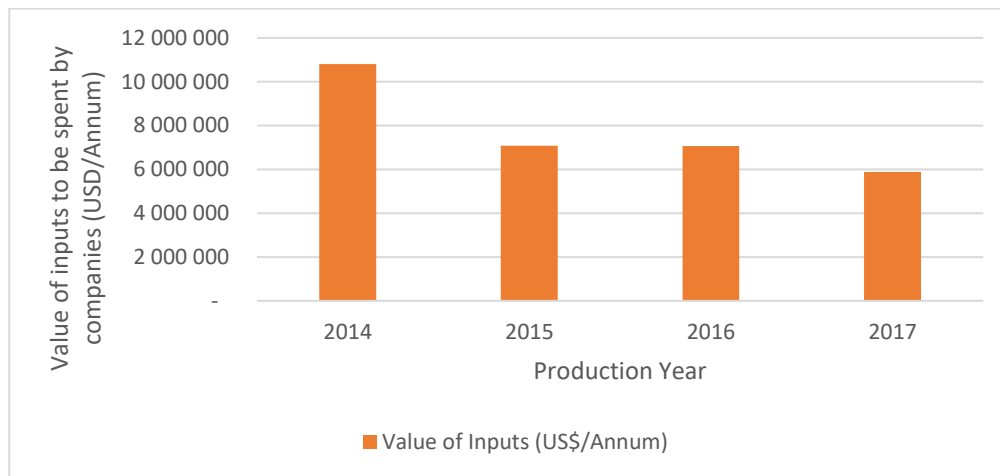
Company	Permanent employees	Seasonal employees
NWK	289	2000
Cargill	150	1500
Parrogate	140	1450
CAC	120	1500
Alliance Ginneries	116	1500 - 1600
Grafax Ginneries	131	1000
LUDI Investments	90	800 - 900
MFGPC	10	45

Source: Key Informant Interviews Cotton by-product Survey 2017

The cotton companies in Zambia only have a presence in the five agricultural provinces, namely: Central, Eastern, Lusaka, Southern and Muchinga. These provinces are found in agro-ecological regions I and IIa. The total ginning capacity for all ginneries was 366,000 MT in the 2016/17 season. NWK Agri-Services has the highest share of total ginning capacity, at 124,000 MT (34% of total capacity), followed by Cargill at 60,000 (16%). Mumbwa Farmers Ginning and Pressing Company is the smallest operation, representing 5,000 MT (1.3%) of the total.

Ginners finance the production of seed cotton by providing farmers with inputs on credit. Figure 13 shows ginners' intended investment in inputs, announced at the start of each season. These figures indicate that their investment in production, in USD terms, has been declining. In 2014, the ginners planned to invest about USD 10.8 million worth of seed and chemicals. By 2017, ginners announced only USD 5.9 million of support, representing a 46% reduction. Ginners declining investment in inputs in USD terms is partly explained by the weakening of the Zambian kwacha against the dollar, by 36% between 2014 and 2017.

Figure 13. Total Value of Inputs to be Supplied by Production Year (USD)



Source: Cotton Board of Zambia 2017

All the ginning companies are engaged in processing fuzzy cottonseed. However, ginners, particularly Parogate and China Africa Cotton argued that the value chain has potential to develop by-products at each stage of the value chain because by-products of economic value could be extracted and targeted at a particular category of consumers.

5.5 Other key stakeholders

Apart from farmers and ginning companies, there are associations and other institutions that support the production of seed cotton. The apex board for the cotton sector is the Cotton Board of Zambia (CBZ), which regulates the production and marketing of seed cotton through the Cotton Act. While the cotton research and development component is a preserve of the Cotton Development Trust (CDT) which is a quasi-government institution as well. This institution spearheads the development of parent cotton varieties and also development of cotton extension guidelines for cotton production.

We asked the government agencies to find out if Zambia has harnessed the cotton by-products. All the government agencies and Ministries indicated that the cottonseed cake has the highest prospects for development except the Cotton Board of Zambia which indicated that cottonseed had highest prospects considering that there is huge ginning capacity in the country which is over 360,000 MT per annum.

Government agencies and Ministries perceptions on the policies is that there are policies that can spur the development of the cotton by-products. For example, they cited the industrialization strategy paper, the commercial and Industry and Trade policy, and the 7th National Development Plan as those that guide in some aspect with regards to value addition. One of the agencies perception with regard to implementation was that it was lack of some of the key documents.

Perceptions on the challenges were also obtained from government agencies. Like other key stakeholders in the sector, low production of seed cotton and low level of industrialization were cited as the major impediments for the development of the cotton by-products in Zambia. Furthermore, they also perceived that a lot of people are not aware about the by-products that can be obtained from cottonseed.

The Zambia Cotton Ginners Association represents the interest of the ginners in the sector, including in interactions with the Government. In the 2016/17, there were nine ginners active in the sector, of which seven were registered with the Zambia Cotton Ginners Association.

Meanwhile, the function of the Cotton Association of Zambia is to represent the interests of the cotton farmers. When the CAZ was established in 2005, it was intended for all cotton farmers to be members. Nevertheless, in 2016/17, only about 40,000 farmers were paid members of the Association. Mixed

reactions were obtained from the different associations in terms of the country having the prospects of developing the cotton by-product especially for SMEs because the seed is a preserve of the ginning companies. Furthermore, fuzzy cottonseed attracts VAT. All these aspects affect the full development of the by-products. However, with regard to prospects of development, the association indicated that there is high demand for edible oil in the country. Furthermore, there is already developed infrastructure at ginnery and crushers' level which can support cotton by-product development.

6. Conclusion and recommendations

6.1 Conclusion

Stakeholders in the cotton sector understand the economic potential of the cotton by-product sector, as well as the opportunities for its development. There is a thriving local market for cottonseed oil and cake, especially after the entry into the sector of the large oil crusher Mount Meru in 2007. Nevertheless, more needs to be done to realize the full development potential of the cotton by-product value chain in Zambia.

In particular, policy support is needed to allow the local edible oil industry to develop, without being undercut by cheap imports, especially palm oil. Many policy instruments already exist, but are not adequately enforced.

Low productivity and production of seed cotton, due mainly to low adoption among farmers of recommended agronomic practices, is a serious challenge that deters investment in the sector. For example, some ginners find it uneconomical to run oil expression plants alongside their gins due to an insufficient supply of cottonseed. Despite the stockfeed industry utilizing cottonseed cake in feed production, the small quantities available on the market mean that it is not one of the industry's primary feedstocks.

Unstable cotton prices have discouraged farmers from committing to growing cotton year after year, to say nothing of expanding their hectareage under cotton. As a result, farmers tend to switch to competing crops, such as soybean, undermining the consistency of seed cotton production in Zambia.

The fuzzy seed cotton by-product value chain has been mainly a preserve of the ginners and mostly end at edible oil expression and yet there are a number of products that can be produced beyond edible oil. The initiative of supporting smallholder farmers in toll ginning by CAZ under the MFCGP has shown potential to attract more farmers to grow cotton and has opened opportunities for farmers to increase their incomes by adding value to their cotton.

6.2 Recommendations

Policy

The local cotton by-product sector needs policy instruments that are aimed at making the sector more competitive despite the importation of cheap by-products. Tax exemption, especially a VAT exemption on cottonseed may help revamp the development of the cotton by-products sector and make it more competitive against the competing imported products.

Development and effecting tax incentives for cotton production inputs (pesticides, foliar fertilisers, equipment and many other inputs) would also play a critical role in lowering the cost of cotton production and attract more investment by the ginning industry into the sector. Therefore, it is recommended that tax incentives should not only focus on outputs but also on cotton production inputs.

Market incentives for cotton are lacking. For example, the price of seed cotton is volatile and, transmitted to farmers, causes them to vary their hectareage under cotton or some cases just switch to

competing crops such as soybeans. The Government, in collaboration with ginners, need to establish a cotton price stabilisation fund to ensure farmers receive an economical price for their cotton and avoid them incurring losses. This may revamp production of cotton and hence support sustainable production of the crop.

Meanwhile, the Government has realized that it cannot ban outright the importation of cheap substitutes of cotton by-products, as many Zambians rely on these affordable products. Nevertheless, the Government has a responsibility to apply an appropriate duty on such imported products, to level the playing field for local products. Policy enforcement is critical to ensure that the local industry can compete and develop.

Government facilitation is key in the cotton by-products development. There is need to advocate for the “Let’s consume Zambian” advocacy to try and stimulate demand for local products, for example through a requirement to buy local products, e.g. cottonseed oil or cake, before allowing imports.

It is also proposed that Government and key stakeholders needs to support the development of cooperatives as a model of engaging farmers in input, extension service and market provision. Organization of farmers by CAZ into cooperatives where they even own a ginnery (e.g. Mumbwa Farmers Ginnery and Pressing Company) should be supported and scaled up as that has shown greater potential for multi-stakeholder participation in the cotton by-products value chain including the smallholder farmers.

Technical considerations

Farmer training in recommended cotton production agronomic practices is key to improving productivity and production of cotton. The ginning industry needs to invest more in cotton extension services as they are a key beneficiary of the cotton industry. This could be achieved through the recruitment of qualified extension workers specifically focusing on cotton agronomy as well as pest and disease management. Currently, the extension services under the Ministry of Agriculture in Zambia put little emphasis, if any, on cotton extension services.

Soil fertility practices and Climate Smart Agriculture practices such as minimum tillage, crop rotation, manure application, use of improved seed, should be enhanced in cotton production and make sure they are emphasized in the current extension services. Furthermore, there is need to promote the use of fertilizer and other sources of fertilizer in order to enhance productivity in cotton production.

Development of varieties that are resilient to climate change and have high oil content should be a high priority for breeders in the cotton sector, as this directly impacts on the development of the cotton by-products. The oil content for the current varieties is low, thereby undermining the profitability of the fuzzy cottonseed business.

Finally, there is need to improve access to small-scale and medium scale cottonseed processing machinery at community level in order to motivate more farmers to actively engage in cotton production as potentially this is a more lucrative venture.

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Appendix 1. Cotton value chain diagram for Zambia

